JIMMA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

JIMMA INSTITUTE OF TECHNOLOGY

SCHOOL OF CIVIL AND ENVIROMENTAL ENGINEERING

CONSTRUCTION ENGINEERING AND MANAGEMENT CHAIR

ASSESSMENT OF CONSTRUCTION MATERIALS MANAGEMENT PRACTICE ON BUILDING CONSTRUCTION PROJECT SITES IN JIMMA TOWN

A Thesis Submitted to School of Graduate Studies of Jimma University, Institute of Technology in Partial Fulfillment of the Requirements for the Degree of Masters of Science in Civil Engineering (Construction Engineering and Management)

By: Asmare Molla

January 2016

Jimma, Ethiopia

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By: Asmare Molla

Main Advisor: Dr. - Ing. Fekadu Fufa (PhD)

Co-Advisor: Mr.Getachew Kebede (MS.c)

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Declaration

I, the undersigned, declare that this thesis entitled "Assessment of Construction Materials Management practice on Building Construction Project sites in Jimma town" is my original work, and has not been presented by any other person for an award of a degree in this or any other University.

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Date of submission: January 2016

Place: Jimma, Ethiopia

Acknowledgment

With the help of Almighty God and peoples around me this thesis paper comes to an end.

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Collecting data from different building construction project sites and communicating with different contractors, consultants, clients and other professionals specially for those respondents who postpone the day of collecting paper were a challenging tasks for me. So, I wish to express my gratitude to BEKTER CONSULTING ENGINEERS PLC that supports me in the process of data collection by giving travelling service which was driven by Resom Asefa.

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Abstract

Construction Material management is a function that significantly contributes to the success of a project in the construction industry.

There are many issues which contribute to poor construction materials management in construction projects such as wastage of construction materials, transport difficulties, improper handling on site, misuse of the specification, lack of a proper work plan, inappropriate materials delivery and excessive paperwork etc. This research considers the management practice of construction materials on building construction project sites. The study of this research was analyzed using descriptive statics including mean index score method and frequency analysis and the principal tool used for collection of data is questionnaires for field survey, interview and site observation to make the study strong. The identified major problems such as weather conditions, management of surplus materials and slow response from company to site about submittals, major wastages, such as design change, lack of proper work planning and scheduling and in adequate supervision in usage of materials, major effective measurements such as training people on how to reduce waste, usage of packaging in an efficient way and getting samples for materials approved.The result also indicated that some ICT activities such as Progress Reports and Project Drawings, ICT applications such as Spreadsheets, Presentations and ICT softwares such as AutoCAD and Eagle point, were identified as the major computer activities, ICT applications and Softwares respectively. Generally the study conclude that , major activities on construction materials management which is Problems related with construction material management, Wastage in building construction project sites, measures for effective on construction material management and usage of ICT tools and applications were identified. Finally the study of this research recommend that Contractors, consultants, clients and other professionals working in the construction industry should increase their resource commitment to staff training and development in construction materials management so as to develop the necessary skills, update their knowledge, and enhance new product development for the reduction of problems and wastages as well as to increase efficiency of ICT to working with.

Keywords: *Construction materials Management, construction Materials wastage and Problems, measures for effectiveness and usage of ICT in the construction industry..*

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Acronyms

CII	Construction Industry Institute
JiT	Jimma Institute of Technology
JU	Jimma University
ICT	Information Communication Technology
PMS	Project Management System
RFI	Request for information,
RFI	Radio frequency Identification
STD	Standard Deviation
SPSS	Software packages for socials sciences
SST	Site surveillance Technologies

CHAPTER ONE
INTRODUCTION

1.1. Back Ground and Justification

Successful completion of projects requires all resources to be effectively managed. Considering that for a typical construction project, total cost for engineering design is much less than total cost for equipment and construction materials and labor cost, it is obvious that almost half of project cost consists of construction materials cost. According to Khypmesh (2011), 30% to 70% of project cost is consumed by construction materials with about 30% to 40% of labor. Hence, it is clearly important to manage all construction materials from design to construction stage in every project. Construction Material management is a function that significantly contributes to the success of a project in the construction industry. As projects grow in scale and complexity, construction material management is required really to use them. It is also the process that coordinates planning, assessing the requirement sourcing, purchasing, transporting, receiving and inspection, storing, handling and controlling of construction materials, minimizing the wastage and optimizing the profitability by reducing cost of construction materials. The goal of construction material management is to ensure that construction materials are available at their point of use when needed and the right quantity and quality of construction materials are appropriately selected, purchased, delivered, and handled on site in a timely manner and at a reasonable cost. Indeed, the management of construction materials would cause a huge effect on the total project cost, time and quality. Construction material management should be considered in construction projects as a vital management to achieve better productivity and profit, which should be translated into cost reduction and successful completion with best quality. It is surely that construction material management practices could increase efficiency in operations and reduce overall costs. Hence, special attention has to be given in construction material management to obtain the successful completion of every project operation without difficulty (Mandalay, May , 2014).

Thus construction materials management in building construction project site is an important element in project management. Poor construction materials management can result in increased costs during construction. Efficient management of construction materials can result in substantial savings in project costs. If construction materials are purchased too early, capital may be held up and interest charges incurred on the excess inventory of construction materials. Construction Materials may deteriorate during storage or get stolen unless special

care is taken. Delays and extras expenses may be incurred if construction materials required for particular activities are unavailable. Ensuring a timely flow of construction materials is an important concern of construction material management. For effectively managing and controlling construction materials, the performance of construction materials management should be measured. A performance measure calculates the effective working of a function. These performance measures may differ from system to system. The measures divide the construction materials management system in parts and make the working of the system more efficient. When joined, the measures make the complete construction materials management system (Student , 2011).

1.2. Statement of the Problem

An important problem that adversely affects the performance of construction projects is the improper handling of construction materials during site activities. The inappropriate handling and management of construction materials on construction sites has the potential to severely hamper project performance. There are major issues which affect construction materials management activities such as constraints on storage areas, site logistics with regards to materials handling and distribution, and also ordering and delivery of materials to the construction site. There are many issues which contribute to poor construction materials management in construction projects. Zakeri et.al (1996) suggested that waste, transport difficulties, improper handling on site, misuse of the specification, lack of a proper work plan, inappropriate materials delivery and excessive paperwork all adversely affect construction materials management. Shortage of materials contributes to the cause of delay in managing construction materials in the construction site (Mansfield et.al, 1994; Ogunlana et.al, 1996; Abdul-Rahman et.al; 2006; Aibinu and Odeyinka, 2006). Construction materials management is an important function for improving productivity in construction projects. The management of construction materials should be considered at all the phases of the construction process and throughout the construction and production periods. This is because poor construction materials management can often affect the overall construction time, quality and budget. Bell and Stukhart (1986) stated that it is important for planning and controlling of construction materials to ensure that the right quality and quantity of construction materials and installed equipment are appropriately specified in a timely manner, obtained at a reasonable cost, and are available when needed. (Kasim , 2008).

The scope of the research was focused on constraints due to construction materials management on building construction projects sites. Many construction projects apply

manual methods, not only for the tracking of construction materials, but also for construction materials management as a whole and this involves paper-based techniques and is problematic with many human errors. In Jimma town there are many building construction projects which are constructed by different contractors, and owners within the supervision of consultants. There are major issues which affect construction materials management activities such as early purchase, transportation problems, constraints on storage areas, site logistics with regards to materials handling and distribution, construction wastages and also ordering and delivery of materials to the construction site which causes delay in construction. This paper described the main results of survey carried out in Jimma town that assessed the construction material management practice on building construction projects sites.

In light of the arguments presented above, there was a clear need for the assessment of construction materials management practice and identify the major problems, wastages, measures for effectiveness and impact of computerization on building construction project sites that would allow to take remedial measures to minimize the improper construction materials management on building construction projects in the town.

1.3. Research Questions

The study of this research was examined the following research questions

1. What are the construction material management problems and wastage on building construction project sites?
2. What are the elements of good practice in construction materials management on building construction project sites?
3. Which ICT systems are used in the construction materials management on building construction project sites?

1.4. Expected Outcomes

The findings from the study were identified the following outcomes which will be discuss in chapter four, result analysis and discussion.

- Construction material management problems and wastages on building construction project sites were identified.
- The elements of good practice in construction materials management on building construction project sites were identified.

- The usages of ICT on construction materials management on building construction project sites were assessed.

1.5. Objectives of the study

1.5.1. General Objectives

The aim of this research is to assess construction material management and usage of ICT in construction materials management on building construction project sites in Jimma town.

1.5.2. Specific Objectives

The specific objectives of this study are the following;

1. To identify construction material management problems and wastage on building construction project sites.

2. To identify elements of good practice in construction materials management on building construction project sites.

3. To assess the usage of ICT in construction materials management on building construction project sites.

1.6. Significance of the Study

The improper management of construction materials during site activities is one of the major causes of wastage and problems in the schedule and change on budget. These problems may lead to the failure of the project and loss of money in construction industry.

It is observed that construction materials are less homogeneous, less standardized, and more numerous than those of manufacturing, and that the characteristics of demand are different. There should be awareness about construction material planning & scheduling at every stage of construction material management.

Therefore, the paper is supportive for contractors, consultants, clients and other civil engineer professionals by bountiful information on management of construction materials and it also gives baseline information for other researchers who want to conduct study on the related area.

1.7. Scope of the study

The study of this research covers all building construction project sites which are under construction in Jimma town. In this study participating respondents (contractors, consultants, clients and other civil engineer professionals) were included by different mechanisms like questionnaire, interview and site observation.

1.8. Limitations of the study

In the study, only management of construction materials were assessed and not all respondents in each building construction project were directly participated (by questionnaire, interview, and open their site for observation) because of limiting factors like budget and time. So, only actively participating respondents from each building construction project sites like project engineers, site and office engineers and construction Forman were included.

CHAPTER TWO

LITERATURE REVIEW

2.1. Management of Construction Materials

Construction Materials management is an important function in order to improve productivity in construction projects. According to Bell and Stukhart (1986) materials management functions include "material requirement planning and material take off, vendor evaluation and selection, purchasing, expenditure, shipping, material receiving, warehousing and inventory, and material distribution"(Kasim , 2008)

According to (Kasim, 2008), an essential factor adversely affecting the performance of construction projects is the improper management of materials during site activities (Gulghane1 , 2015). Material is the main component in any of the construction projects. Therefore, if the material management in construction projects is not managed properly it will create a major project cost variance. The total cost of the project can be well controlled by taking corrective actions towards the cost variance occur in the project (Madhavi et al. 2013; Veronika et.al. 2006). Studies by the Construction Industry Institute (CII) have shown that materials and installed equipment can make up 50–60% of the total project cost and impact 80% of its schedule (Caldas et al. 2014). During the last few years, enormous growth in infrastructure has been found, by wide range of diversity construction organization (Desale et.al. 2013). Fundamental principles of site material management enlighten the factors considered during site layout and planning for efficient material management. Ineffective material management practices are evident on many projects and cause considerable waste in time and money (Randolph et al. 2005; Keitany et al. 2014).For managing a productive and cost efficient site efficient material management is very essential. The materials management system in any project insure that the right quality of material and quantity of materials are appropriately selected, effectively purchased, properly delivered and safely handled on site in a timely manner and at a proper reasonable cost (Kanimozhi et.al, 2014 ; Donyavi et.al. 2009). Any organizations need to put their effects for proper materials management techniques for the effectiveness of project execution (Gulghane1, 2015).

Material management involves storage, identification and retrieval, transport, and construction methods. Each of above is indelibly linked to ensure safety, productivity, and schedule performance. According to Kini (1999), materials management is an indispensable part of the project management which can be integrated with engineering to provide an end

product that meets the client's requirements and is cost effective. Over the years, materials management in any construction project has become a critical component of successful project execution (Caldas et.al, 2014; Georgekutty et.al, 2012). There should be a centralized material management team co-ordination between the site and the organization so that effective material management strategies can be applied and monitored.

Construction materials management may present similarities at the conceptual level but the implementation details vary. Material planning considers materials in the order of requirement at site (Desale et.al, 2013). Material procurement and storage on construction sites need to be properly planned and executed to avoid the negative impacts of material shortage or excessive material inventory on-site deficiencies in the supply and flow of construction material were often cited as major causes of productivity degradation and financial losses (Kanimozhi et.al, 2014). It is observed that construction materials are less homogeneous, less standardized, and more numerous than those of manufacturing, and that the characteristics of demand are different. There should be awareness about material planning & scheduling at every stage of material management (Patil et.al, 2013).

This is concerned with the planning and controlling process to ensure that the right quality and quantity of materials and installed equipment are appropriately specified in a timely manner, obtained at reasonable cost and are available when needed. Materials management involves the logistics of the materials components of a supply chain which involves the process of planning, implementing and controlling of the movement and storage of raw materials, work-in-process inventory, and finished goods from point-of-origin to point-of consumption. The management of materials should be considered from the phases of the construction process and throughout the construction period. Generally, construction materials are bulky, expensive and are supplied in large amounts to construction sites. Therefore, there is a need for an excellent management system for handling materials.

Ballot (1971), defines material management as the process of planning, acquiring, storing, moving, and controlling materials to effectively use facilities, personnel, resources and capital (Haddad, 2006).

Tersine and Campbell (1977), define material management as the process to provide the right materials at the right place at the right time in order to maintain a desired level of production at minimum cost. The purpose of material management is to control the flow of materials effectively.

Beekman-Love (1978), states that a material management structure should be organized in such a way that it allows for integral planning and coordination of the flow of materials, in order to use the resources in an optimal way and to minimize costs (Haddad, 2006).

Materials management is a process for planning, executing and controlling field and office activities in construction. The goal of materials management is to insure that construction materials are available at their point of use when needed. The materials management system attempts to insure that the right quality and quantity of materials are appropriately selected, purchased, delivered, and handled onsite in a timely manner and at a reasonable cost. Materials management is the system for planning and controlling all of the efforts necessary to ensure that the correct quality and quantity of materials and equipment are properly specified in a timely manner, are obtained at a reasonable cost, and, most importantly, are available at the point of use when required (ASAD, 2005).

An extensive study of the literature survey revealed that projects are implementing without a specific method in construction material procurement and storage. It is usually done by approximation based on the project estimate. As a result the procurement cost and storage cost is high, which leads to huge overheads in projects. The literature study leads to a conclusion that construction projects will suffer slippages at the beginning to every stages of its implementation and finally project loss is the net result. The major area of loss is identified in procurement and carrying of construction materials. A new approach has suggested through this paper. This can be adopted as a general method to other projects (Georgekutty, (July-Aug 2012)).

2.2. Management of Construction Tools

Construction Materials and tool management are a large part of any construction project. In more recent years, construction firms have allocated more focus on retaining small tools, which in the past were perceived as "disposable". Numerous technological advances have been made that enable tool tracking to be more efficient. Barcodes and scanners are one of the most common techniques used to track tools today. The problem with implementing this system is the complexity of the process. In the past the tools were just replaced, one simple step. The barcode system requires labeling, tracking, cataloguing, filing, and coordinating a multitude of tools. The process is much more demanding (Kuykendall, 2007).

2.3. Factors Related With Construction Material Management

There are several factors within the scope of construction material management and each of these factors can give rise to potential problems. The more factors are divided, the more potential problems that exist. There are many factors which contribute to poor construction material management in construction projects. Zakeri et al (1996), suggested that factors such as waste, transport difficulties, improper handling on site, misuse of the specifications, and lack of proper work plan, inappropriate material delivery and excessive paperwork all adversely affect on construction material management (Phu1, 2014). Factors related with construction material management can be mostly found in the following areas in the construction projects.

A. Planning and Scheduling
B. Monitoring and Controlling
C. Organization and Personnel
D. Procurement
E. Delivery
F. Storage and Storage facilities
G. Usage
H. Surplus and Waste control

A. Planning and Scheduling

Planning is a fundamental, important process for every project. Construction Material planning, which is a key function of construction material management, is closely linked with project planning and control set-up. Scheduling the entire construction material program is essential to meeting the project timetable. Indeed, planning and scheduling are significant in terms of increasing productivity, profit and facilitating the timely completion of construction projects.

The need for an effective construction materials planning system becomes mandatory. Some companies have increased the efficiency of their activities in order to remain competitive and secure future work. Many other firms have reduced overheads and undertaken productivity improvement strategies. Considerable improvement and cost savings would seem possible through enhanced construction materials management. Timely availability of construction materials and systems are vital to successful construction. Construction materials management functions are often performed on a fragmented basis with minimal

communication and no clearly established responsibilities assigned to the owner, engineer or contractor.

B. Monitoring and Controlling

Monitoring and Controlling of all construction activities in construction material management are conducted to ensure the right source of construction materials with the exact quality, at the right time and place suitable for minimum cost construction process. It is a process in which facilities, personnel, resources and capital are monitored and controlled to a significant impact on the operations of construction projects.

C. Organization and Personnel

Construction material management structure is organized in such a way that it allows for integral planning and coordination of the flow of construction materials, in order to use the resources in an optimal way and to minimize costs. The organization must be structured to provide for the timely performance of the work, with construction material personnel located at appropriate level of project management and influence the decision making process.

D. Procurement

Preliminary investigations for developing sources for procurement of construction materials are made by floating enquiry indents. It is processed by the construction material procurement responsible personnel for inviting quotations with samples of construction materials where applicable.

E. Delivery

Delivery in terms of organizing the movement of vehicles, people and construction materials ensures the efficient use of workforce and production or process in construction projects. The routing of construction materials is one of the main causes which affect cost and time during construction.

F. Storage and Storage facilities

Construction material storage can be defined as the provision of adequate space, protection and control of building materials and components held on site during the construction process. A good and systematic storage of construction materials provides better management of construction materials in construction industry.

G. Usage

Usage of construction materials is the flow component that provides for their movement and placement. Construction Material usage can be Surplus and Waste Control.

All projects can expect a certain amount of surplus and waste of construction materials after construction. Surplus and waste construction materials arise at any stage of construction

process from inception, right through design, construction and operation of the building facility. Hence, control of surplus and waste construction materials is important to successful construction material management.

Stock control is classified as a technique devised to cover and ensure all items are available when required. Stock control can include raw construction materials, processed construction materials, components for assembly, consumable stores, general stores, maintenance construction materials and spares, work in progress and finished products. It is of great importance that the bulk of construction materials delivery requires proper management of stock control. Meanwhile, construction activities can generate an enormous amount of waste and construction materials waste has been recognized as a major problem in the construction industry. However, tighter construction materials planning can reduce waste and can directly contribute to profit-improvement and productivity. Each processes stated above plays an important role for an effective construction materials management. However, there are construction materials management issues that have not yet been tackled effectively. Section 2.6 will highlight on the current construction materials management problem faced in the construction industry (Maniammai, 2014).

2.4. Importance of construction materials for a project

Problems related to managing the flow of construction materials can be found in every organization. The efficient management of construction materials plays a key role in the successful completion of a project. The control of materials is a very important and vital subject for every company and should be handled effectively for the successful completion of a project. Construction materials account for a big part of products and project costs. The cost represented by construction materials fluctuates and may comprise between 50-70% of the total project cost and sometimes more.

Construction Materials are critical in the operations in every industry since unavailability of construction materials can stop production. In addition, unavailability of construction materials when needed can affect productivity, cause delays and possible suspension of activities until the required construction material is available. Unavailability of construction materials is not the only aspect that can cause problems. Excessive quantities of construction materials could also create serious problems to managers. Storage of construction materials can increase the costs of production and the total cost of any project. When there are limited areas available for storage, the managers have to find other alternatives to store the construction materials until they are needed. Some of these alternatives might require re-

handling of construction materials, which will increase the costs associated with them. Provisions should be taken to handle and store the construction materials adequately when they are received. Special attention should be given to the flow of construction materials once they are procured from suppliers (Kass, 2012).

2.5. Control of construction Materials

According to (Cheng Hu), Construction Materials (including raw materials, finished products, semi-finished products, components and parts) are construction material conditions of construction, and construction material quality is one of necessary conditions to ensure construction quality (Ying, 2010). Main contents of quality control of construction materials:

(1) Construction Material procurement

The contractor should purchase construction materials based on the integrated consideration of engineering characteristics, construction contracts, and the scope of application, construction requirements, the performance and price of construction materials. The procurement should be arranged in advance according to the construction schedule. Project manager department or enterprises should establish common information of construction material suppliers and track the market timely. If necessary, construction material sample or field trip is required, and the strict instruction of quality items in construction material procurement contracts should be paid attention.

(2) Construction Material testing

Through a series of detection methods, the construction material data obtained is compared with quality standards, to judge the reliability of quality construction materials, and whether they can be used for engineering. Sampling inspection is commonly used method.

2.6. Construction Materials Management Problems

There are many issues which contribute to poor construction materials management in construction projects. Zakeri et.al (1996), suggested that waste, transport difficulties, improper handling on site, misuse of the specification, lack of a proper work plan, inappropriate materials delivery and excessive paperwork all adversely affect construction materials management. Shortage of construction materials contributes to the cause of delay in managing construction materials in the construction site (Mansfield et.al 1994; Ogunlana et. al, 1996; Rahman et.al 2006; Aibinu and Odeyinka, 2006). Late delivery of ordered construction materials is also problematic in construction materials management. Furthermore, Dey (2001), noted that the common issues relating to construction materials management are as follows;

- Receiving construction materials before they are required, causing more inventory cost and chances of deterioration in quality;
- Not receiving construction materials at the time of requirement, causing loss of productivity;
- Incorrect construction materials take-off from drawings and design documents;
- Subsequent design changes;
- Damage/loss of items;
- Selection of type of contract for specific construction materials procurement;
- Vendor evaluation criteria;
- Piling up of inventory and controlling of the same; and
- Management of surplus construction materials.

The traditional construction methods apply paper-based work during the construction process. This can produce excessive paperwork and contributes poor construction materials management in construction projects (Zakeri et.al, 1996). There is also give problematic, effort-prone and inefficient in the recording and exchanging information of construction materials component within a supply chain.

The implementation of ICT can help the management of construction activities to become more effective and faster. The emergence of ICT systems could transform conventional methods and improve construction materials management. The use of ICT has also increased with new software related to the construction industry and can support the effective management of construction materials practices. Therefore, the ICT-enabled solution could help in order to overcome the problems. For example, improving construction materials supply management through an intelligent system to facilitate bidding, requisition and ordering of materials. The following sections will highlight about ICT and its application in the construction industry.

2.7. Use of Information Communication Technology (ICT) in the construction projects.

2.7.1 General

There are many millions of documents (such as drawings, specifications, bills of quantities, correspondence, schedules, programmes) currently exchanged on paper between practitioners in the construction industry. It is common place that each of these documents are subsequently re-keyed, photocopied and filed, as they pass between different locations and computer applications (Hore1, 2006).

At present the extent of use of Information Communication Technology (ICT) in the construction industry is relatively unsophisticated, mainly dependent on telephone, facsimile

machines and networked personal computers. At the simplest level, the electronic transmission of business documents offers savings in paper and postage. By going a step further, businesses can make strides in communicating with their partners, at relatively low cost, through direct links between their computers.

2.7.2. Opportunities for Electronic Support in Construction Projects.

Construction sectors in many countries around the world are increasingly recognising the importance of ICT. ICT is improving the capability and efficiency of specific aspects within the construction process. ICT should support the entire construction process from inception through to the operational maintenance of the building asset. The idea of a project model that supports improved co-ordination and management of information throughout the project life cycle is gained increased recognition (Hosseini, 2012).

2.7.3. Information and communication requirements in construction Projects

According to (Murray *et al.*, 2001), the construction sector is considered one of the most information-dependent industries. For instance, a construction project chain may involve large numbers of skilled professionals and companies with, quite often, much repetition of activities and accumulation of paperwork. Majority of these participants require access to the regular project information at one time or another (Sekou, 2012).

This means that, timely and accurate access to information is therefore important for all project participants as it forms the basis on which decisions are made and physical progress is achieved. Currently, several construction documents such as drawings, specifications, bills of quantities, correspondence, schedules, and programmes produced on construction projects are currently exchanged on paper bases and face to face communication between practitioners in industry (West, 2008).

Admittedly, effective collaboration between all the role players during construction is not only important but also necessary for the successful completion of a construction project. With so many interested parties, effective communication and information sharing among them is vital. Not only must the formal structures and networks be examined to understand the level of information sharing that is happening on a formal basis, but the informal relationships among parties will depend on how and when information is shared and how and when information is flowing.

2.7.4. Need for ICT in the construction Projects

According to, Hassanain et al, 2000, the implementation of these ICT technologies in construction are aimed at supporting information sharing among individuals and groups since the construction industry of today and of the future demand the use of sustainable systems

enabled by information and communication technologies. Currently, Information and Communication Technologies (ICT) are said to be providing construction firms with new opportunities for enhancing information management processes, communication and collaboration.

According to Songer (2000), owner organizations are requiring the engineering/construction industry to perform at extraordinary levels of project delivery, hence, advances in project delivery systems and use of information technologies provide tremendous potential for enhancing the construction industry's overall performance.

2.7.5. Role of ICT in the construction process

According to (Peansupap, 2004), the benefits offered by ICT on construction project are well documented in literature. This include among others improved access to richer information to aid decision making, quicker information, improved information flow, greater management control and getting geographically dispersed group to work together.

The roles of implementing ICT are highlighted in the following stages of the construction process.

1. Tender stage

According to (COBRA, 2009; Çaglar, 2005; Björk, 2002), the main functions of ICT usage at this stage are to advertise and distribute tender documents, select successful Tenderers and award contracts. Software used in the stage can:

- Speed up the distribution of documentation and Tenderers‟ communications;
- Register Tenderers online and download tenders/work packages electronically;
- Provide a simple environment to evaluate the Tenderers‟ responses through standard templates;
- Prevent unauthorized access through built in security mechanisms;
- Communicate changes in the tender documents, during the tender process, quickly and easily.

2. Design and construction stage

According to (cowel, 2005), both design and production of construction projects share a need for rapid access to information and communication in real time. Improving information and communication support for the core activities at the design and construction stage has become a strategic challenge for the construction industry to increase efficiency and productivity in the construction process (Samuelson, 2003).

Project managers and contractors control and manage the exchange of documents between members of the project team so that the overall deadlines of the project are met (Business Market Watch, 2005).

It is essential that each team member receives the right documents at the right time such as the latest version of drawings, specifications requirements among others. ICT softwares are used at this stage to:

- Improve efficiency of work
- Reduce the risk of errors and rework by ensuring that everyone in the project team is working with the most current drawings and other documents;
- Save time in the query (request for information, RFI) and approval process, by allowing the design team to mark up and comment on drawings online;
- Eliminate the risk of losing important files, by maintaining all current and past versions in one central location;
- Improve team communication by enabling team members to raise and respond to queries in a structured way;
- Maintain a complete log of all communications for tracking purposes (audit trail facility);
- Provide clients and other participants with a view of the project as it is built; as some software have incorporated virtual reality models to denote the status of a project at any point in time (a snap shot view of a project);
- Provide a collaborative environment whereby the diverse participants can perform online collaboration via the web.
- The real exchange of information takes place via other, informal channels, where other forms of information and communication technology such as e-mail, SMS messaging and mobile telephones, which enable direct contacts between project members in network-like cooperation.

3. Trading (e-commerce)

According to (Woksepp and Olofsson, 2007; e-Business Market Watch, 2005), purchasing of construction materials is a lengthy and complex process, which requires the identification of considerable resources and potential suppliers as well as the evaluation of quotes, which are normally received in different formats. Web-enabled Software used in this stage can:

- Save time in the procurement of construction materials by automating document distribution and communications (E-procurement);
- Reduce the administrative costs of document handling and distribution to multiple parties;
- Reduce errors due to effective communication;
- Ensure ease of comparison and evaluation of bids.
- Despite these significant roles, studies indicate that the ICT utilization ratio is still relatively low in the construction industry.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Study area and period

The study was conducted in Jimma Town which is one of the 17 zones in the Oromia Regional State, from July to December 2015. Jimma town is located in Oromia National Regional State, in Jimma zone, Jimma Woreda at a distance 346 Km from Addis Ababa. Its astronomical location is 7º 4’ North Latitude and 36º 5’ East Longitude.

Jimma town was founded in 1837 which is one of the reform towns in the region and has a city administration, municipality and 13 kebeles. The town has a structure plan prepared in 2009 with estimated population of about 207,573.

In the Town, different infrastructures such as building construction, road constructions, water supply and drainage expansions and stadium constructions are carried out including Jimma University. There for the research was conducted on Building construction projects found in the Town.

3.2 Study design

The study was conducted using descriptive statics (design to determine the characteristics of a population or phenomenon to be studied).

3.3. Population

The populations for this research were all ongoing building construction project sites in Jimma Town and the main sources of the information were contractors, consultants, clients and other civil engineer professionals.

3.4. Sample Size and Sampling Procedures

According to, Chien (2010); citing Naoum (1998), there are two main criteria that need to be taken into account when selecting the research sample. First, what do you want to know? Second, about whom do you want to know it? Following these recommendations, the study adopted purposive sampling technique to select the contractors, consultants, Clients and other civil engineer professionals. This was preferred because purposive sampling allows the researcher to select respondents who have good knowledge about the subject in question. Besides, looking at the nature of building construction industry, the study seeks to solicit information from a section of the population of contractors, consultants, clients and other professionals who have experiences of building construction in Jimma town to know the problems and wastages in construction sites, their effective measures about construction management and the use of ICT for their operations. This resulted in the selection of all ongoing building construction project sites which was constructed by different grade of contractors and supervised by different consultants and owners. Therefore, the respondents to the questionnaires were targeted professionals and managerial level personnel such as managing directors, Project Managers, site and office engineers, Resident engineers, Quantity Surveyors, Forman's, and project owners who are working in building construction projects in jimma town.

3.5. The Sample Size

According to, Israel (1992), several approaches used in determining the sample size for a study. These, include using a census for small populations, imitating a sample size of similar studies, using published tables, and lastly applying formulas to calculate a sample size.

Since the populations were all ongoing building construction projects and there were small populations by using census, a total sample size of 100 was adopted and used for the study (Chien and Barthope, 2010).

Table 3.1: *Sample frame of the respondents*

Respondents	Questionnaires Allowed
Contractors	40
Consultants	35
Clients or owners	15
Other professionals	10
Total	100

3.6. Interview and site observation

Interview and site observation were conducted along with the questionnaire survey from those respondents who are willingness to interview and open their site for site observation.

3.7. Study Variables

Dependent Variable*:* Construction material management in Jimma town.

Independent Variable:

- Problem related factors, wastage related factors, and Effective measurement related factors and ICT related factors.

3.8. Data Collection Process

After a thorough review of relevant literature related to construction materials management practice on building construction projects, questionnaire, interview and site observation were developed.

The design of the research involved the following techniques

- Questionnaire design
- Pilot Questionnaire
- Main Questionnaire administration
- Data Analysis tools

3.8.1 The Questionnaire

Based upon a review of current literature and research objectives, structured questionnaire was prepared and self administered to the various respondents. Almost all the questionnaires have closed-ended questions since the study was assessment for the first time and to ensure consistency of respondent feedback. Because it is not entirely possible to design all questions

as closed-ended, some questions were left open-ended, to obtain numerical data or to request some written comment.

For the purpose of the study, the questions were grouped under four main sections.

(1) General Information, **(2)** Major activities on construction materials managements on building construction project sites, **(3)** Impact of ICT usage and its application and**(4)** Factors hindering ICT usage.

The General Information dealt with the demographics with respect to firms, professional background of respondents, and years of experience in building construction, organizational categories, positions of respondents and general views on ICT system. This aspect was deemed necessary in order to ascertain the reliability and credibility of the data and as a result, be used to correlate performance and satisfaction with the test system among different groups of users. The second section "Major activities on construction materials managements on building construction project sites" asked more specific questions in relation to objective of this study. This aspect covered activities related to pproblems and Wastages on construction materials management on building construction project sites. It employed the five point type Likert ordinal scale to measure level of usage by responding firms from "Strongly Disagree" to "Strongly Agree" that is, 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree , 5= Strongly Agree.

The third section "Impact or Extent of ICT usage and its application'' inquires about the level of ICT usage by the firms. This is in relation to proportion of tasks and activities carried out digitally or by the computer and usage ICT tools and applications within the building construction firms. It employed the five point type Likert ordinal scale to measure level of usage by responding firms from "Never" to "Always" that is, 1= Never, 2= Not always, 3= Average, 4= Quiet always, 5= Always.

The fourth and the final section "Factors hindering ICT usage" asked responding firms to score identified reasons hindering the use of ICT by contractors, consultants' clients and others in building construction industry. Based on the criteria identified, the Likert rating scale was again adopted to extract the appropriate ratings as per their influence as a reason hindering use of ICT by contractors, consultants' clients and others in building construction industry. Once more, the five point Likert ordinal scale (1-5) was used where1= Very weak, 2= Weak, 3= Average, 4= Strong, 5= Very strong.

3.8.2. Pilot Questionnaire

Before the main survey was undertaken, a draft version of the questionnaire was piloted in two building construction contractors and one building construction consultant starting from august to September 2015 in Jimma town. This pilot study was intended to elicit responses that would help to test the wording of the questionnaire, identify ambiguous questions, extra points that was added and removed and also provide an indication of the time to complete the questionnaire. Some of the comments and suggested amendments from the pilot study respondents were used to amend the questionnaire prior to its final distribution.

3.8.3. Main Questionnaire Administration

The administration of the questionnaire began in 2015 and completed in November, 2015. A period of four weeks was allowed for the administration of the questionnaire; however all the completed questionnaires were retrieved by the four week. A total of 100 questionnaires were administered to the ongoing building construction project site respondents. Forty (40) were targeted at contractors, thirty five (35) were targeted at consultants, fifteen (15) targeted at clients or owners and the remaining ten (10) were targeted at other civil professionals who have experiences related to building construction. A total of 36 respondents from contractors, 30 from consultants, 12 from clients or owners and 9 from other civil professionals representing 87% were retrieved. The total administered questionnaires and the return rate are shown in Table 3:2.

The data obtained from the field survey were analyzed through a five-point Likert-type scale to measure a range of opinions from ‘‘strongly disagree’’ to ‘‘strongly agree’’, from “Never” to “Always” and from “Very weak” to “Very strong” as used in the other studied areas.

Table 3.2: Detail of Questionnaires administered and returned

	No of questionnaires sent to respondents.	No of questionnaires returned.	Response rate (%)
Respondents	100	87	87%

3.9. Data Processing and Analysis

Data collected from the questionnaires were analyzed using three methods from descriptive and inferential statistics. These include Frequency Analysis, Mean/average Index Score and One Sample T-test. In order to generate the result, the researcher used Microsoft Excel and SPSS.

3.9.1. Frequency Analysis

Under frequency analysis, descriptive statistical methods such as tables and charts were used to analyse the responses from the questionnaire.

3.9.2. Mean Index Score

Mean index score was used to generate ranking of the variables of interest based on the scores assigned by the respondents. According to (Egbu and Botterill, 2002; McCaffer and Edum-Fotwe, 2001), the formula is very popular with researchers in the construction management field. The factors are then ranked according to the formula below using Excel

The mean score is calculated as follows.

$$\text{Mean score (I)} = \quad I = \frac{\sum a_i x_i}{\sum x_i} \tag{3.1}$$

Where I=Mean Score, a=Rank of event i and x=frequency of event i

With this formula, the events measured here include: Major Activities on construction materials management related to problems and wastages, measures for effectiveness and levels of usage of ICT softwares, tools and applications on building construction project sites.

3.10. Ethical Consideration

According to Creswell (2003) under ethics of research, the following parts need to be considered.

A. **Research Problem Statement** - During the identification of the research problem, it is important to identify a problem that will benefit individuals being studied.

B. **Statement and Research Questions**- In developing the purpose statement or the central intent and questions for a study, proposal developers need to convey the purpose of the study that will be described to the respondents.

C. **Data Collection**-As researchers anticipate data collection they need to respect the respondents and the sites for research.

Other procedures during data collection involve gaining the permission of individuals in authority (e.g., gatekeepers) to provide access to study respondents at research sites.

- Researchers need to respect research sites so that the sites are left undisturbed after a research study.

- Researchers also need to anticipate the possibility of harmful information being disclosed during the data collection process.

D. **Analysis and Interpretation**-In anticipating a research study, consider the following:

- How the study will protect the anonymity of individuals, roles, and incidents in the project.
- Data once analyzed, need to be kept for a reasonable period of time. This is to protect leakage of information/raw data
- In the interpretation of data, researchers need to provide an accurate account of the information.

Considering the above recommendations and other procedures, formal letter was obtained from JiT Post Graduate and Research Program office and submitted to respondents (contractors, consultants, Clients/owner and other civil engineer professionals who have experiences in building construction projects) for the remaining interviews the formal letters was also be used. Before starting data collection the purpose of the study was explained to all respondents and informed consent was obtained

3.11. Reliability of data

The reliability of an instrument is the degree of consistency (Polit & Hunger 1985) as cited on (Hammad 2013).In order to have accurate finding Creswell (2003) recommends using different data sources. The methods used in this study were from different sources and one data supports the other data. For questionnaire it is essential to check internal reliability of data (Creswell 2003). The less variation an instrument produces in repeated measurements of an attribute, the higher its reliability (Hammad 2013).Cronbach's Coefficient Alpha can be used to check reliability of questionnaire. The normal range of Cronbach's coefficient alpha value between 0.0 and + 1.0, and the higher values reflects a higher degree of internal consistency (Hammad 2013). The equation used to analyze Cronbach's Coefficient Alpha is

$$\alpha = \frac{Kr}{1+(K-1)r} \tag{3.2}$$

Where K is items (variables) in the scale and r is the average of the inter-item correlations For major activities on construction materials managements and ICT level of usage, the value of Cronbach's Coefficient Alpha analyzed using SPSS20 shows the questionnaire is reliable and most are highly reliable.

CHAPTER FOUR

RESULT ANALYSIS AND DISCUSSION

4.1. Introduction

The aim of this research project was to assess construction materials management practice and usage of ICT on building construction project sites in Jimma Town. The rationale for conducting the research was the need for a well defined assessment of construction materials in the management processes. The aim was achieved through the following specific objectives:

1. To identify existing construction material management problems and wastages on building construction project sites.
2. To establish elements of good practice in construction materials management on building construction project sites.
3. To assess the usage of ICT on construction materials management on building construction project sites.

These, the chapter present data analysis and findings from the interview, site observation and survey questionnaire. It begins with descriptive analysis of the demographics variables of participating firms and respondents. This is followed by analysis of problems and wastages related to building construction, measures for effectiveness in construction materials management on building construction project sites, the firms levels of ICT usage. The main statistical methods and tools used were Mean index Score. Data collected from the questionnaires were tabulated and analyzed according to their ranking on mean index score. Charts were created, where appropriate, in support of the descriptive analysis to clarify their status. Again, ratings by respondents on the firms‟ level of ICT usage were also discussed.

4.2. Demographic variables and respondents profiles

A. Respondents Information

With one hundred questionnaires which were administered to the contractors, consultants, clients and other civil engineer professionals, a total of 87 questionnaires were returned constituting 87% response rate. Figure 4.1 shows the breakdown of the number of response received from the selected organizations. From the survey results from Figure 4.1, 36 questionnaires out of 40 were received from contractors, 30 questionnaires out of 35 were received from consultants, 12 questionnaires out of 15 were received from clients or owners and 9 out of 10 were received from other civil engineer professionals constituting 41.4%,

34.5 %, 13.8% and 10.3 % responses respectively from the total questionnaire were sent to respondents.

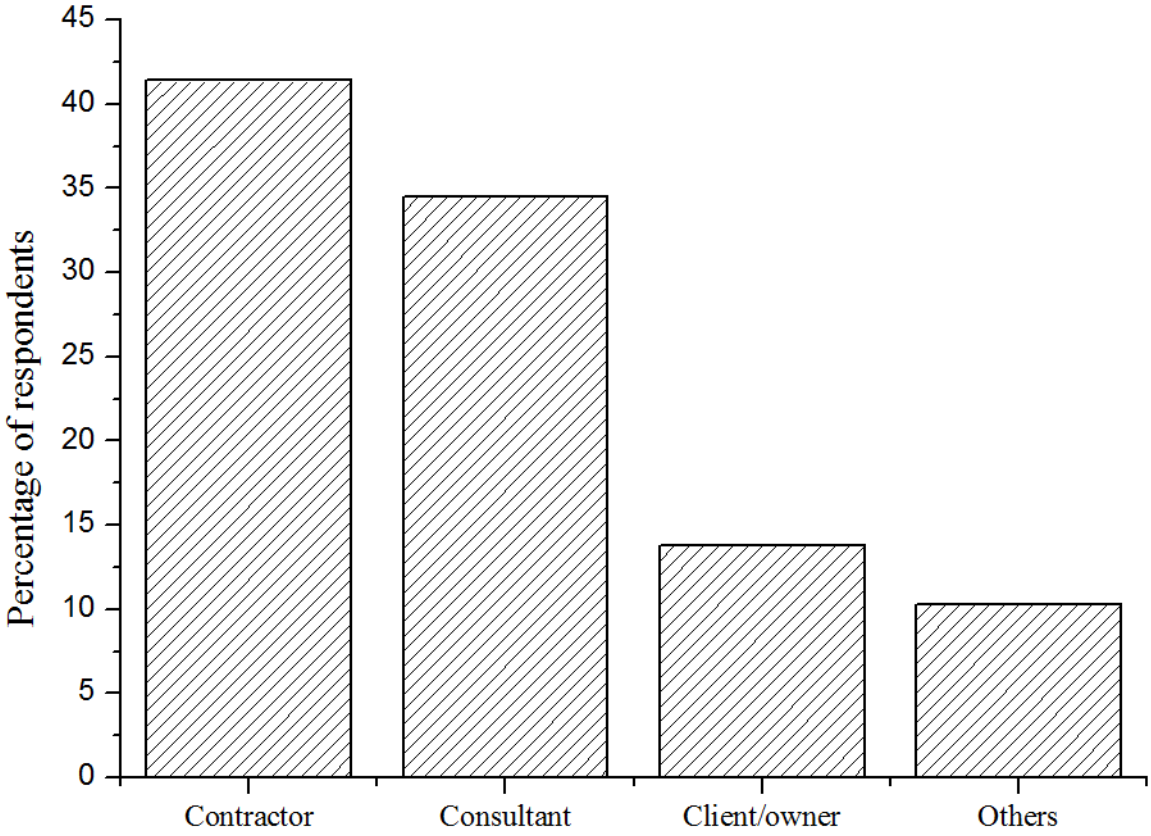

Figure 4. 1: Respondent's information

B. Sex of respondents

Concerning sex and age of respondents, surveyed, figure 4.2, showed that 60 represents male respondents and 27 respondents, female respondents from total of 87 respondents.

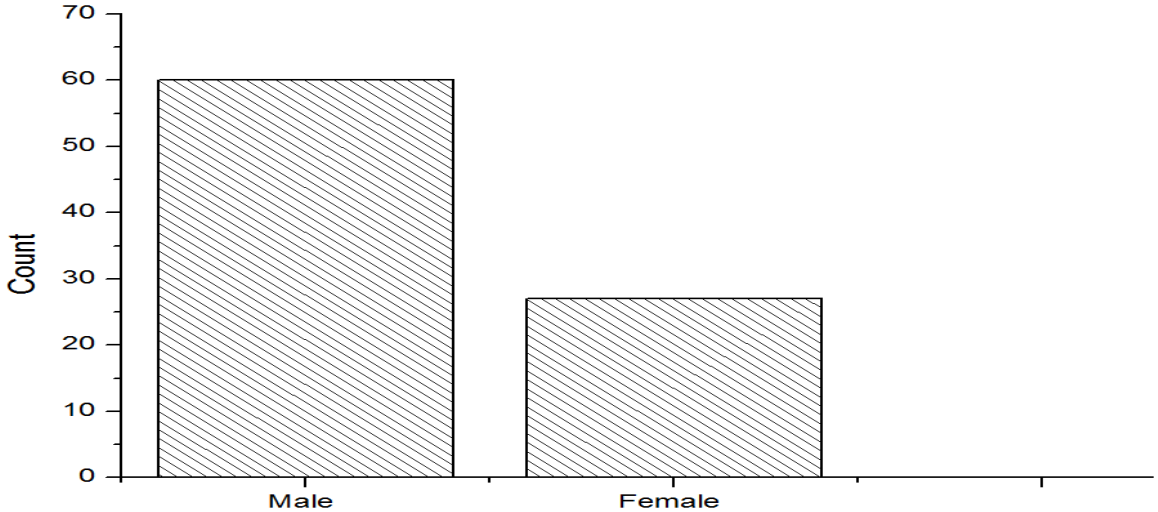

Figure4. 2: Sex of respondents

C.Age of Respondents

According to Figure 4.3, 21 % respondents were under the age range of 18-25 years, 68% under the age range of 26-35 years and 11% under the age range of 36-45 years

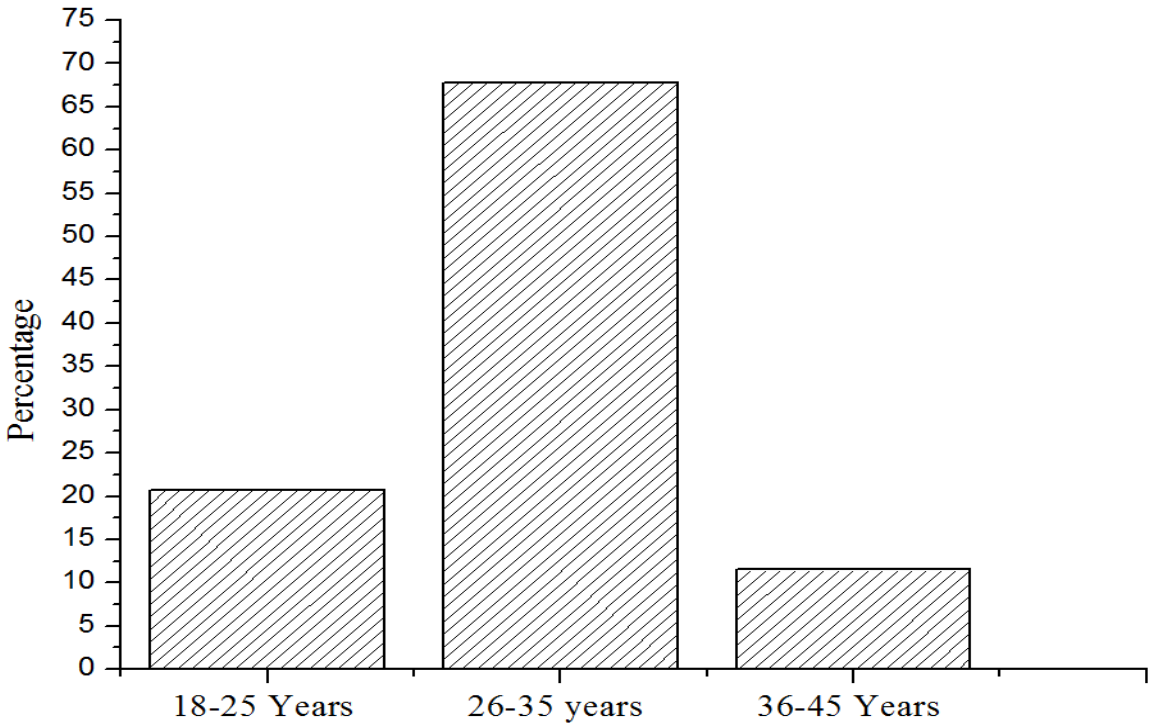

Figure 4. 3: Age of respondents

D.Academic Qualification of Respondents

Concerning professional backgrounds of respondents, Figure 4.4, showed that, academic qualifications of respondents comprised diploma (9.2%), bachelor degree (64.4%), and master degree (26.4%) and there were no qualifications below diploma or above master degree.

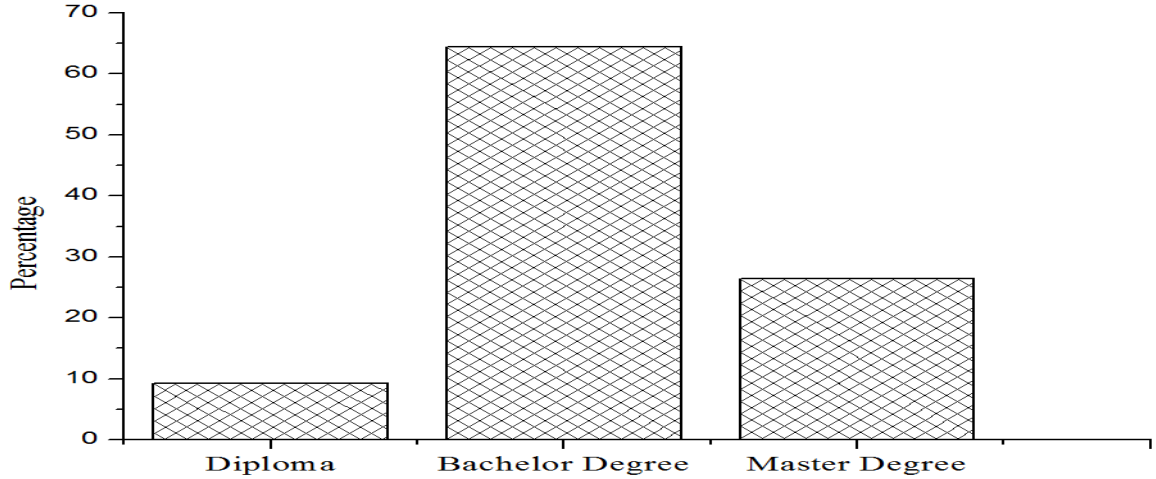

Figure 4. 4: Academic qualification

E. Experience of respondents

Regarding the working experience of the respondents surveyed, Figure.4.5 shows that , majority of the respondents (about 47.1%) had worked in the construction industry less than 5 years, 32.2 % between 6-10 years, and 20.7% between 11-15 years. However, none of the respondents indicated professional experience of over 16 years.

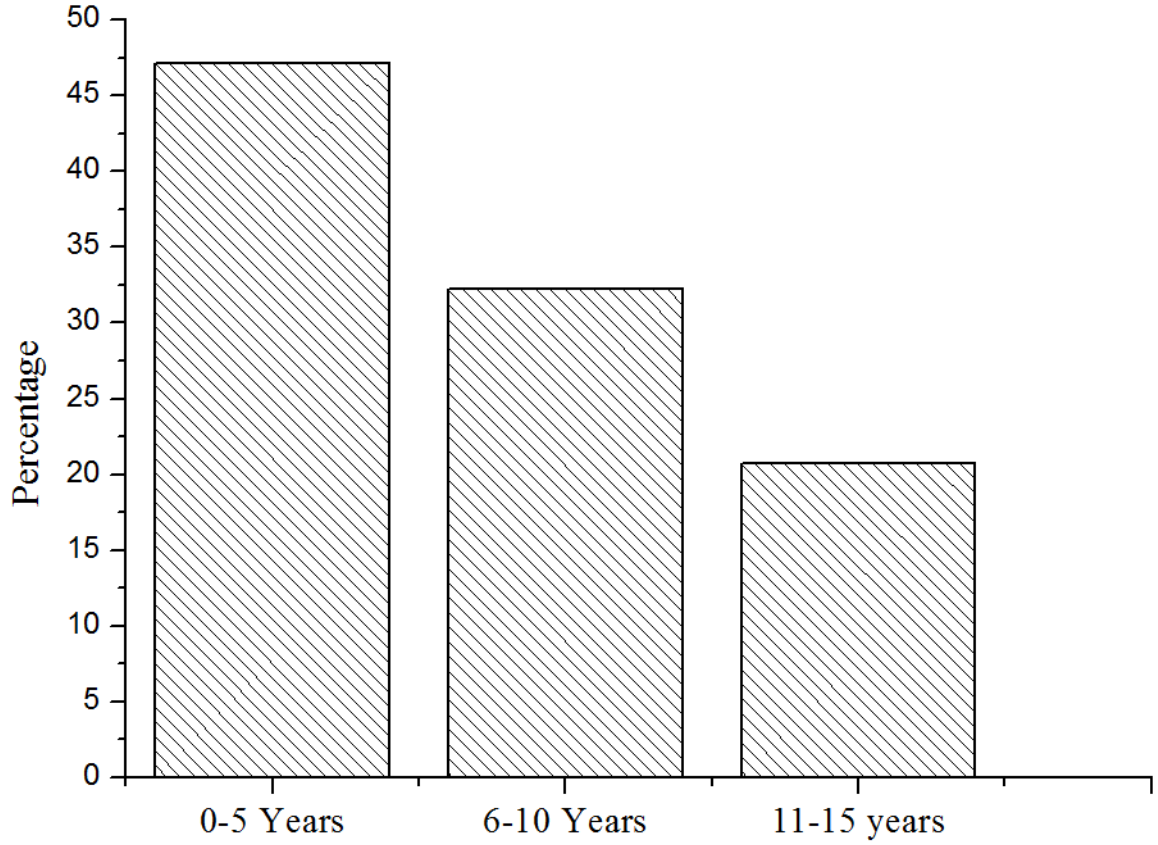

Figure 4. 5: Experience of respondents

F. Position of respondents in the organization

Again, the data analysis revealed that, positions of respondents in the organisations were represented in the survey. Considering the current positions in their construction industry , 2.3%, were managing directors, 8.0% project managers, 21.8% office engineers, 17.2% site engineers, 33.3% resident engineers , 2.3% quantity surveyors , and 14.9% others like Forman's, supervisors, project inspectors. The high representation of resident engineers, office engineers, site engineers and project managers was inevitable as these are the very key professionals usually engaged in the construction industry in Jimma Town.

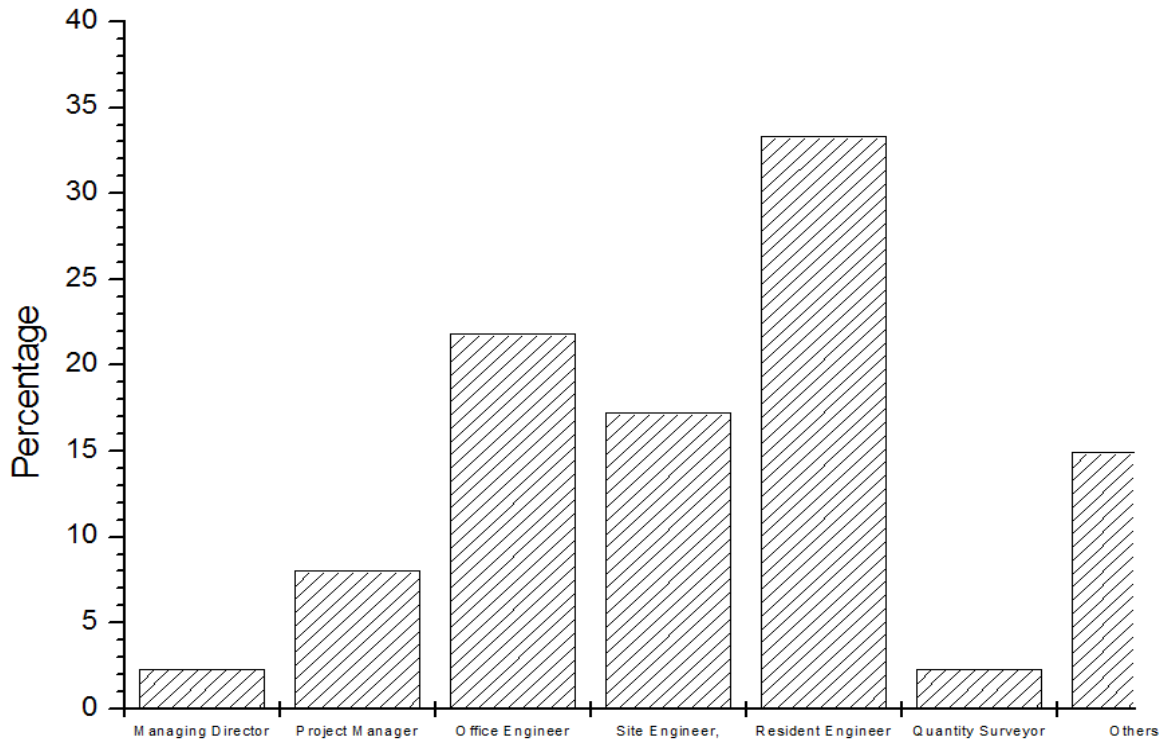

Figure 4. 6: position of respondents

G. Classification of Firms in the construction Business

Concerning organizations classification of respondents, figure 4.7, Shows that, a majority were private organization (47.1%), governmental/ public organization (32.2%), share companies (16.1%) and the minorities were other firms (4.6%)

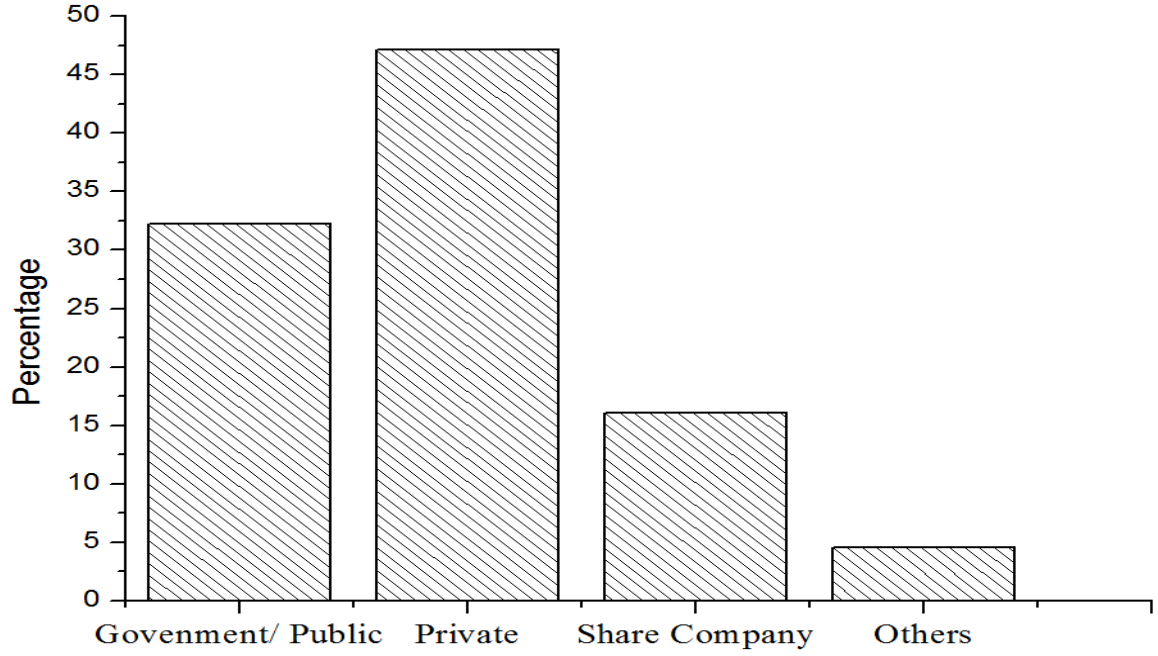

Figure4. 7: Classification of Firms in the construction Business

4.3. Reliability Check - Cronbach's Alpha

SPSS 20 was used to run the value of Cronbach's Alpha and the results for problems, wastages, measures for effectiveness and ICT usage were shown in the table 4.1. The values show that, all are reliable because they are greater than 0.5 all are greater than 0.7 which shows questionnaires are highly reliable.

Table 4.1.Cronbach's Alpha for Questionnaires

No	Factors to be evaluated	*Cronbach's Alpha*
1	Problems	0.914
2	Wastages	0.927
3	Measures for effectiveness	0.919
4	Usage of ICT	0.919

4.4. Analysis of major activities on construction materials management

In this section, respondents answered questions of objective one and two that is Problems related with construction material management**,** Wastage in building construction project sites and Measures for effective on construction material management.

Objective one: To identify existing construction material management problems and wastages on building construction project sites in Jimma Town.

This objective was examined through the research question indicated below using Likert Scaling.

Research Question No 8: Kindly indicate major activities associated with problems and wastages on construction materials management on building construction project sites.

According to KASIM 2008, the review of existing literature on materials management practices identified many problems in managing materials on construction projects such as shortages, delays in supply, price fluctuations, damage and wastage, and lack of storage space. (Repository, January 2008).

The key findings on the construction materials management on building construction project sites has been presented in the following sections.

4.4.1. Analysis of Problems and wastages Related with Building Construction Project sites.

1. Analysis of Problems in Building Construction Project sites.

This part examined the problems associated with building construction project sites. The statistical analysis employed in this situation was the Mean index score.

In order to determine the degree of identified problems associated with building construction project sites, the following classification of the ratings based on the Likert Scaling were used and the test value of 3.0 (Majidn,1997; Aminudin ,2006) where,

Very highly identified problems/wastages: **4.50 ≤ mean score≤ 5.00**

Highly identified problems/ wastages: **3.50 ≤ mean score≤ 4.50**

Moderately identified problems/ wastages: **2.50 ≤ mean score≤ 3.50**

Less identified problems/ wastages: **1.50 ≤ mean score≤ 2.50**

None identified problems/ wastages: **1.00 ≤ mean score≤ 1.50**

Mean ratings on the problems and wastages were calculated based on a scale of 1-5 (from "strongly disagree" to "strongly agree").

Table4.2.Identified problems associated with building construction project sites

Factors related to problems	**N**	**Mean**	**Std.**	**Ranking**
Weather conditions	87	3.94	0.920	1
Management of surplus materials	87	3.82	1.018	2
Slow response from company to site about submittals	87	3.75	1.059	3
Project delay due to slow delivery materials	87	3.69	1.260	4
Material Shortage during construction	87	3.68	1.271	5
Defects due to improper skill in materials usage	87	3.61	1.458	6
Improper Selection of contract for specific material	87	3.61	1.270	7
Suddenly alternation price of materials	87	3.60	1.186	8
Usage of materials without systematic control	87	3.59	1.177	9
High price of materials in the market	87	3.56	1.208	10
Piling of inventory materials	87	3.56	1.227	11
Poor material selection	87	3.34	1.396	12
Delivery materials with wrong dimension and quantities	87	3.32	1.443	13
Too early receiving of materials before usage	87	3.31	1.194	14
Disturbance due to poor materials storage	87	3.26	1.146	15
Ineffective control of storage	87	3.21	1.163	16
Improper selection of type of material	87	3.20	1.180	17
Unavailable required quantity	87	3.01	1.316	18
Receiving incorrect material type	87	2.94	1.481	19
High cost in material transportation	87	2.89	1.061	20
Incorrect material takeoff from drawing and design	87	2.89	1.324	21

Factors related to problems	**N**	**Mean**	**Std.**	**Ranking**
Delivery wrong materials	87	2.87	1.371	22
Increase materials quantity in storage	87	2.82	0.909	23
Destroy material in shipping	87	2.79	1.112	24
Burglary, theft and vandalism	87	2.62	1.269	25
A**verage mean**		**3.32**		

Based on the above criteria Table 4.1, itemizes 25 activities which result in problems associated with building construction project sites which can be identified and the mean index score of the respondents level of responses. Mean ratings on the identified problems were calculated based on a scale of 1-5 (from "Never" to "always"). On the average, a mean deployment index of about 3 indicates a moderate level of identified problems.

From table 4.1, it is apparent that the mean response ratings for half of the respondents' response were above average with an overall average mean score of about 3.32. From the total of 25 activities stated above, almost all (23 in number) had a standard deviation greater than 1.0. This is an indication that, all of the respondents, had variations in the rating of their level of identified problems of their activities while a minority of (2) had a standard deviation less than 1.0 indicating some level of agreement among the respondents ratings. According to the survey, the most well-known activities identified and highly occurred problems associated with building construction project sites in the respondents organisations are Weather conditions (mean = 3.94), Management of surplus materials (mean = 3.82), Slow response from company to site about submittals(mean = 3.75), Project delay due to slow delivery materials(mean = 3.69), Material Shortage during construction(mean = 3.68), Defects due to improper skill in materials usage and Improper Selection of contract for specific material procurement(mean = 3.61), Suddenly alternation price of materials(mean = 3.60), Usage of materials without systematic control(mean = 3.59), High price of materials in the market and Piling of inventory materials (mean = 3.56). The trend further shows that, identified problem related to Poor material selection (mean = 3.34) is also above the average value of 3.32. The moderately identified problem activities related to building construction indicated by the respondents are Delivery materials with wrong dimension and quantities (mean = 3.32), Too early receiving of materials before usage (mean = 3.31), Disturbance due to poor materials storage (mean = 3.26), Ineffective control of storage (mean = 3.21), Improper selection of type of contract for material procurement (mean = 3.20), Unavailable required quantity (mean = 3.01), while Receiving incorrect material type (mean = 2.94),

High cost in material transportation(mean = 2.89), Delivery wrong materials(mean = 2.87), Increase materials quantity in storage(mean = 2.82), Destroy material in shipping(mean = 2.79) and Burglary, theft and vandalism were the least rated.

Based on the findings presented above, it is reasonable to deduce that, problem of construction materials management activities on building construction projects sites in a developing town like Jimma appears quiet high.

2. Analysis of Wastage in Building Construction sites.

Table 4.2, provides a range of identified wastages in building construction sites and the mean index score of the respondents' level identified wastage. Mean ratings on the level of identified wastage were also calculated based on a scale of 1-5 (from "strongly disagree" to "strongly agree").

Table 4.3. Wastage in building construction sites

Wastages in building construction sites	**N**	**Mean**	**Std.**	**Ranking**
Design changes	87	3.94	1.004	1
Lack of proper work planning and scheduling	87	3.74	1.307	2
Inadequate supervision in usage of materials	87	3.74	1.062	3
Inappropriate coordination of Teamwork in site	87	3.68	1.262	4
Rework due to improper quality and mistakes	87	3.64	1.267	5
Over-ordering of materials	87	3.53	0.998	6
Lack of care in transportation	87	3.52	1.130	7
Delay in material supply to sites	87	3.48	1.380	8
Poor security on site (theft and vandalism)	87	3.47	1.396	9
Lack of supervision and proper control during storage	87	3.45	1.310	10
Poor materials storage facility	87	3.43	1.254	11
Poor cutting of materials (glass, tiles, plywood)	87	3.39	1.341	12
Insufficient places for material storage	87	3.37	0.916	13
Wrong material utilization	87	3.33	1.117	14
High frequent materials movement	87	3.26	1.072	15
Inadequate skill in utilization of materials	87	3.26	0.994	16
Poor quality of materials	87	3.22	1.333	17
Inefficient utilization of temporary materials (formwork,)	87	3.22	1.005	18
Delay in material inspection and testing	87	3.22	1.016	19
Incomplete drawing design and specification	87	3.18	1.385	20

Wastages in building construction sites	**N**	**Mean**	**Std.**	**Ranking**
Wrong methods and regulations in materials usage	87	3.10	1.390	21
Shortage of materials	87	3.09	1.386	22
Damage due to weather	87	3.08	1.232	23
Manufacturing defects (pipe, supporting pipe, electricity)	87	3.01	1.280	24
Existence of unnecessary materials on site	87	2.95	1.389	25
Average mean		**3.37**		

By considering wastage of construction materials in building construction project sites; the study revealed that half of wastages by the firms were below average (average mean score of 3.37). Out of 25 activities stated above, about 22 activities had a standard deviation greater than 1.0. This is an indication that, almost all of the respondents, had variations in the rating of their level of identified wastages of construction materials in their activities while a minority of three had a standard deviation less than 1.0 indicating some level of agreement among the respondents ratings.

According to the data, the most identified wattages in building construction sites was Design changes (mean = 3.94), Lack of proper work planning and scheduling and Inadequate supervision in usage of construction materials (mean = 3.74), Inappropriate coordination of Teamwork in site (mean = 3.68), Rework due to improper quality and mistakes (mean = 3.64), Over-ordering of construction materials (mean = 3.53) and Lack of care in transportation (mean = 3.52). The survey further shows that, Delay in material supply to sites (mean = 3.48), Poor security on site (theft and vandalism) (mean = 3.47), Lack of supervision and proper control during storage (mean = 3.45), Poor materials storage facility (mean = 3.43) and Poor cutting of materials (glass, tiles, plywood) (mean = 3.39) are above average and identified as moderate in building construction project sides. Other moderately identified wastages in building construction project sites are, insufficient places for material storage (mean = 3.37), Wrong material utilization (mean = 3.33), High frequent materials movement (mean = 3.26), Poor quality of materials, Inefficient utilization of temporary materials (formwork, scaffold) and Delay in material inspection and testing (mean = 3.22), Incomplete drawing design and specification(mean = 3.18), Wrong methods and regulations in materials usage(mean = 3.10), Shortage of materials(mean = 3.09), Damage due to weather(mean = 3.08) and Manufacturing defects (pipe, supporting pipe, electricity)(mean = 3.01) while Existence of unnecessary materials on site(mean = 2.95) was the least identified wastages in building construction project sites.

Generally, the finding from the questionnaire survey concludes, Weather conditions , Management of surplus materials, Slow response from company to site about submittals, Project delay due to slow delivery materials and Material Shortage during construction were the first five major identified problems respectively while Design changes, Lack of proper work planning and scheduling and Inadequate supervision in usage of materials, Inappropriate coordination of Teamwork in site, Rework due to improper quality and mistakes and Over-ordering of materials were the first five major identified wastages respectively in the building construction project sites. But as it has been observed on the site and based on the interview that I have taken from respondents there is a little variations regarding to problems and wastages in building construction project sites in the town but they were within the limit. For instance Management of surplus material , Project delay due to slow delivery materials ,Weather conditions , Material Shortage during construction and Slow response from company to site about submittals were the first five major identified problems respectively while Inadequate supervision in usage of materials, Over-ordering of materials, Design changes, Lack of proper work planning and scheduling and, Inappropriate coordination of Teamwork in site, Rework due to improper quality and mistakes were the first five major identified wastages respectively in the building construction project sites.

4.4.2. Analysis of Measures for Effective on Construction Material Management on sites.

This section analyzed objective two that is measures for effectiveness on construction materials management on building construction project sites in the town.

Objective two: To establish elements of good practice in construction materials management on building construction project sites.

This objective was examined through the research question indicated below using Likert Scaling like objectives one as discussed above.

Research Question No 9: Kindly indicate major activities associated with Measures for effectiveness on construction materials management on building construction project sites.

The measures for effectiveness on construction materials management on building construction project sites in the town was analyzed using mean index score method as indicated above. The mean ratings on the measures for effectiveness were also calculated based on a scale of 1-5 (from “strongly disagree” to “strongly agree”).

Table 4.4. Measures for Effectiveness on construction materials on sites

Measures for effectiveness	**N**	**Mean**	**Std.**	**Ranking**
Training people on how to reduce waste	87	4.60	0.769	1
Usage of packaging in an efficient way	87	4.51	0.525	2
Getting samples for materials approved	87	4.44	0.758	3
Reporting the situation of materials in the project's store	87	4.40	0.619	4
Daily recording of using materials in the project	87	4.40	0.723	5
Considering required communication methods for material	87	4.37	0.612	6
Planning and monitoring construction activities	87	4.33	0.623	7
Work done by qualified employees	87	4.33	0.710	8
Accepted materials used	87	4.30	0.733	9
All quality problems have been fixed	87	4.26	0.842	10
Scope of work requirements achieved	87	4.26	0.559	11
Controlling over-ordering and purchasing	87	4.26	0.869	12
Preparing for material storage	87	4.25	0.669	13
Using suitable, safe and secure storage	87	4.22	0.754	14
Consideration off-site construction	87	4.21	0.593	15
Following up the prices in the market and recording prices	87	4.18	0.691	16
Defining accurate materials specifications	87	4.17	1.070	17
Employment of store keeper and security personnel	87	4.15	0.815	18
Completed preceding work segments	87	4.09	0.725	19
Forecasting materials price in market	87	4.07	1.021	20
Attention to weather condition	87	4.05	0.861	21
Forecasting of field condition, weather and event in the future	87	4.03	.982	22
Identifying Material Schedule	87	4.02	0.889	23
Performing recycle and reuse methods for surplus and waste materials	87	3.97	1.083	24
Reporting the problems (wastage and loss-storage in delivery)	87	3.97	0.813	25
Consideration efficient mechanical systems and machinery	87	3.89	0.722	26
Locating sources of materials for procurement	87	3.87	0.998	27
Installation specifications met	87	3.80	1.087	28
Average mean		**4.19**		

Based on the table 4.3, the study has shown that more than half of the measures for effectives for construction materials management on building construction project sites in the organization were above average (average mean score of 4.19). From the total of 28 activities indicated above, 24 activities had a standard deviation less than 1.0. This is an indication that, almost all of the respondents, had agreement among the rating of their measures for effectiveness on construction materials management in their activities while a minority of four had a standard deviation greater than 1.0 indicating had variations in the respondents ratings.

According to table 4.3, the Excessive measures for effectiveness for construction materials management on building construction project sites were Training people on how to reduce waste(mean = 4.60) and Usage of packaging in an efficient way(mean = 4.51) and the most measures for effectiveness for construction materials management on building construction project sites were Getting samples for materials approved(mean = 4.44), Reporting the situation of materials in the project's store and daily recording of using materials in the project(mean = 4.40), Considering required communication methods for material management(mean = 4.37), Planning and monitoring construction activities and Work done by qualified employees(mean = 4.33), Accepted materials used(mean = 4.30), All quality problems have been fixed, Scope of work requirements achieved and Controlling over-ordering and purchasing(mean = 4.26), Preparing for material storage(mean = 4.25), Using suitable, safe and secure storage(mean = 4.22), Consideration of-site construction(mean = 4.21) and other most measures for effectiveness for construction materials management on building construction project sites but below the average value were Following up the prices in the market and recording the variations of prices(mean = 4.18), Defining accurate materials specifications(mean = 4.17), Employment of store keeper and security personnel(mean = 4.15), Completed preceding work segments(mean = 4.09), Forecasting materials price in market(mean = 4.07), Attention to weather condition(mean = 4.05), Forecasting of field condition, weather and event in the future(mean=4.03), Identifying Material Schedule(mean = 4.02) while Performing recycle and reuse methods for surplus and waste materials and Reporting the problems for examples (wastage and loss-storage in delivery)(mean = 3.97), Consideration efficient mechanical systems and machinery for moving materials(mean = 3.89), Locating sources of materials for procurement(mean = 3.87) and Installation specifications met(mean = 3.80) were the least rated.

Generally the findings presented above shown that, Training people on how to reduce waste and Usage of packaging in an efficient way were the most highly identified while Getting

samples for materials approve, Reporting the situation of materials in the project's store and daily recording of using materials in the project, Considering required communication methods for material management were highly identified for measures for effectiveness in the construction materials management activities on building construction projects sites in the town. The finding from site observation and interview also has shown the same result with the findings from the questionnaire survey.

4.4.3. Analysis of Impact of computer on building construction project sites.

This section presents data analysis and findings from the survey. It begins with descriptive analysis of the general demographics variables of respondents. This is followed by analysis of levels of ICT usage.

1. Analysis of General information of Respondents related to ICT.

A. Use of ICT in the firms for different activities

Part of the questionnaire sought respondent's awareness on the role of ICT in their firms. From Figure.4.8, it can be deduced that all the respondents (100%) were used ICT in their company. It is however surprising to note that, the majority of the company (68%) used computer for different activates in both company and project sites 15% used at company office only and a minority of 4% were used at project sites only.

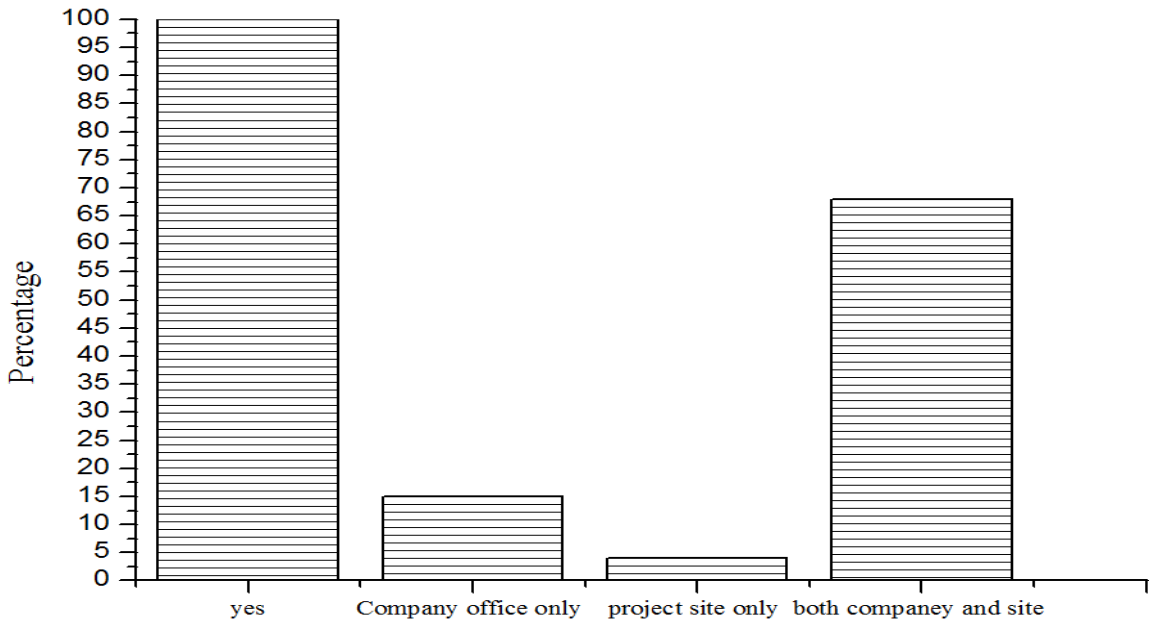

Figure 4. 8: Use of ICT in the firms for different activities

B. Range of ICT usage in the firm

The survey further revealed that (Figure 4.9), the majority (42%) used this ICT application in medium way, 23% were used as low while 22% used was high.

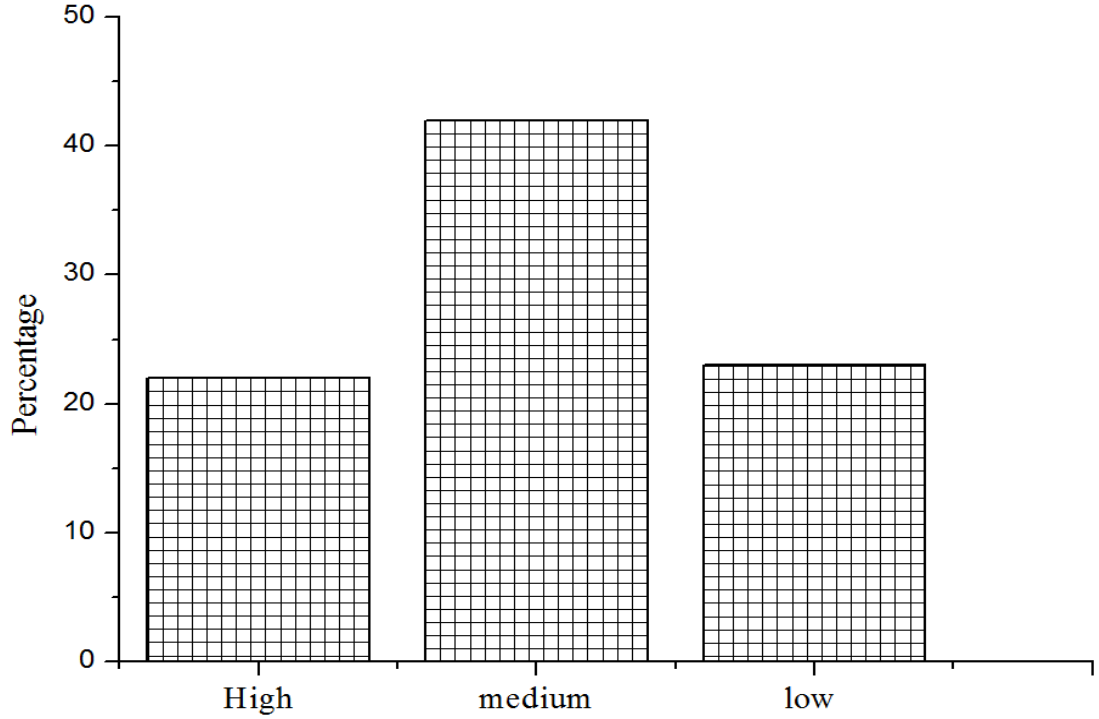

Figure 4. 9: Range of ICT usage in the firm

C.Use of ICT related to time, quality and cost

The data analysis shown that, the respondent had varied in usage of ICT in related to Time, Quality and cost. According to figure.4.10, 40% of the respondents were agreed that, ICT used in relation to Time Quality and time medium, 29% high and 18% low respectively.

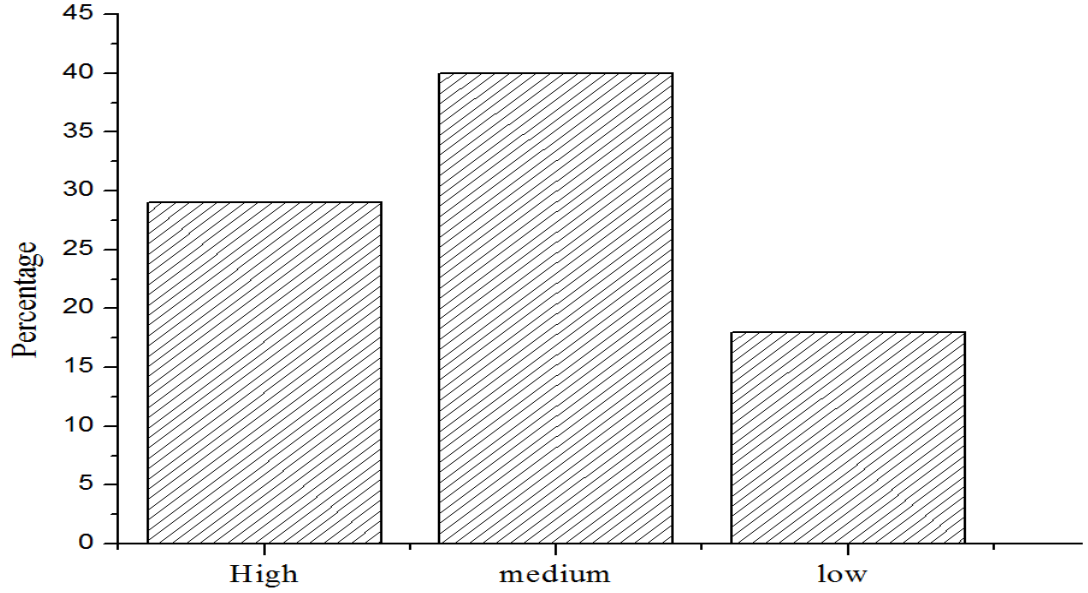

Figure4. 10: Use of ICT related to time, quality and cost

2. ANALYSIS OF FIRMS LEVEL OF USAGE OF ICT.

This section analyzed the final objective that is level of computerization of the firm's operations/activities including extent of usage of some advanced ICT tools and applications.

Objective three: To assess the impact of computerized system on construction materials management on building construction project sites.

This objective which was indicated above was examined through the research question indicated below using Likert Scaling like objectives one and two as discussed above.

Research Question No 15: Please indicate the extent of Computerization or usage of computer tools, software's and its application for the following activities in your organization.

The statistical analysis employed in this situation is also the Mean index score. In order to determine the degree usage of ICT for the firms operations, the following classification of the ratings based on the Likert Scaling were also used and use a test value of 3.0 (Maid, 1997; Aminudin, 2006) where,

Very Highly Computerized/Used: $4.50 \leq$ mean score≤ 5.00

Highly Computerized/Used: $3.50 \leq$ mean score≤ 4.50

Moderately Computerized/Used: $2.50 \leq$ mean score≤ 3.50

Less Computerized/Used: $1.50 \leq$ mean score≤ 2.50

Not Computerized/Used: $1.00 \leq$ mean score≤ 1.50

To simplify the analysis the research question indicated above was categorized in to three main parts. These were Activities Computerized in the firms which contain 18 activities, usage of advanced ICT tools and applications which also contain 18 ICT tools and usage of ICT Soft ware's which contains 10 ICT soft ware's. Site observation and interview was not on conducted for this case due to its difficulty to ask about knowledge of ICT application and soft ware's individually. Each of the three categories has been analyzed in the following sections.

A. Activities Computerized in the firms.

Based on the review of data from literature, this aspect itemized 18 activities /operations of contractor, consultants, clients/owners and other Civil Engineer professionals in organisations and it analyzed the level of computerization or digitization of these operations/activities.

Table 4.4.below itemizes some of the activities or operations of respondents' organisation which can be computerized digitally and the mean index score of the respondent's level of digitization. Mean ratings on the level of usage were calculated based on a scale of 1- 5 (from

"Never" to "always"). On the average, a mean score index of about 3 indicates a moderate level of computerization of such operation.

Table 4.5. Activities computerized/ digitized in the firm

Activities Computerized	**N**	**Mean**	**Std.**	**Ranking**
Progress reports	87	4.56	0.694	1
Project Drawings	87	4.43	0.897	2
Scheduling and works planning	87	4.36	0.731	3
Subcontractors and suppliers information	87	4.32	1.062	4
Estimating	87	4.24	0.915	5
Financial management	87	4.23	0.803	6
Taking- off	87	4.23	.911	7
Communication (with project sites and external Parties)	87	4.09	1.052	8
Project Cost control	87	4.09	1.127	9
Distributions of project Documents.	87	4.06	1.124	10
Site management and security	87	3.99	1.084	11
Project Records	87	3.98	1.171	12
Resources Management (Labour, Material and Equipment)	87	3.98	1.089	13
Accounting/payroll	87	3.80	1.199	14
Costing and budgeting	87	3.80	1.228	15
Technical Calculations	87	3.68	1.176	16
Book-keeping	87	3.52	1.265	17
Purchases and Invoicing	87	1.66	0.546	18
Average mean		**4.05**		

From table 4.4, it is apparent that the mean response rating for most of the respondent's main operations/ activities was above average with an overall average mean score of about 4.05. Out of 18 activities listed above, almost greater than half (12 number) had a standard deviation greater than 1.0. This is an indication that, almost about half of the respondents, had variations in the rating of their level of computerization of their operations/ activities while a minority of six had a standard deviation less than 1.0 indicating some level of agreement among the respondents ratings.

According to the survey, Very highly computerized/digitize in the respondents organisations is Progress Reports (mean = 4.56) and the most prominent activities highly computerized/digitize in the respondents organisations are Project Drawings (mean = 4.43),

Scheduling and works planning (mean = 4.36**),** Subcontractor and suppliers information (mean = 4.32), Estimating (mean = 4.24), Financial Management and Quantity Take off (mean = 4.23), Communication with project sites and external parties and Project Cost Control (mean = 4.09), Distribution of Project documents (mean = 4.06), Site Management and Security(mean = 3.99), Previous project records and Resource management (labour, Plant and Materials) (mean = 3.98), accounting/ Payroll and Costing and Budgeting (mean = 3.80), Technical Calculations (mean = 3.68). Bookkeeping/Accounting (mean = 3.52**)**, and the less computerized activities identified by the respondents is Purchases and Invoicing (mean = 3.46).

Based on the findings presented above, Progress Reports is a Very highly computerized/digitize in the respondent's organisations/company while project Drawings, Scheduling and works planning, Subcontractor and suppliers information and Estimating are the most prominent activities highly computerized/digitize in the respondent's organisations /company. It is also reasonable to deduce that, digitization of the respondent's " main business activities in a developing country like Ethiopia (case study in jimma town) appears very high.

B. Level of usage of advanced ICT tools and applications

In fulfilling this objective, eighteen (18) relevant factors affecting the use of ICT were drawn from the literature.

Table 4.5 below provides a range of ICT tools and application and the mean index score of the respondents' level usage. Mean ratings on the level of usage were calculated based on a scale of 1-5 (from "Never" to "always").

Table 4.6. ICT application in the construction organization

ICT application Variables	**N**	**Mean**	**Std.**	**Ranking**
Spreadsheets (e.gg. Ms Excel)	87	4.40	0.799	1
Presentations (e.gg. Ms Power Point)	87	4.23	0.803	2
E-mail and Short Message Services (SMS)	87	3.99	1.262	3
Word Processors (e.gg. Ms Word)	87	3.93	1.129	4
Databases (egg Ms Access)	87	3.63	1.163	5
Mobile internet	87	3.46	1.379	6
Integrated software(e.g. Enterprise Resource Plan)	87	3.39	1.425	7
Modelling and visualization(eg.3D-CAD,4D-CAD)	87	3.25	1.391	8
Global Positioning Systems (GPS)	87	2.98	1.486	9
Electronic tendering (E-tendering)	87	2.91	1.317	10
Geographic information Services (GIS)	87	2.77	1.178	11
Electronic document management systems (EDMS)	87	2.57	0.923	12
Teleconferencing	87	2.46	0.887	13
Videoconferencing	87	2.11	0.920	14
Project specific websites (Extranets)	87	1.16	0.370	15
Site surveillance Technologies (e.g. CCTV etc)	87	1.15	0.359	16
Radio Frequency Identification (RFID)	87	1.13	0.334	17
Electronic purchasing (E-purchasing)	87	1.13	0.334	18
Average mean		**2.81**		

By considering usage the range of emerging ICT technologies; the study revealed that about half of current level of usage by the organizations/ firms was below average (average mean score of 2.81). According to the data, the most prominent ICT application in used was Spreadsheets (Eg. Ms Excel) (mean = 4.40), Presentations (Eg. Ms Power Point) (mean = 4.23), E-mail and Short Message Services (SMS) (mean = 3.99), Word Processors (Eg. Ms Word) (mean = 3.93), Databases (Eg. Ms Access)(mean = 3.63). The moderately ICT application identified by the respondents are mobile internet (mean=3.46), Integrated software (eg. Enterprise Resource Planning; ERP) (mean = 3.39) and Modelling and visualization (eg.3D-CAD, 4D-CAD etc) (mean = 3.25) which are above the average value. Apart from these technologies which were significantly above average, data analysis revealed that the respondent's usage of other ICT tools and applications are generally deficient. For instance, usage of applications such as Global Position System (GPS) (mean = 2.98), Electronic Document management systems (EDMS) (mean=2.77), Teleconferencing (mean=2.46), Videoconferencing (mean=2.11) were found to be very inadequate and below test level of 3.0

Besides, other tools and applications such as Project specific websites (Extranets) (mean=1.16), Site surveillance Technologies (e.g. CCTV etc) (mean =1.15), Radio frequenc Identification (RFID) / Barcodes and Electronic purchasing (E-purchasing) (mean = 1.13) were basically not used.

Drawing from the results above, it is plausible to conclude that more advanced and newer technologies are poorly utilized by contractors, consultants, clients/owners and other professionals in Jimma. The findings suggest that, while there is some level of awareness about these technologies, the motivation for usage is lacking due to both internal and external constraints.

C. Level of usage of ICT Soft wares

Table.4.6. shows the extent of ICT Softwares support services provided in-the construction industry such as building construction projects. For this analysis, the Mean ratings on the level of usage of ICT Softwares were calculated based on a scale of 1-5 (from "Never" to "always").

Table 4.7. ICT softwares used in the construction firm

ICT software's variables	**N**	**Mean**	**Std.**	**Ranking**
AutoCAD	87	4.22	0.827	1
Eagle point	87	4.22	1.185	2
ArchiCAD	87	4.16	0.987	3
Microsoft Project	87	4.16	0.963	4
Primavera	87	3.99	0.958	5
Master bill,	87	3.62	1.164	6
Power Project	87	3.60	1.262	7
Build soft,	87	3.51	1.140	8
PM Systems,	87	3.47	1.256	9
Estimate,	87	3.29	1.109	10
Average mean		**3.82**		

As shown in the table 4.6, it is evident that the mean response rating for half of the respondents' usage of ICT soft ware was above average with an overall average mean score of about 3.82. Of the 10 soft ware's stated above, almost above half of the activities (6 numbers) had a standard deviation greater than 1.0. This is an indication that, almost above half of the respondents, had variations in the rating of their level of ICT software in their activities while a minority of four had a standard deviation less than 1.0 indicating some level of agreement among the respondent's ratings.

According to the survey, the most highly used ICT soft ware's in the respondents organisations is AutoCAD and Eagle point (mean = 4.22), ArchiCAD and Microsoft Project (mean = 4.16), and Primavera (mean = 3.99) and Master bill (mean = 3.62), Power Project (mean = 3.60), Build soft, (mean = 3.51), which are below average. PM Systems Control (mean = 3.47), and Estimate (mean = 3.29), are the next highly used ICT Softwares.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATION

5.1. Conclusions

This research investigated the assessment of construction materials management practices and usage of ICT on building construction project sites. The following conclusions can be drawn from the research:

- Concerning the major activities on construction materials management, Problems related with construction material management**,** Wastage in building construction project sites and measures for effective on construction material management were analyzed.
- Weather conditions, Management of surplus materials, Slow response from company to site about submittals, Project delay due to slow delivery materials and Material Shortage during construction, were highly identified problems in building construction project sites while, , Delivery wrong construction materials, Increase construction materials quantity in storage, Destroy construction material in shipping and Burglary, theft and vandalism were the least rated.
- Design changes was the most highly identified wastages while Lack of proper work planning and scheduling and Inadequate supervision in usage of materials were highly identified wastages in building construction project sites.
- Training people on how to reduce waste and Usage of packaging in an efficient way were the Excessive measures for effectiveness for construction materials management on building construction project sites.
- Finally the study shown activities by using ICT Very highly computerized/digitize in the respondents organisations was Progress Reports and the most prominent activities highly computerized/digitize in the respondents organisations were Project Drawings , Scheduling and works planning , Subcontractor and suppliers information , Estimating , Financial Management and Quantity Take off while Purchases and Invoicing were the less computerized activities identified by the respondents.
- By considering usage, the range of emerging ICT technologies; the study revealed that, the most well-known ICT application in used were Spreadsheets (Eg. Ms Excel), Presentations (Eg. Ms Power Point), E-mail and Short Message Services (SMS), Word Processors (Eg. Ms Word) and Databases (Eg. Ms Access) while other tools and applications such as Project specific websites (Extranets),Site surveillance Technologies

(Eg. CCTV etc) and Radio frequency Identification (RFID) / Barcodes and Electronic purchasing (E-purchasing) were basically not used.

- The most highly used ICT soft ware's in the respondents organisations is AutoCAD and Eagle point, while ArchiCAD , Microsoft Project , Primavera , Master bill Power Project, Build soft, PM Systems Control, and Estimate , were the next highly used ICT Softwares..

5.3. Recommendation

On the basis of findings and conclusions drawn from the study, the following recommendations are proposed.

- Contractors, consultants, clients and other professionals working in the construction should increase their resource commitment to staff training and development in construction materials management so as to develop the necessary skills, update their knowledge, and enhance new product development for the reduction of problems and wastages.
- Construction materials management department should support the management of an organization in the production activities, as it could help in marketing, selling, promotion and even control of all types of construction materials for its quantity, quality and cost for effective construction materials management.
- The management of construction activities is gradually moving from the traditional paper based format to more digital processes. It is therefore recommended that adequate ICT training and technical support for professionals in building construction firms should be vigorously promoted.
- There employees in the construction industry need to be trained to develop their skill in the use and application of ICT in construction materials management.

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Appendixes

A. Questionnaire survey

JIMMA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

JIMMA INSTITUTE OF TECHNOLOGY

SCHOOL OF CIVIL AND ENVIROMENTAL ENGINEERING

CONSTRUCTION ENGINEERING AND MANAGEMENT CHAIR

ASSESSMENT OF CONSTRUCTION MATERIALS MANAGEMENT PRACTICE ON BUILDING CONSTRUCTION PROJECT SITES IN JIMMA TOWN

A Thesis Submitted to School of Graduate Studies of Jimma University, Institute of Technology in Partial Fulfillment of the Requirements for the Degree of Masters of Science in Civil Engineering (Construction Engineering and Management)

By: Asmare Molla

January 2016

Jimma, Ethiopia

Dear Respondent,

QUESTIONNAIRE IN AID OF MSc. THESIS

I am MSc. Student of the above named institution carrying out a research work titled:

"*Assessment of Construction Materials Management Practice on Building Project Sites in Jimma Town"* .The research will enable the candidate to assess the construction materials management practice on building construction project sites.

Your kind assistance is required in filling the questionnaire and making relevant information available. I wish to assure you that the information so provided will be treated with strict confidence and use for academic purpose only.

Thank you for your anticipated cooperation and understanding.

Yours faithfully,

……

Asmare Molla. (Mrs)

Questionnaire ID: _____

QUESTIONNAIRE ON

''Assessment of Construction Materials Management Practice on Building Construction Project Sites on Jimma Town''

(**Please Encircle Where Appropriate**)

Section I: General Information

1. Sex of respondent **1**. Male **2**. Female

2. Age of respondent **1**. 18-25yrs **2**. 26-35yrs, **3**. 36-45yrs **4.** Above 46

3. Respondent academic qualifications:

1. Below diploma **2.** Diploma **3**. Bachelor Degree **4**. Master Degree

5. Doctoral Degree and above

4. Please specify what most represents your organization:

1. Contractor **2.** Consultant **3.** Client **4.** Others

5. Respondent's years of experience related to building construction:

1. 0– 5Yrs, **2.** 6 – 10Yrs, **3.** 11 – **15Yrs,** **4.** 16 – 20yrs, 5. Over 20yrs

6. Classification of your firm in construction business:

1. Governmental Or public, **2.** Private, **3.** Share company **4.** Others

7. Please indicate your current position in this company.

1. Managing Director, 2. Project Manager, **3.** Office Engineer, **4.** Site Engineer,

5. Resident Engineer, **6.** Quantity Surveyor**, 7.** Others (specify) ----------

Section II: Major Activities on Assessment of Construction Materials Management Practice on Building Construction Project Sites in Jimma Town.

8. Kindly indicate major activities associated with problems and wastages on construction materials management on building construction project sites.

1. SDA=strongly disagree, **2.** DA=Disagree, **3**. N=Neutral, **4.** A= agree, **5.** SA=Strongly Agree

Issues	**Question ID :NO**	**Problems and Wastages on construction materials management on building construction project sites**	**1 (SDA)**	**2 (DA)**	**3 (N)**	**4 (A)**	**5 (SA)**
Problems related with material management	Q9.1	Receiving incorrect construction material type					
	Q9.2	Unavailable required quantity					
	Q9.3	Too early receiving of construction materials before usage					
	Q9.4	Incorrect material takeoff from drawing and design documents					
	Q9.5	Improper selection of type of contract for construction material procurement					
	Q9.6	Slow response from company to site about submittals					
	Q9.7	Delivery wrong construction materials					
	Q9.8	Delivery construction materials with wrong dimension and quantities					
	Q9.9	Increase construction materials quantity in storage					
	Q9.10	Weather conditions					
	Q9.11	Burglary, theft and vandalism					
	Q9.12	Destroy construction material in shipping					
	Q9.13	High cost in construction material transportation					
	Q9.14	Construction material Shortage during					

Issues	**Question ID :NO**	**Problems and Wastages on construction materials management on building construction project sites**	**1 (SDA)**	**2 (DA)**	**3 (N)**	**4 (A)**	**5 (SA)**
		construction					
	Q9.15	Piling of inventory construction materials					
	Q9.16	Poor construction material selection					
	Q9.17	Defects due to improper skill in construction materials usage					
	Q9.18	Improper Selection of type of contract for specific construction material procurement					
	Q9.19	Disturbance due to poor construction materials storage					
	Q9.20	Project delay due to slow delivery materials					
	Q9.21	High price of materials in the market					
	Q9.22	Suddenly alternation price of materials					
	Q9.23	Ineffective control of storage					
	Q9.24	Usage of materials without systematic control					
	Q9.25	Management of surplus materials					
Wastage in building construction sites.	Q9.26	Incomplete drawing design and specification					
	Q9.27	Design changes					
	Q9.38	Inadequate supervision in usage of materials					
	Q9.49	Over-ordering of materials					
	Q9.30	Delay in material inspection and testing					
	Q9.31	Inappropriate coordination of Teamwork in site					
	Q9.32	Manufacturing defects (pipe, supporting pipe, electricity)					
	Q9.33	Poor cutting of materials (glass, tiles, plywood)					
	Q9.34	Inefficient utilization of temporary materials (hoarding, formwork, scaffold)					
	Q9.35	Damage due to weather					

Issues	Question ID :NO	Problems and Wastages on construction materials management on building construction project sites	1 (SDA)	2 (DA)	3 (N)	4 (A)	5 (SA)
	Q9.36	Poor security on site (theft and vandalism)					
	Q9.37	Lack of care in transportation					
	Q9.38	Inadequate skill in utilization of materials					
	Q9.39	Rework due to improper quality and mistakes					
	Q9.40	Insufficient places for material storage					
	Q9.41	Wrong methods and regulations in materials usage					
	Q9.42	Poor materials storage facility					
	Q9.43	High frequent materials movement					
	Q9.44	Lack of supervision and proper control during storage					
	Q9.45	Wrong material utilization					
	Q9.46	Lack of proper work planning and scheduling					
	Q9.47	Existence of unnecessary materials on site					
	Q9.48	Poor quality of materials					
	Q9.49	Shortage of materials					
	Q9.50	Delay in material supply to sites					

9. Kindly indicate major activities associated with Measures for effectiveness on construction materials management on building construction project sites.

1. SDA=strongly disagree, **2.** DA=Disagree, **3**. N=Neutral, **4.** A= agree, **5.** SA=Strongly Agree

Issues	Question Id:No	Measures Effective on construction materials management on building construction project sites.	1 (SDA)	2 (DA)	3 (N)	4 (A)	5 (SA)
Measures for effective	Q10.1	Defining accurate materials specifications					
	Q10.2	Locating sources of materials for					

Issues	**Question Id:No**	**Measures Effective on construction materials management on building construction project sites.**	**1 (SDA)**	**2 (DA)**	**3 (N)**	**4 (A)**	**5 (SA)**
on material management		procurement					
	Q10.3	Getting samples for materials approved					
	Q10.4	Forecasting of field condition, weather and event in the future					
	Q10.5	Forecasting materials price in market					
	Q10.6	Preparing for material storage					
	Q10.7	Considering required communication methods for material management					
	Q10.8	Identifying Material Schedule					
	Q10.9	Daily recording of using materials in the project					
	Q10.10	Reporting the situation of materials in the project's store					
	Q10.11	Reporting the problems for examples (wastage and loss-storage in delivery)					
	Q10.12	Following up the prices in the market and recording the variations of prices					
	Q10.13	Using suitable, safe and secure storage					
	Q10.14	Consideration efficient mechanical systems and machinery for moving materials					
	Q10.15	Planning and monitoring construction activities					
	Q10.16	Consideration off-site construction					
	Q10.17	Usage of packaging in an efficient way					
	Q10.18	Training people on how to reduce waste					
	Q10.19	Performing recycle and reuse methods for surplus and waste materials					
	Q10.20	Controlling over-ordering and purchasing					
	Q10.21	Attention to weather condition					
	Q10.22	Employment of store keeper and security					

Issues	**Question Id:No**	**Measures Effective on construction materials management on building construction project sites.**	**1 (SDA)**	**2 (DA)**	**3 (N)**	**4 (A)**	**5 (SA)**
		personnel					
	Q10.23	Work done by qualified employees					
	Q10.23	Completed preceding work segments					
	Q10.25	Accepted materials used					
	Q10.26	Scope of work requirements achieved					
	Q10.27	All quality problems have been fixed					
	Q10.28	Installation specifications met					

SECTION III: Impact of computer on building construction

A. ICT General Information (please encircle where appropriate)

11. Does your firm own and use computers for its operations? **1**. Yes, **2**. No - (If you Say No, Pls go to section **IV**)

12. If yes, please indicate where computers can be accessed in your organization?

1. Company Office/s only, **2.** Project Site/s only, **3.** Both Company Office/s and Project Site/s

13. In your view, to what extent is ICT currently being applied in your company?

1. High, **2.** Medium**, 3.** Low

14. Kindly indicate the effectiveness of using ICT associated with Time, Quality and Cost of the project in your organization.

1. High**, 2.** Medium, **3.** Low

B. Level of usage of Information and Communication Technology (ICT) and its effectiveness in organization.

15. Please indicate the extent of Computerization or usage of computer tools, software's and its application for the following activities in your organization.

(Note: 1= Never; 2=Not always; 3=Average; 4=Quiet always; 5=Always.)

Issues	**Question Id:No**	**usage of computer Tools, software's and Its application**	**1**	**2**	**3**	**4**	**5**
Activity	Q15.1	Book-keeping					
	Q15.2	Project Drawings					
	Q15.3	Purchases and Invoicing					
	Q15.5	Technical Calculations					
	Q15.6	Costing and budgeting					
	Q15.7	Estimating					
	Q15.8	Resources Management (Labour, Material and Equipment)					
	Q15.9	08. Scheduling and works planning					
	Q15.10	Accounting/payroll					
	Q15.11	Project Records					
	Q15.12	Taking- off					

Issues	**Question Id:No**	**usage of computer Tools, software's and Its application**	**1**	**2**	**3**	**4**	**5**
	Q15.13	Progress reports					
	Q15.14	Financial management					
	Q15.15	Site management and security					
	Q15.16	Project Cost control					
	Q15.11	Subcontractors and suppliers information					
	Q15.18	Communication (with project sites and external Parties)					
	Q15.19	Distributions of project Documents.					
ICT Application	Q15.20	E-mail and Short Message Services (SMS)					
	Q15.21	Mobile internet					
	Q15.22	Videoconferencing					
	Q15.23	Electronic purchasing (E-purchasing)					
	Q15.24	Teleconferencing					
	Q15.25	Global Positioning Systems (GPS)					
	Q15.26	Geographic information Services (GIS)					
	Q15.27	Radio Frequency Identification (RFID) and barcodes					
	Q15.28	Project specific websites (Extranets)					
	Q15.29	Site surveillance Technologies (e.g. CCTV etc)					
	Q15.30	Electronic tendering (E-tendering)					
	Q15.31	Modelling and visualization (eg.3D-CAD, 4D-CAD etc)					
	Q15.32	Electronic document management systems (EDMS)					
	Q15.33	Integrated software (e.g. Enterprise Resource Planning; ERP)					
General Adminis	Q15.34	Word Processors (e.gg. Ms Word)					
	Q15.35	Spreadsheets (e.gg. Ms Excel)					
	Q15.36	Presentations (e.gg. Ms Power Point)					
	Q15.37	Databases (egg Ms Access)					

Issues	**Question Id:No**	**usage of computer Tools, software's and Its application**	**1**	**2**	**3**	**4**	**5**
tration/ Business Systems	Q15.38	Others(Pls.Specify…….. ……..)					
Project Planning and Scheduling	Q15.39	Microsoft Project					
	Q15.40	Primavera					
	Q15.41	Power Project					
	Q15.42	PM Systems,					
	Q15.43	Others(Pls.Specify…… …… ……)					
QS,Estimating and Cost calculations	Q15.44	01 Estimate,					
	Q15.45	02 Build soft,					
	Q15.46	03 Master bill,					
	Q15.47	Others(Pls.Specify…… ……)					
Computer Aided Design (CAD)	Q15.48	AutoCAD					
	Q15.49	ArchiCAD					
	Q15.50	Agile point					
	Q15.51	Others(Pls.Specify…… …… ……..)					

B. Interview and Field Observation in aid of MSc. Thesis

Dear Respondent,

Interview and Field Observation in aid of MSc. Thesis on

'Assessment of Construction Materials Management Practice on Building Project Sites in Jimma Town

QUESTIONAR ID: ----------

The following interview question and field observation is prepared to support the questioner which is distributed to the different respondents.

I. INTERVIEW

1. What do you think what are the problems and wastages related to building construction sites in your organization?
2. What are the elements of good practice for effective construction materials management on building construction projects?
3. What do you think the advantage of using ICT system regarding to Time, Quality and Cost of the project on building construction sites?
4. In some cases some organizations don't use ICT system what is your reason for such type of organization?

II. Site observation

The site observation will focuses on the following points.

1. Materials type, control of storage, management of surplus and inventory materials and usages are whether under problem or not.

2. Drawing and specification, supervision of works and storages, ordering of materials, organizational frame works, cutting of materials and damages, security and care in transportation of materials and planning and scheduling of materials to observe the wastage ranges.

3. Sample of materials for approval, report formats, efficient mechanical systems and machinery for moving materials, Usage of packaging in an efficient way, and Completed preceding work segments to observe effective construction materials managements.

4. Different ICT tools and software applications to observe Usage of ICT for construction

C. Reference

Ref.No_____
Date: _____

Subject: <u>To whom it may concern</u>

Mr.Asmare Molla is Ethiopian Road Authority (ERA) –sponsored post graduate student in Construction Engineering and Management at Jimma University Institute of Technology.

Currently he is undertaking MSc research work titled: ***Assessment of Construction Materials Management practice on Building construction Project Sites in Jimma Town.***

So we are kindly requesting your cooperation to provide him with all the relevant data necessary for his research work.

We would like to assure you that the findings from the research will be used only for academic purpose.

With regards!

D. SAMPLE OF SPSS COPUTATION FOR THE ANALYSIS OF DATA

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Q8.23 Q8.24 Q8.25
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Descriptive Statistics

	N	Mean	Std. Deviation
Weather conditions	87	3.94	.920
Management of surplus materials	87	3.82	1.018
Slow response from company to site about submittals	87	3.75	1.059
Project delay due to slow delivery materials	87	3.69	1.260
Material Shortage during construction	87	3.68	1.271
Defects due to improper skill in materials usage	87	3.61	1.458
Improper Selection of type of contract for specific material procurement	87	3.61	1.270
Suddenly alternation price of materials	87	3.60	1.186
Usage of materials without systematic control	87	3.59	1.177
Unavailable required quantity	87	3.01	1.316
Receiving incorrect material type	87	2.94	1.481
High cost in material transportation	87	2.89	1.061
Incorrect material takeoff from drawing and design documents	87	2.89	1.324
Delivery wrong materials	87	2.87	1.371
Increase materials quantity in storage	87	2.82	.909
Destroy material in shipping	87	2.79	1.112
Burglary, theft and vandalism	87	2.62	1.269
Valid N (listwise)	87		