



JIMMA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
JIMMA INSTITUTE OF TECHNOLOGY
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING
CONSTRUCTION ENGINEERING AND MANAGEMENT STREAM

Assessment on the Housing Development Construction Materials Management System: Case Study in Addis Ababa housing construction Projects

By:
Assegedech Tesfaye

A Thesis submitted to the School of Graduate Studies of Jimma University in Partial fulfillment of the requirements for the Degree of Masters of Science in Construction Engineering and Management

May, 2016
Jimma, Ethiopia



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Abstract

This paper considers the management of materials in building construction in Addis Ababa housing construction projects. Construction industry has complexity in its nature because it contains large number of parties as owners, consultants, contractors, stakeholders and micro and small enterprises. Material management was a process of planning, executing and controlling field and office activities in housing construction projects.

In housing construction project the main problem was material management system obstacle to achieve the goal of housing. However, here was a problem of inefficient material management and procurement, unnecessary material on site, delay material delivery, inadequate material storage and poor material control on site.

In this study, construction material management can be viewed as four categories which are assess the method of material procurement practices in construction projects, compare the planned materials with the actual materials utilized Addis Ababa housing construction projects, identify the mechanism of material management system in construction projects and its challenges and identify the factors affecting effective material management system.

The study was limited to Addis Ababa housing construction projects because it's a government project. Low cost houses built for the low income people and also the owners all construction material suppliers by itself except sand supply by contractors.

Data collection was used including observation, documentation and questionnaire with interviews. The structural questionnaire prepared based on literature review and seventy questionnaires were distributed to the owners, consultants and contractors, fifty-five questionnaires were received and analyzed.

The main result in this thesis material procurement was open bid and procures materials for construction sites by head office provisions with site requisition; according to the three parties all material used as per planned and also used some mechanism with challenges of delivery at the wrong time which interrupted the work schedule and failure to order on time

which delays the projects and factors affecting effectiveness of material management system was inefficient work force

All parties interested in using some techniques of managing construction materials such as creating and updating data base for materials price and provided listing of materials with computerized form. The most challenges of material managements system was delivery at the wrong time which interrupted the work schedule and failure to order on time which delays the projects and factors affecting effectiveness of material management system was inefficient work force.

A researcher recommends owner should be to develop human resource in construction industry through proper and continuous training program about material management system and should be create Awareness and accountability within the organization

Consultants should be awareness creation how to stacking and storage materials as per specification for contractors

Contractors should ensure the use of skilled craftsmen for their works and provide efficient supervision with professionals to ensure effective material management on building construction sites

Key word: - construction material, management, project

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Abbreviation

BOQ-	Bill of Quantity
ERA-	Ethiopian Road Authority
RII-	Relative Importance Index
HCB-	Hollow Concrete Block

CHAPTER ONE

INTRODUCTION

1.1 Backgrounds

Material management is a scheduled procedure that contains the procuring, control, supply and waste minimization to ensure the requirements. It is a procedure for executing, planning, and controlling site activities in the construction project(s).

Material constitutes substantial portion of the total project cost. Thus material related issues can escalate project(s) cost and may cause time overrun in the project. On the other hand, management of construction materials in building projects can raise the project profit dramatically and saves considerable times.

Mostly, projects fails due to the unplanned material availability and mismanagement of material stocks provided to sites for the construction.

Shortage of materials and equipment for construction projects in developing countries are very common due to which construction projects are adversely affected [1]. This research paper is visualized to promote awareness in the Addis Ababa housing construction projects material procurement and management which helps the professionals in construction projects to avoid issues occurring due to ill planning of materials.

Materials if not properly managed at site can lead to termination or even suspension of a project that is why it is the most critical part of a project and needs serious attention. Materials management covers an integrated coordination of the materials related functions such as to takeoff, purchase, and speeds up, transport, receive, warehouse and distribute [2].

Materials management is a process for planning, executing and controlling field and office activities in construction [17]. The goal of materials management is to assure 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 on site 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 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. Thus Materials management is an important element in project management. Materials represent a major expense in construction, so minimizing procurement costs improves opportunities for reducing the overall project costs. Poor materials management can result in increased costs during construction. Efficient management of materials can result in substantial savings in project costs. If materials are purchased too early, capital may be held up and interest charges incurred on the excess inventory of materials. Materials may deteriorate during storage get stolen unless special care is taken. Delays and extra expenses may be incurred if materials required for particular activities are unavailable. Ensuring a timely flow of materials is an important concern of material management. For effectively managing and controlling materials, procurement is described as the purchase of materials and services from outside organizations to support the firm's operations from production to marketing, sales and logistics [15].

Logistic the process of planning, implementing, and controlling the efficient, cost effective & material flow and storage of raw materials to the finished product to meet customer requirements, material handling, which includes procurement, inventory, shop fabrication and field servicing, requires special attention for cost reduction. Poor materials management can also result in large and unavoidable costs during construction. First, if materials are purchased early, capital may be tied up and interest charges incurred on the excess inventory of materials. Even worse, materials may deteriorate during storage or be stolen unless special care is taken. Second, delays and extra expenses may be incurred if materials required for particular activities are not available [14].

Handling of materials is the flow component that provides for their movement and placement. Due to the frequency of handling materials there are quality considerations when designing a materials handling system. Stock control is classified as a technique devised to cover and ensure all items are available when required. Also, receiving material and reducing the waste.

Material management process initiates from need generated from site then this information conveyed to store department and material is ordered in the store, indent is generated.

Material management challenges on construction site are in terms of purchasing and logistic has many challenges which are mismatched ordering. In Ethiopia today the construction industries are become very wider and complex. Especially in building construction and infrastructure, now a day the government focused in building construction and infrastructure industry, the government constructs low cost houses by considering low income peoples [29].

The housing development construction project would be usually used imported and local materials for construction. These materials must be available and well managed to achieve the construction and to satisfy the low income people.

In these case the importing materials does not reach on time and also the same manner for local materials. As a researcher seen it would be inefficient material management system. It may be inefficient material planning and materials procurement, inadequate material storage on site, delay material deliver to the site, over ordering and poor material control on construction site.

The study area where located Addis Ababa housing construction projects, It governed under the Addis Ababa city, so the government is construct low cost house in that area which is expect to comfortable for the community.

The housing construction project is construct building residence for low income people. The government to be achieves these building construction need a construction materials, which are well managed and control.

1.2 Historical Housing Development in Ethiopia

Housing, second essential human need, next to food and water, Housing considered as the major development task to reduce urban poverty and improve the lives of slum dwellers and to bring sustainable socio-economic transformation. To enable low-income urban dwellers to acquire homes of their own, Alleviation of urban poverty through the participation of

Micro and Small Enterprises (MSE) and creation of employment opportunities in the construction sector which can absorb more labor force,

Changing the image of the city so as to meet international standards, transfer of knowledge and skill to the construction industry, promoting cost efficient housing construction technology, empowering citizens of the city through ownership of houses and tenure security

Ethiopia will be confronted with a population increase of 45 million people over the next 15 years. Along with increased demand for basic like food, water, safety and shelter which are not yet existent, or already over stressed urban settlements.

Ethiopia must re-invent its indigenous building methods construction technology and material use.

It must also reduce its dependency on imported materials.

The capital of Ethiopia, Addis Ababa represents an ideal situation where the urban phenomena growth expansion and densification can be experienced and investigated. This can be accomplished firsthand through its geographic location, demographic development and most importantly, its unbelievable potential in people ideas and interactions.

Ethiopia needs to develop regulations for, and visions of how to use its rich culture and its reliable resource. These are first and foremost, locally available construction materials and know-how, such as natural stone, loam brick technology and rammed earth construction techniques [29].

1.3 Rationale

Construction projects can be accomplished utilizing management processes. These processes include planning; organizing, executing, monitoring, and controlling. Successful completion of projects requires all resources to be effectively managed. Materials management is considered as a means to achieve better productivity, which should be translated into cost reduction[9].

1.4 Statement of the Problem

The problems normally vary in nature and intensity in construction site but usually related to the inefficient management of construction resources including materials, labour, plant and subcontractors. However, the main problem of every construction project organization is material handling. This means inefficient material planning and material procurement, inadequate storage on site, delay material deliver to the site, over order materials, poor material control on construction site and lack of construction materials management techniques [9, 27].

In our country today, the construction industries are become large and complex, especially In building constructions and infrastructures, so for to be achieving this construction material management is very important. However, here is a problem of inefficient materials planning and material procurement, over order material, unwanted materials excess in stock, inadequate material storage, poor material control on construction site and lack of materials construction management mechanism. In the study area the problem of construction materials management system excess in the store, material would be damage and deteriorate during storage, material will be stolen unless especial care is taken, mismatch order, delay material deliver on the site. This entire problem affects the construction achievability.

1.5 Research Questions

1. What are the different methods of construction material procurement practices in housing development projects of Addis Ababa?
2. How is the planned and actual materials utilized in housing project?
3. What are the mechanism of the materials management system and its challenges in housing development projects of Addis Ababa?
4. What are the factors affect effective material management system in housing construction projects?

1.6 Objectives of the study

1.6.1 General objective

The general objectives of the study are to assess the Construction Material Management System in Addis Ababa Housing Development projects.

1.6.2 Specific objectives

- To identify the method of material procurement practices in construction projects
- To compare the planned materials with actual materials used in construction projects
- To identify the mechanism of material management system in construction projects and its challenges
- To determine the factors affecting effectiveness of material management system in housing construction projects

1.7 Scope and limitations of the Study

The study is limited to Addis Ababa housing construction project that are government projects on low cost house. So, this study more emphasized on the building construction which built by the government and also materials are supplied by government.

The study will not provide or show an exhaustive account assesses construction materials management system in Addis Ababa Housing construction projects. Because of as housing construction project there are many construction material management issues, as an example: cost, quality, quantity, time factor, procurement method, mechanisms of management system and so on.

1.8 significance of the study

Construction industry has complexity in its nature because it contains large number of parties as clients, contractors, consultants and stakeholders. However, in the capital city of the country in Addis Ababa building construction become very wider. Housing construction

projects was built low cost houses for homeless and low income peoples. The construction projects suffer from materials management problems and others because of many reasons and factors. This thesis is very important to identify material procurement practice, to compare material utility, to identify mechanism of material management system and to determine material management system in Addis Ababa housing construction projects.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

What is Material Management?

Different researchers provide different definitions for material management.

Therefore, different definitions can be found in different references. Basically, material management is concerned with the planning, identification, procuring, storage, receiving and distribution of materials. The purpose of material management is to assure that the right materials are in the right place, in the right quantities when needed. The responsibility of one department (i.e. Material management department) for the flow of materials from the time the materials are ordered, received, and stored until they are used is the basis of material management [16].

Defines material management as the process of planning, acquiring, storing, moving, and controlling materials to effectively use facilities, personnel, resources and capital. 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 [8].

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.

States that material management systems should be implemented to plan, order, check deliveries, warehousing, controlling the use of materials, and paying for materials. Defines material management as the process in which a company acquires the materials that it needs to achieve their objectives. This process usually begins with the requisition of materials from the supplier until the material is used or incorporated into a product. Define material management as a concept concerned with the management of materials until

the materials have been used and converted into the final product. Activities include cooperation with designers, purchasing, receiving, storage, quality control, inventory control, and material control [8].

Indicates that a material management system should have standard procedures for planning, expediting, transportation, receipt, and storage to ensure an efficient system for materials control, material management involves the control of the flow of goods in a firm. It is the combination of purchasing with production, distribution, marketing and finance. Material management is a function responsible for planning and controlling of materials flow [15].

Materials represent a major expense in construction, so minimizing procurement or purchase costs presents important opportunities for reducing costs. Poor materials management can also result in large and unavoidable costs during construction. First, if materials are purchased early, capital may be tied up and interest charges incurred on the excess inventory of materials. Even worse, materials may deteriorate during storage or be stolen unless special care is taken. For example, electrical equipment often must be stored in waterproof locations. Second, delays and extra expenses maybe incurred if materials required for particular activities are not available [16].

Accordingly, insuring a timely flow of material is an important concern of project managers. Materials management is not just a concern during the monitoring stage in which construction is taking place. Decisions about material procurement may also be required during the initial planning and scheduling stages. For example, activities can be inserted in the project schedule to represent purchasing of major items such as elevators for buildings [14].

The availability of materials may greatly influence the schedule in projects with a fast track or very tight time schedule. Sufficient time for obtaining the necessary materials must be allowed. In some cases, more expensive suppliers or shippers may be employed to save time. Materials management is also a problem at the organization level if central purchasing and inventory control is used for standard items. In this case, the various projects undertaken by the organization would present requests to the central purchasing group. In turn, this

group would maintain inventories of standard items to reduce the delay in providing material or to obtain lower costs due to bulk purchasing [17].

This organizational materials management problem is analogous to inventory control in any organization facing continuing demand for particular items. Materials ordering problems lend themselves particularly well to computer based systems to insure the consistency and completeness of the purchasing process. The use of automated materials requirements planning systems is common. In these systems, the master production schedule, inventory records and product component [12]

Lists are merged to determine what items must be ordered, when they should be ordered, and how much of each item should be ordered in each time period. The heart of these calculations is simple arithmetic: the projected demand for each material item in each period is subtracted from the available inventory.

When the inventory becomes too low, a new order is recommended. For items that are non-standard or not kept in inventory, the calculation is even simpler since no inventory must be considered. With a materials requirement system, much of the detailed record keeping is automated and project managers are alerted to purchasing requirements [26].

The role that a materials manager plays in an organization is strictly economical since the materials manager should keep the total cost of materials as low as possible. The person in charge of handling materials should keep in mind the goals of the company and insure that the company is not paying extra money for materials. The goal of every company is to make a profit. This is the basis for company survival, costs should not exceed income, but keeping in mind customer's expectations.

The typical tasks associated with a material management system are

Procurement and purchasing

Expediting

Materials planning

Materials handling

Distribution

Cost control

Inventory management / Receiving/ Warehousing

Transportation

Purchasing and procurement deals with the acquisition of materials to be used in the operations, The primary function of purchasing and procurement is to get the materials at the lowest cost possible, but keeping in mind quality requirements.

Expediting is the continuous monitoring of suppliers to ensure on time deliveries of materials purchased. The purpose of materials planning is to procure the materials for the dates when they are needed, storage facilities, and handling requirements. The primary function of materials handling is to manage the flow of materials in the organization. The manager has to assure that the costs associated with handling materials are kept to a minimum. In cost control, the manager has to insure that the costs to buy materials are kept to a minimum. In other words, the manager has to insure that he is buying the products at the lowest possible price. The inventory management deals with the availability of materials. Transportation involves using the safest most economical means to transport the materials to the site where they are needed.

Construction industry has complexity in its nature because it contains large number of parties as clients, contractors, consultants, stakeholders, shareholders, regulators and others [25].

Materials Management is simply the process by which an organization is supplied with the goods and services that it needs to achieve its objectives of buying, storage and movement of materials.

Basically, material management is concerned with the planning, identification, procuring, storage, receiving, and distribution of materials. The purpose of material management is to assure that the right materials are in the right place, in the right quantities when needed [1].

Material management is defined as a coordinating function responsible for planning and controlling materials flow. In a detailed view, materials management is a planned procedure that comprises the purchasing, delivery, handling and minimization of waste with the aim of ensuring that requirements are met [16].

Material management was defined as a process that coordinates planning, assessing the requirement, sourcing, purchasing, transporting, storing and controlling of materials, minimizing the wastage and optimizing the profitability by reducing cost of materials. Building materials account for 60 to 70 percent of direct cost of a project, the remaining 30 to 40 percent being the labour cost [17].

material management as the activities involved to plan, control, purchase, expedite, transport, store, and issue in order to achieve an efficient flow of materials and that the required materials are bought in the required quantities, at the required time, with the required quality and at an acceptable price [11].

Better material management practices could increase efficiency in operations and reduce overall cost. Top management is paying more attention to material management because of material shortages, high interest rates, rising prices of materials, and competition. There is a growing awareness in the construction industry that material management needs to be addressed as a comprehensive integrated management activity.

States that construction material can be classified into different categories depending on their fabrication and in the way that they can be handled onsite. He classifies the materials into five categories. They are:

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

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

Palleted materials- these are bagged materials that are placed in pallets for delivery. Packaged materials- these are materials that are packaged together to prevent damage during transportation and deterioration when they are stored.

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

Bulk materials- these are materials manufactured to standards and are purchased in quantity. They are bought in standard length or lot quantities.

Examples of such materials include pipes, wiring, and cables. They are more difficult to plan because of uncertainty in quantities needed.

Engineered materials- these materials are specifically fabricated for a particular project or are manufactured to an industry specification in a shop away from the site. These materials are used for a particular purpose. This includes materials that require detailed engineering data. Fabricated materials- these are materials that are assembled together to form a finished part or a more complicated part [11].

There are multi-facility problem for construction material management but by a realistic analysis this work out, Handling material, optimizing location of haul roads and crane location problem are some sort of this kind of problems. To properly supply the materials we should have a good understanding of different type of materials. This will help us to order the materials according to their sizes, time of the usage on site and other factors [8].

2.1.1 Ordering system

What materials, quantity, volume and location or distance to the site are the main issues in terms of ordering and this information will be clarified from contract documents such as the contract bill of quantities. Classification materials into an ordering system are very important. Classification can be in terms of size and essential rate to the construction programmed and quality control into four ordering systems [13].

Synchronized system

Prescheduled ordering system

Periodic ordering system

Non-periodic ordering system

Ordering large components such as air conditioning system, steel work, called synchronised system. The next step, big volume material such as panels and door called prescheduled ordering system; these are not as big as the synchronised system. Such materials like cement, gravel, called periodic ordering system which is required at various stage of project. And at least the materials which are obtained at the circumstance of the project and those are small volume and large quantity such as bolts, nails are called non-periodic ordering system.

2.1.2. Site arrangement

Material flow on site is the process of moving materials from the site entrance through a set of function areas to the final installation areas. This can be through a model such as Site entrances, lay down areas, staging areas, assembly areas, installation areas, and wastes areas.

Lay down area is for the long term use for main material to their owned lay down area for example steel or large panel formwork. For the frequency use of material if they are small volumes it should be shared with the same area. For short term temporary storage “ storage area” is suitable. “assembly areas” is the working area needed when materials are being placed when they finally remain and “wastes area” are also needed for the waste material [8, 26].

Materials management has directly affected the project cost and schedule as the efficiency of installation of construction materials and equipment highly depends on the planning and scheduling during materials management [12].

it is important to plan and control construction materials to ensure that the right quality and quantity installed and that the equipment are appropriately specified in a timely manner, obtained at a rational cost, and are available when needed. This is important as improper handling and management of materials during site works have great influences on the performance of construction projects. Further, improper handling of construction materials

will result in high generations of construction waste. Material management is a function that significantly contributes to the success of a project [16, 11].

As projects grow in scale and complexity, 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 materials, minimizing the wastage and optimizing the profitability by reducing cost of materials [20].

Generally, there are five stages involved within the materials management, namely the planning stage, procurement stage, logistics stage, handling stage, stock stage and waste control stage

2.2 Components of material management are:

- Material estimation, budgeting, planning and programming (the planning stage)
- Scheduling, purchasing and procurement (procurement stage, logistics stage)
- Receiving and inspection(
- Inventory control, storage and warehousing
- Material handling and transport (handling stage)
- Waste management (stock stage and waste control stage)

2.2.1 Material Planning

Project planners identify all the key construction materials from the project drawings, bill of quantities and specifications. This work is started, while preparing the bid and further refined in the project buyout stage. All these key materials are coded with unique ids. These IDS names, technical features, specifications, usages, design drawing numbers, manufacturers, together with the scheduled site and data are input in to the material database. Lack of planning is one of the major problems for construction on site, there are lots of factors which have the capability for significant effect on improving construction planning such as consuming more time for planning before starting job, relationship between different parties, alternative plan and sufficient time, control time, revision interval and finally construction method control. Portable reader and other supporting facilities on site allow site engineers to

track material delivery on site storage, installation, progress and changes. This information is sent to the dynamic material database in alive or nearly live manners and the other project team will be able to obtain the material information in a real time manner [28, 8].

Re-planning and scheduling, key project management staff can compare the live information received with the material plan schedule and design to identify and predict problems and to take corrective actions.

Materials planning include quantifying, ordering and scheduling. It is stressed that planning is especially in terms of increasing productivity, profit and facilitating the timely completion of construction projects. Hence, productivity will suffer if the material planning process is not executed properly [15].

Material planning would provide guides to all the subsequent activities and that this could have a great impact on the project plan. The materials planning process covers the set up and maintenance of records and determines the target inventory levels, and delivery frequency. Planning of access and routing of materials within a construction site has an important implication for the development of an effective materials management strategy [14]. The most commonly used basis for planning things out for the project is the BOQ prepared by the client. Companies may have two major levels in planning- micro and macro level. Time, cost, material and labour are the four major types of planning undertaken on sites. The planning should be revised as frequently as possible in order to monitor whether work is progressing as planned [17].

2.2.2 Procurement

Construction is a complex industry where the needs of the project owner changes over the duration of the project. The project owner relies on a network of manufacturers, manufacturing representatives, general contractors, sub-contractors, distributors, engineers and architects to provide a high quality product at the lowest possible price in a timely manner. In a construction project material and equipment procurement has been targeted by owners as a place where they can lower the price of construction. Today, project owners employ a variety of methods to achieve perceived cost-saving on material and equipment.

Owners procure material directly from the manufacturer or from the distributors. Typically the owner and manufacturer have developed processes chains that remove transactional cost from the supply chain.

Managing material procurement can have a significant impact on the time and cost of a project. Materials management is not just a concern during the monitoring stage in which construction is taking place. Decisions about material procurement may also be required during the initial planning and scheduling stages [12].

Procurement covers a wide purchasing of materials, equipment, labor and services needed for execution of a project. Procurement is organizing the purchasing and scheduling delivery of materials to the suppliers. Over-ordering of materials can result wastage problems in the construction site [9]. The purpose of the supply sourcing function for construction organizations is to buy materials and services of the right quality, in the right quantity, and at the right price from the right source at the right time. The supply sourcing department assists the project team in performing their responsibilities within the project's budgetary and scheduling goals. Supply sourcing managers and purchasing agents seek to obtain the highest-quality subcontractors and materials at the lowest possible cost for their organizations. Sourcing managers determine which bulk materials, commodities, or services are best; choose the suppliers of the material or service; negotiate the lowest price and award contracts that ensure that the correct amount of the material or service is received at the appropriate time. In small construction firms, the owner is usually responsible for all of the sourcing and purchasing functions. In order to accomplish these tasks successfully, sourcing managers (owners) must identify the most qualified suppliers. Supply sourcing managers must also become experts on the materials and services that they purchase [27].

Materials management is also a problem at the organization level if central purchasing and inventory control is used for standard items. In this case, the various projects undertaken by the organization would present requests to the central purchasing group.

Materials ordering problems lend themselves particularly well to computer based systems to insure the consistency and completeness of the purchasing process. In the manufacturing realm, the use of automated materials requirements planning systems is common.

Procurement is described as the purchase of materials and services from outside organizations to support the firm's operations from production to marketing, sales and logistics. A detail material schedule and co-ordination of the procurement and order of material are important in assuring material availability [15].

Purchase requisitions: Purchase requisitions are documents listing the requirements of materials from the various stores written by the storekeeper received by the purchase department from various departments. The planning department for special purchases for non-stock items also prepares the purchase requisitions [25].

Purchasing and procurement deals with the acquisition of materials to be used in the operations. The primary function of purchasing and procurement is to get the materials at the lowest cost possible, but keeping in mind quality requirements. Expediting is the continuous monitoring of suppliers to ensure on time deliveries of materials purchased. The purpose of materials planning is to procure the materials for the dates when they are needed, storage facilities, and handling requirements. The primary function of materials handling is to manage the flow of materials in the organization. The manager has to assure that the costs associated with handling materials are kept to a minimum [11].

The purpose of the supply sourcing function for construction organizations is to buy materials and services of the right quality, in the right quantity, and at the right price from the right source at the right time. The supply sourcing department assists the project team in performing their responsibilities within the project's budgetary and scheduling goals. Supply sourcing managers and purchasing agents seek to obtain the highest-quality subcontractors and materials at the lowest possible cost for their organizations. Sourcing managers determine which bulk materials, commodities, or services are best; choose the suppliers of the material or service; negotiate the lowest price and award contracts that ensure that the correct amount of the material or service is received at the appropriate time. In small

construction firms, the owner is usually responsible for all of the sourcing and purchasing functions. In order to accomplish these tasks successfully, sourcing managers (owners) must identify the most qualified suppliers. Supply sourcing managers must also become experts on the materials and services that they purchase [1, 13].

Managers in this critical sourcing function evaluate suppliers on the basis of quality, price, service support, availability, and reliability in order to purchase services competitively and wisely.

Poor planning leads to inefficiency, low productivity, excessive waste, and health and safety problems. Supply chain management is one of the most important solutions for improving productivity and efficiency and preventing wasted time and cost. Planning and controlling of raw materials, components and finished produced are some obstacles for supply chain management for communication and feedback in supply chain management.

Firstly the construction material needs for the project to prepared estimation of material needs by the consultant/by the designer /the engineer give to the construction follow-up and agreement administration office [7, 5].

Secondly the construction follow-up and agreement administration office ask these materials to the construction material supplier office.

Thirdly the construction material supplier office award contract of the supplier, then procure materials for the material purchasing by the material purchasing office. After purchasing receive the material deliver to the construction site then inspect the material by the construction material control officer. Then after the contractor receive the material from the client and consume it when the material surpluses the contractors return to the construction material supplier office store [10].

Total Surplus: This measure reports the percentage value of unused materials in relation to the total purchase cost of materials.

The value of unused materials is determined before being coded for return or restocking or disposition by third parties or facility operations and maintenance.

2.2.3 Logistics

Generally, logistics is a concept that emphasizes movement and it may include planning, implementing, and controlling the flow and storage of all goods from raw materials to the finished product to meet customer requirements. There is evidence that the routing of materials is one of the main points which affect cost and time during construction projects [14, 15].

According to American council of logistic management: Logistics as “the process of planning, implementing and controlling the efficient, cost effective flow and storage of raw materials, in-process inventory, finished goods and related information from point of origin to point of consumption for the purpose of conforming to customers’ requirements”

In terms of logistics, the main problems are wrong time of materials arriving to the site or even wrong quality, lack of information for materials arrival to the site or site stock, missing materials, unavailability of storage space, and waste of labour for materials searching on site.

2.2.4 Handling

Material handling, which includes procurement, inventory, shop fabrication and field servicing, requires special attention for cost reduction.

effective material handling as using the right method, amount, material, place, time, sequence, position, condition, and cost. This involves handling, storing, and controlling of the construction materials. Handling of materials is the flow component that provides for their movement and placement. The importance of appropriate handling of materials is highlighted by the fact that they are expensive and engage critical decisions. Due to the frequency of handling materials there are quality considerations when designing a materials handling system [14].

Material handling equipment selection is an important function as it can enhance the production process, provide effective utilization of manpower, increase production and improve system flexibility. Material storage on site requires close attention in order to avoid waste, loss and any damage of materials which would affect the operation of the construction

project. Problems always arise during materials supply because of improper storage and protection facilities.

Material handling, which includes procurement, inventory, shop fabrication and field servicing, requires special attention for cost reduction. Materials management is an important element in project planning and control. Materials represent a major expense in construction, so minimizing procurement or purchase costs presents important opportunities for reducing costs. Poor materials management can also result in large and avoidable costs during construction. First, if materials are purchased early, capital may be tied up and interest charges incurred on the excess inventory of materials. Even worse, materials may deteriorate during storage or be stolen unless special care is taken [13, 21].

Second, delays and extra expenses may be incurred if materials required for particular activities are not available. Accordingly, insuring a timely flow of material is an important concern of project managers. Materials management is not just a concern during the monitoring stage in which construction is taking place. Decisions about material procurement may also be required during the initial planning and scheduling stages.

The availability of materials may greatly influence the schedule in projects with a fast track or very tight time schedule: sufficient time for obtaining the necessary materials must be allowed. In some case, more expensive suppliers or shippers may be employed to save time [18].

2.2.5 Stock and Waste Control

Stock control is classified as a technique devised to cover and ensure all items are available when required. Stock control can include raw materials, processed materials, assembly components, consumable stores, general stores, maintenance materials and spares, work in progress and finished products. It is of great importance that the bulk of construction materials delivery requires proper managements of stock control [15].

Materials delivery to site is a critical, productivity-related aspect which demands the introduction of a carefully developed system of monitoring and control as early as possible

[14].Reducing waste really means making more efficient use of materials. The end product is the same, but in adopting efficient practices you will purchase less material and generate less waste. You save on both material costs and waste disposal costs.

Stock Record Cards: - as opposed to bin card, stock record cards are kept together in one place under the custody of the stock clerk. The purpose of maintaining Stock Records Cards is to have record of the cost price and value of stock received, issued and remaining balance in the storage. One card should be prepared for each item in the stock. The stock card should be arranged and maintained based on the stock classification and coding [23].

Types of physical storage system on site vary according to the space availability and company practices. Industrial guidelines are also taken into consideration for the stacking and storage of particular materials. Materials are most often classified as per the comfort level of working of the workers. Basic categories followed are civil, electrical, plumbing, finishes, construction chemicals, miscellaneous. The materials are also often stacked as per the specification of the vendor or manufacturer. Relevant IS Codes (IS: 4082: recommendations on stacking and storage of construction materials at site) specifications are also followed. E.g.: As per IS: 4082, 1.The materials should not be affected by impurities or atmospheric agencies. 2. Materials like cement should must be stored in covered sheds and stacked on timber raised platforms. 3. Reinforcing bars should be stacked yards away from moisture to prevent rusting and also away from oil and lubricants. Bars of different classification, sizes and lengths should be stored separately to facilitate issues. [17].

Material waste has been recognized as a major problem in the construction industry that has important implications both for the efficiency of the industry and for the environmental impact of construction projects. [1].

2.2.6 Receiving and issuing material

According to sunders an, M. the receipt system can be divided into:

Receipt from outside suppliers

Materials Receiving Processing Time: This measure reports the percentage of material received by the warehouse that is processed within two time periods: same day and next day.

The processing time starts when a shipping document is time/date stamped by the warehouse receiving activity, and a copy is returned to the transport carrier. The processing time ends when the material is updated to receive status within the materials management system [21].

Materials Receipt Problems: This measure reports the data or information discrepancies associated with a material delivery that if not detected and corrected would cause inaccuracies in the project materials management database. Material receipt problems occur when shipping documents or materials do not agree in specific areas with the purchase order or receiving report. This measure is the percentage of line items received without discrepancy.

PO to Materials Receipts Duration: This measure represents the average duration from the issuance of the PO until the receipt date of the material. It is the ratio of the average duration to planned duration. Average duration is calculated based on each PO line item. Therefore, the measure is the sum of the issuance-to-receipt duration divided by the total number of receipts [25].

Receipt from internal divisions

System of receipt starts even before the material reaches the site. The three documents that should be dispatched are copy of purchase order, suppliers advance document and the consignment note. This enables the store's manager to organize and plan for clearances of materials. For receipt from internal divisions, usually transfer notes and return to stores documents are used.

According to Sundersan, M. issues can be divided into

1. Issues to consuming departments
2. Issues to outside suppliers for processing or conversion.

Issuing on site does not happen in the case of all construction materials. In the case of sand or aggregate, the materials are consumed as and when required corresponding to the progress of the project. For other materials, issues are based on production programs. Based on this and the bill of materials, work orders are printed, listing for each material, quantity to be issued against each component requiring that material. This automatically controls consumption [4].

2.3 Process of Material Management

Material management process initiates from need generated from site then this information conveyed to store department and material is ordered in the store, indent is generated.

Vendor selection is to be carried out for the least value and best items. Materials are received at store department and inspection is carried out [6].

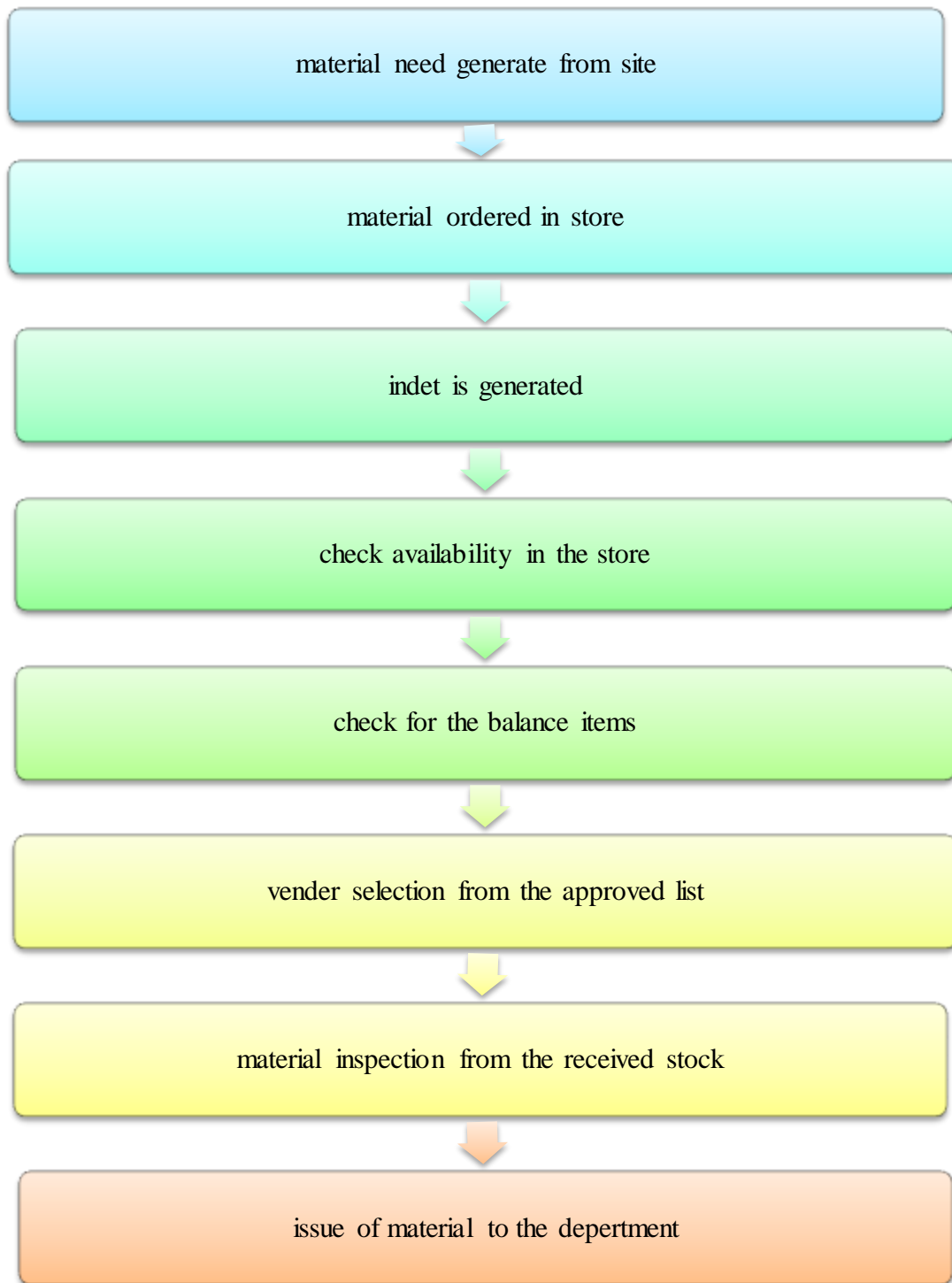


Figure2.1 Process of Material Management

2.4 Material management challenges on construction site.

Materials management can be divided into five categories:

- ✚ The measurement and specification;
- ✚ The procurement and purchasing process where the order is transmitted to the supplier;
- ✚ Delivery to site and logistics of checking the order, offloading, and storing on site;
- ✚ The administrative and financial process of payment;
- ✚ Using the materials in production on the job site and removing the waste.

In terms of purchasing and supply of materials, not matching materials with the ordering purchase, forgetting ordering materials, over or less materials, early or late materials arriving, lack of training and adequate management, lack of communication and relation between contractor and supply chain companies are the main obstacles [8].

Some common problems on construction site are more obvious which are namely:

- ✚ Failure to order on time which delays the projects;
- ✚ Delivery at the wrong time which interrupts the work schedule;
- ✚ Over ordering;
- ✚ Wrong materials or error in direction of materials requiring re-work;
- ✚ Theft of materials from delivery into production;
- ✚ Double handling of materials because of inadequate material.

In terms of logistics, the main problems are wrong time of materials arriving to the site or even wrong quality, lack of information for materials arrival to the site or site stock, missing materials, unavailability of storage space, and waste of labour for materials searching on site

The research has identified a gap between the procurement and ordering of materials and the delivery and use of the material on site at the production stage

2.5. Importance of Materials for a Project

Problems related to managing the flow of materials can be found in every organization. The efficient management of 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. Materials account for a big part of products and project costs. The cost represented by materials fluctuates and may comprise between 20-50% of the total project cost and sometimes more. Some studies concluded that materials account for around 50-60% of the project cost [11].

Materials are critical in the operations in every industry since unavailability of materials can stop production. In addition, unavailability of materials when needed can affect productivity, cause delays and possible suspension of activities until the required material is available.

Unavailability of materials is not the only aspect that can cause problems. Excessive quantities of materials could also create serious problems to managers. Storage of 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 materials until they are needed. Some of these alternatives might require re-handling of materials, which will increase the costs associated with them. Provisions should be taken to handle and store the materials adequately when they are received. Special attention should be given to the flow of materials once they are procured from suppliers [24].

It is obvious that materials should be obtained at the lowest cost possible to provide savings to the company. Construction companies experienced an increase in costs and a decrease in productivity. Owners of these companies thought that these increases in cost were due to inflation and economic problems. Further research concluded that these companies were not using their resources efficiently and that the decrease in productivity was also attributable to poor management [1].

Material management has been an issue of concern in the construction industry. 40% of the time lost on site can be attributed to bad management, lack of materials when needed, poor identification of materials and inadequate storage [11].

The need for an effective 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 materials management. Timely availability of materials and systems are vital to successful 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 [5].

Better material management practices could increase efficiency in operations and reduce overall cost. Top management is paying more attention to material management because of material shortages, high interest rates, rising prices of materials, and competition. There is a growing awareness in the construction industry that material management needs to be addressed as a comprehensive integrated management activity [3].

2.6 Effective construction materials management system

Effective material management is the most important materials management functions are (I) Primary Functions is to meet the primary objectives, the primary functions of the materials management are given as materials requirements planning (MRP), purchasing, inventory planning and control, ascertaining and maintaining the flow and supply of materials, quality control of materials, departmental efficiency. (II) Secondary functions are standardization and simplification, make and buy decisions, coding and classification of materials, forecasting and planning [1].

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Better material management practices could increase efficiency in operations and reduce overall cost. Top management is paying more attention to material management because of material shortages, high interest rates, rising prices of materials, and competition. There is a growing awareness in the construction industry that material management needs to be addressed as a comprehensive integrated management activity [11].

An effective management system can be vital for the success of Construction Company. It has been estimated that the lack of effective materials management has resulted in work hour overrun of 18% [20]. It was also reported that a basic material management system can be expected to produce a 6% improvement in craft labor productivity. When a sophisticated system is installed, an additional 4 – 6% increase in craft labor savings can be achieved. Material management is the planning and controlling of all necessary efforts to ensure that the quality and quantity of materials and installed equipment are appropriately specified, are obtained at a reasonable cost, and are available when needed [19].

Material price is subject to supply and demand and is affected by many other things, including quality, quantity, time, place, buyer and seller.

Other factors affecting material cost include: currency exchange, low or high demand, material specification, inflation pressure and availability of new materials in the country.

An effective material management system can bring many benefits for a company.

Previous studies by the Construction Industry Institute (CII) concluded that labor productivity could be improved by six percent and can produce 4-6% additional savings [2].

Among these benefits are:

Reducing the overall costs of materials

Better handling of materials

Reduction in duplicated orders

Materials will be on site when needed and in the quantities required

Improvements in labor productivity

Improvements in project schedule

Quality control

Better field material control

Better relations with suppliers

Reduce of materials surplus

Reduce storage of materials on site

Labor savings

Purchase savings

Better cash flow management

From a study of twenty heavy construction sites, the following benefits from the introduction of materials management systems were noted [2].

In one project, a 6% reduction in craft labor costs occurred due to the improved availability of materials as needed on site. Other projects, an 8% savings due to reduced delay for materials estimated.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Location of the study

The study area was located at the capital city of Ethiopia in Addis Ababa

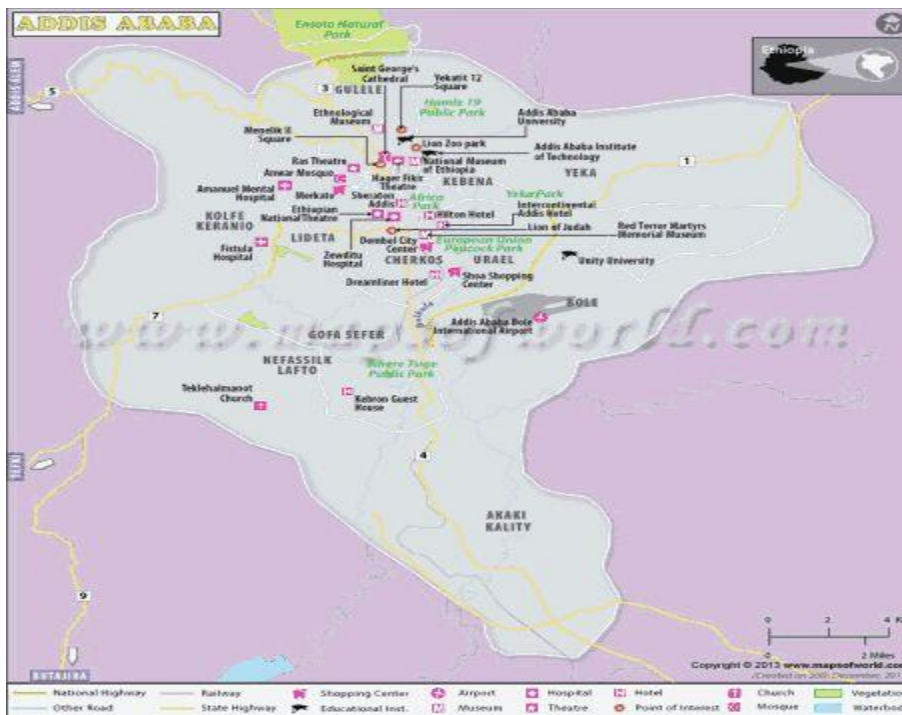


Figure 3.1 Map of Addis Ababa: source (www.mapsofworld.com/where-is/addis-ababa.html)

3.2 Study procedure

The researcher follows a certain procedure in this study starting from proposal to final thesis by referring different literature review based on my title prepare the questionnaires, select the sampling size and distribute the questionnaires to the target group. Then collect the data with interview and finally to made data analysis and also made conclusion and recommendation.

3.3 Sample technique

There was three targeted group in Addis Ababa housing construction projects which are owners, consultants and contractors. Generally, selected eighteen projects and 70 questionnaires were distributed for the three parties which were and still engaged in Addis Ababa housing construction projects. Judgmental purposive technique was hired to select the relevant sample units purposely for the problem and interview some stakeholders among respondents.

There were three groups of respondents considering grouping one as owner group, group two as consultant group and group three as contractor group. 70 questionnaires were distributed for Owner group 35 questionnaires were distributed, for consultant group 15 questionnaires were distributed and for contractor group 20 questionnaires were distributed. 60 questionnaires were received (85.71%) as follows: 30(85.71%) from owners, 10(66.67%) from consultants and 20(100%) from contractors as respondents.

Table 3.1 percentages of questionnaire received

Questionnaire survey	owners	consultants	contractors	total
No of questionnaires distribution	35	15	20	70
No of questionnaires received	30(85.71%)	10(66.67%)	20(100%)	60(85.71%)
No of questionnaires unreceived	5(14.29%)	5(33.33%)	0	10(14.29%)

3.4 Research design

The purpose of this research is to explore the current practices of construction materials management of building projects. In this research, few methods of data collection were used including observation, documentations, interviews and questionnaire. The study was carried out in Addis Ababa Housing Construction Project Office (condominium).

A structured questionnaire with personal interviews is used together in this research.

The structured questionnaire is probably the most widely used data collection technique for conducting surveys. Questionnaires have been widely used for descriptive and analytical surveys in order to find out facts, opinions and views[20]. It enhances confidentiality, facilitates analysis, and saves resources. The advantages of interviews as summarized as follows:

The response rate is relatively high.

Providing more accurate answers and Eliminating the tedium and idleness of the respondents

3.5 study variable

There was two type of variable which was independent variable and dependent variable

Independent variables:

Poor procurement practice

Improper material handling

Mechanism of material management system

Material waste on construction site

Dependent variable:

Good construction material management system

3.6 Instruments

There were no needs of any especial instrument in this study because this thesis was case study, so the researcher use for data collection pen with white paper and simple camera. For the data analysis and finalized the thesis used computer.

3.7 Data collection process

In this research, few methods of data collection were used including observation, documentations, interviews and questionnaire and methods of data analysis.

A structured questionnaire with personal interviews is used together in this research. The questions of the research questionnaire are constructed based on literature review.

There were interviewed 10 stakeholders who are owners, consultants and contractors in Addis Ababa housing construction project and asked them to fill the questionnaire during the interview. The interview gave to a far extent, accurate and clear answers due to the clarifications which made by the researcher.

Before carrying out the interview, the questionnaire was sent to Addis Ababa housing construction project and specific time and date were determined for interview. This provided a chance for the Addis Ababa housing construction project stakeholders to study the questions before answering them. In the beginning of the interview the researcher introduced himself to the respondent to create a friendly atmosphere, then thanked the respondent and affirmed that all the data to be collected would be used only for the research and would not be transferred to any other party.

The questionnaire was built mainly using closed questions, and it was divided into five sections as follows:

Section one: personal information, which includes 4 items.

Section tow: assess the method of material procurement practices in construction projects 4 items.

Section three: compare the planned materials and actual materials used in construction projects 11 items.

Section four: identify the mechanism of material management system in construction projects and its challenges 34 items.

Section five: factors affecting effective material management system 7 items.

The questionnaire was developed An English (Annex 1) to be more understandable by respondents.

The researcher used relative importance index for some calculations. In order to be able to select the appropriate method of analysis, the level of measurement must be understood. For each type of measurement, there is an appropriate methods that can be applied and not others. In this research, ordinal scales were used. Ordinal scale as shown in Table 3.2 is a ranking or a rating data that normally uses integers in ascending or descending order. The numbers assigned to the important (1, 2, 3, 4) do not indicate that the interval between scales are equal, nor do they indicate absolute quantities. They are merely numerical labels. Based on Likert scale we have the following table 3.2[25].

Table (3.2) Ordinal scale used for data measurement

item	Strongly agree	agree	Disagree	Strongly Disagree
scale	4	3	2	1

The relative importance index method (RII) is used here to determine owners, consultants and contractors perceptions of the relative importance of the in housing construction projects. The relative importance index is computed as [25].

Where:

W is the weight given to each factor by the respondents and ranges from 1 to 4

A = the highest weight = 4

N = the total number of respondents

The Relative importance index (RII) was calculated using the formula: $RII = \frac{\sum W}{A \times N}$ (Where W= the weight assigned to each strategy by the respondents, A = Highest weight (which is 4 in this case), N = the total number of respondents. The limits of definition of RII were: $0 < RII \leq 0.25$ = Strongly Disagree, $0.25 < RII \leq 0.50$ =

Disagree, $0.50 < RII \leq 0.75$ = Agree $0.75 < RII \leq 1$ = Strongly Agree. A rank ordering of these variables were then assigned based on the calculated RII.

3.8 Field work

The problem solving approach accompanied with a field survey was adopted for conducting this research. In the problem-solving approach (also named action research), the researcher reviews the current situation, identifies the problem, gets involved in introducing some changes to improve the situation and, possibly, evaluates the effect of his/her changes. This type of research is more attractive to practitioners, industrialists, and students from the professional background that has identified a problem during the course of work and wish to investigate and propose a change to improve the situation [21].

A questionnaire was designed and constructed to survey the situation and reality of construction materials management practices of Addis Ababa housing construction projects.

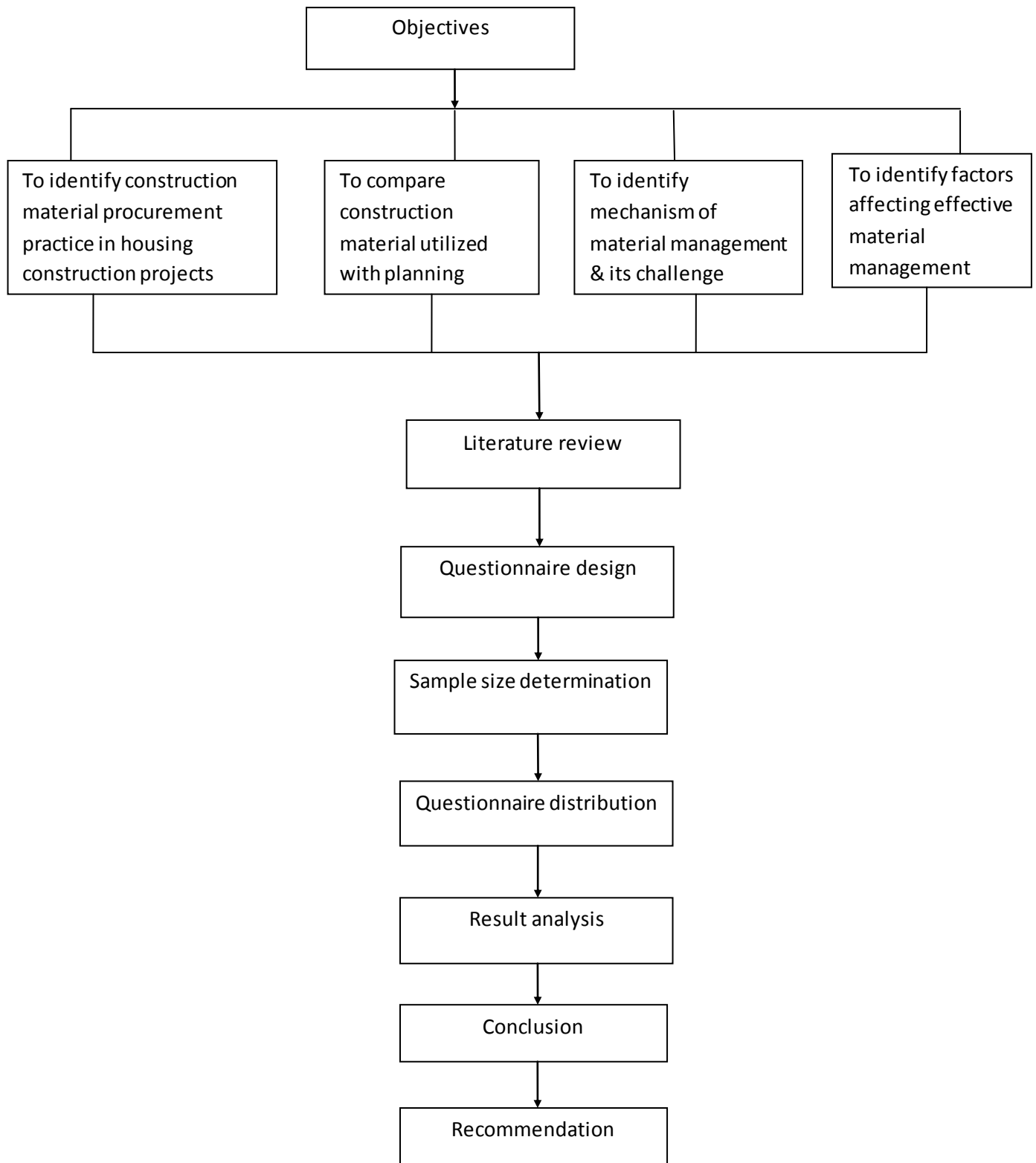


Figure 3.2: Methodology flow chart

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the results of the field survey are presented and discussed. The chapter illustrates and discusses the description of response rate, method of construction materials procurement practice in Addis Ababa housing construction projects, material utility, mechanism of material management system in construction projects and its challenges and Affecting effective material management on construction sites.

4.2 part one: Type of organization and response rate

1. Type of organization

Table 4.1 shows the frequency and percent of each type of organization:

Type of organization	Frequency	percentage
owners	30	54.55%
consultants	10	18.18%
contractors	15	27.27%

2. Response rate:

These respondents in housing construction project office are in charged as Construction follow-up and agreement administration leaders, General Service and material supplier administration leaders and Material purchaser and operation plan senior officers in the side of owners. Resident engineers and site inspectors in the side of consultants and site engineers and construction foreman in the side of contractors, as they have a practical experience in construction industries field. Their sufficient experiences are a suitable to find out the reality of construction material management system of the owner, consultant and contractor parties in housing constructions projects office (condominium houses).

Table 4.2 shows the frequency and percent of job title of the respondent according to each type of target group:

Questionnaire survey	owners	consultants	contractors	total
No of questionnaires distribution	35	15	20	70
No of questionnaires received	30(85.71%)	10(66.67%)	20(100%)	60(85.71%)
No of questionnaires unreceived	5(14.29%)	5(33.33%)	0	10(14.29%)

4.3. Part two: method of construction materials procurement practice in Addis Ababa housing construction projects

1. Type of procurement

The method of material procurement practices on construction sites in housing construction projects as a government projects its open bid use.

Construction is a complex industry where the needs of the project owner changes over the duration of the project. The project owner relies on a network manufacturer, manufacturing representatives, general contractors, sub-contractors, distributors, engineers and architects to provide a high quality product at the lowest possible price in a timely manner. In a construction project material and equipment procurement has been targeted by owners as a place where they can lower the price of construction. Today project owners employ a variety of methods to achieve perceived cost-saving on material and equipment. There for owners procure material directly from the manufacturer or from distributors. Typically the owner and manufacturer have developed processes chains that remove transactional cost from the supply chain.

2. Method of procurement

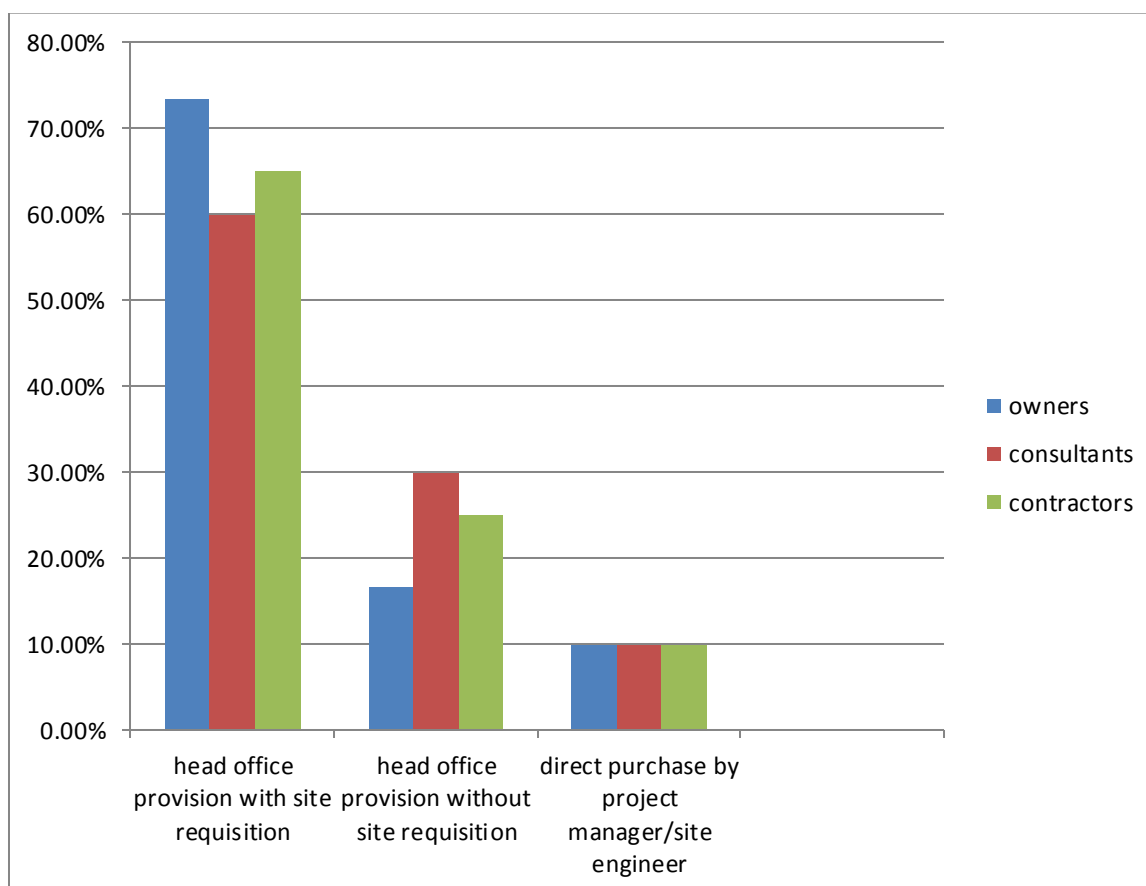


Figure 4.1:- Manner of Material Procurement Practices in Addis Ababa housing Construction projects.

Owners view

The results shows 16.67% of procures materials for construction sites by head office provisions without site requisition, 73.33% of respondent's organization procure materials for construction sites by head office provisions with site requisition and 10% of respondent's organization procures materials for construction sites through direct purchase by site manager or engineer. The low percentage of 10% of methods of procurement of materials for construction sites by direct purchase, by site manager or engineer is not surprising since such method is prone to challenges of accountability and corruption.

Consultants view

The results shows 30% of respondent's organization procures materials for construction sites by head office provisions without site requisition, 60% of respondent's organization procure materials for construction sites by head office provisions with site requisition and 10% of respondent's organization procures materials for construction sites through direct purchase by site manager or engineer. The low percentage of 10% of methods of procurement of materials for construction sites by direct purchase, by site manager or engineer is not surprising since such method is prone to challenges of accountability and corruption.

Contractors view

The results shows 25% of respondent's organization procures materials for construction sites by head office provisions without site requisition, 65% of respondent's organization procure materials for construction sites by head office provisions with site requisition and 10% of respondent's organization procures materials for construction sites through direct purchase by site manager or engineer. The low percentage of 10% of methods of procurement of materials for construction sites by direct purchase, by site manager or engineer is not surprising since such method is prone to challenges of accountability and corruption.

This results also endorses procurement of materials for construction sites by head office provisions with site requisition as a better option than procurement without site requisition which might amount to over supplying or under supplying materials leading to wastage or delay as the case may be. In generally above 60% of the respondents in housing construction project material procurement for construction site by head office provision with site requisition

4.4 part three: material utility

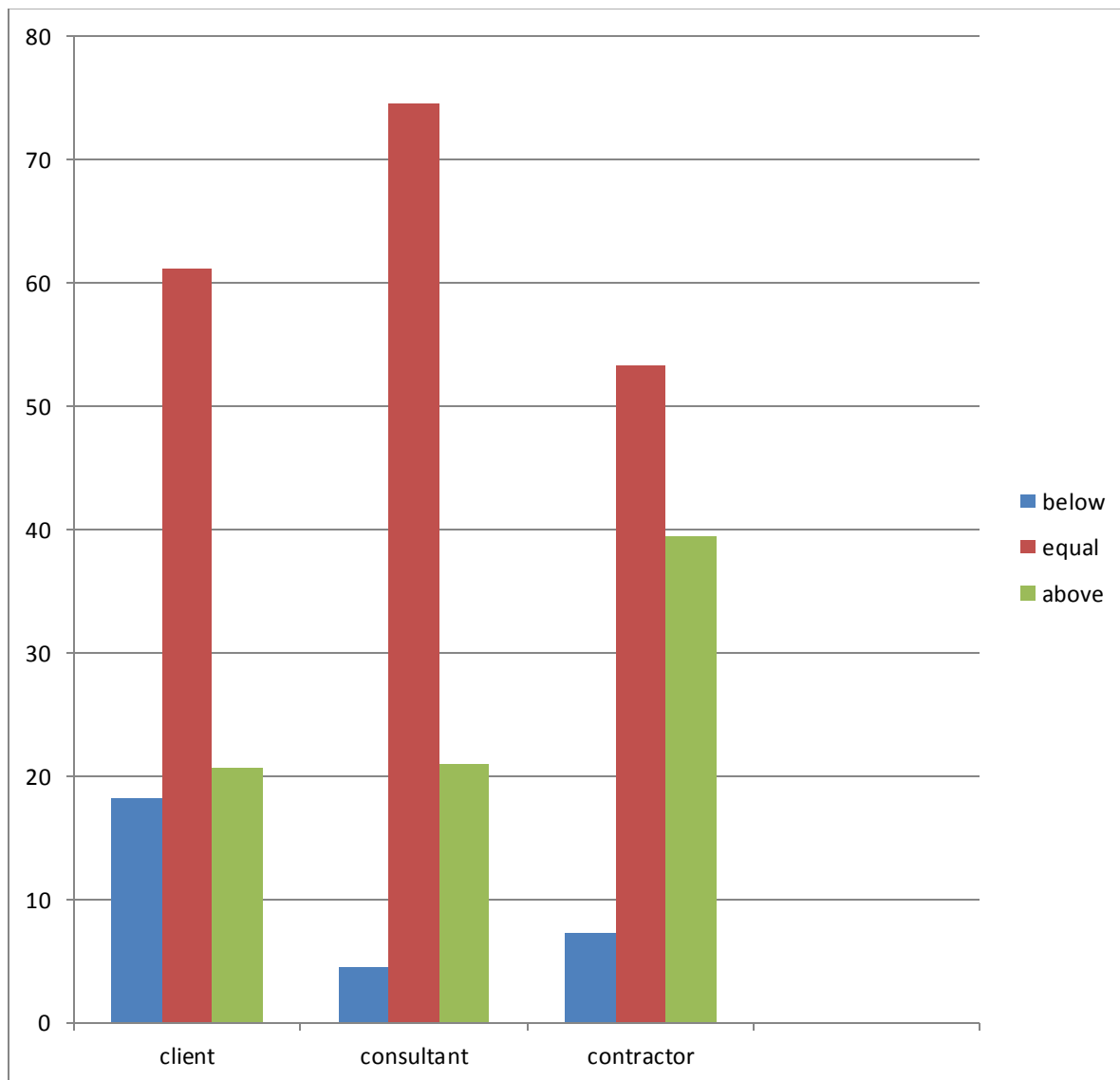


Figure 4.2:- actual material utility as per planned

It is the responsibility of the inspector to inspect all materials delivered to the site prior to their being used in the work. It is desirable to perform inspection of materials or fabricated products prior to their delivery at site. E.g.: pre-cast members. The inspector shall have rights to reject faulty material and have it removed from site. With respect to manufactured goods, the quality requirements should be specified in the purchase order.

Owners view

The results shows that planned versus actual used materials in housing construction projects 83.33% of respondents believe that the actual cement used meet with planned cement, 10% of respondents below of the planned and 6.67% of it above of the planned.

66.67% of respondents believe that the actual aggregate used meet with planned aggregate, 13.33% of respondents below of the planned and 20% of it above of the planned.

76.67% of respondents believe that the actual sand used meet with planned sand, 10% of respondents below of the planned and 13.33% of it above of the planned.

80% of respondents believe that the actual reinforcement bar used meet with planned reinforcement bar, 10% of respondents below of the planned and 10% of it above of the planned.

50% of respondents believe that the actual pipes used meet with planned pipes, 36.67% of respondents below of the planned and 25% of it above of the planned.

43.33% of respondents believe that the actual tiles used meet with planned tiles, 13.33% of respondents below of the planned and 20% of it above of the planned.

33.33% of respondents believe that the actual electric fittings used meet with planned electric fittings, 16.67% of respondents below of the planned and 50% of it above of the planned.

30% of respondents believe that the actual sanitary materials used meet with planned sanitary materials, 20% of respondents below of the planned and 50% of it above of the planned.

63.34% of respondents believe that the actual blocks (HCB) used meet with planned blocks (HCB), 23.33% of respondents below of the planned and 13.33% of it above of the planned.

70% of respondents believe that the actual pre-casts used meet with planned pre-casts, 16.67% of respondents below of the planned and 13.33% of it above of the planned.

76.67% of respondents believe that the actual roofing materials used meet with planned roofing materials, 10% of respondents below of the planned and 13.33% of it above of the planned.

Consultants view

The results shows that planned versus actual used materials in housing construction projects 80% of respondents believe that the actual cement, sand and pipes used meet with planned those and 20% of it above of the planned.

70% of respondents believe that the actual aggregate and pre-casts used meet with planned those, 10% of respondents below of the planned and 20% of it above of the planned.

90% of respondents believe that the actual reinforcement bar and roofing materials used meet with planned those and 10% of it above of the planned.

50% of respondents believe that the actual tiles used meet with planned tiles, 10% of respondents below of the planned and 40% of it above of the planned.

70% of respondents believe that the actual electric fittings used meet with planned electric fittings, and 30% of it above of the planned.

60% of respondents believe that the actual sanitary materials used meet with planned sanitary materials, 10% of respondents below of the planned and 30% of it above of the planned.

80% of respondents believe that the actual blocks (HCB) used meet with planned blocks (HCB), 10% of respondents below of the planned and 10% of it above of the planned.

Contractors view

The results shows that planned versus actual used materials in housing construction projects 46.67% of respondents believe that the actual cement used meet with planned cement and 53.33% of it above of the planned.

53.33% of respondents believe that the actual aggregate used meet with planned aggregate, 6.67% of respondents below of the planned and 40% of it above of the planned.

33.33% of respondents believe that the actual sand used meet with planned sand, 6.67% of respondents below of the planned and 60% of it above of the planned.

53.33% of respondents believe that the actual reinforcement bar and tiles used meet with planned those, 13.34% of respondents below of the planned and 33.33% of it above of the planned.

46.67% of respondents believe that the actual pipes used meet with planned pipes, 6.66% of respondents below of the planned and 46.67% of it above of the planned.

40% of respondents believe that the actual electric fittings used meet with planned electric fittings, 13.33% of respondents below of the planned and 46.67% of it above of the planned.

40% of respondents believe that the actual sanitary materials used meet with planned sanitary materials, 16.67% of respondents below of the planned and 53.33% of it above of the planned.

80% of respondents believe that the actual blocks (HCB) used meet with planned blocks (HCB) and 20% of it above of the planned.

73.33% of respondents believe that the actual pre-casts used meet with planned pre-casts and 26.67% of it above of the planned.

66.66% of respondents believe that the actual roofing materials used meet with planned roofing materials, 13.34% of respondents below of the planned and 20% of it above of the planned.

4.5 part four: mechanism of material management system in construction projects and its challenges

4.5.1 Necessity degree and usage degree

Table (4.3) as owner perception Mechanisms necessity degree and usage degree in managing construction material

	mechanisms	Necessity degree			Usage degree		
		Very necessary	Somehow necessary	unnecessary	usually	occasionally	rarely
Establishing database	Establishing categorized materials database	43.33%	50%	6.67%	66.67%	23.33%	10%
	Creating local supplier database	50%	26.67%	23.33%	43.33%	33.33%	23.33%
	Creating international supplier database	30%	60%	10%	40%	33.33%	26.67%
	Creating materials price database	76.67%	16.67%	6.67%	36.67%	46.67%	16.67%
Updating	Updating the database of local supplier	40%	43.33%	16.67%	36.67%	50%	13.33%
	Updating the database of international supplier	66.67%	16.67%	16.67%	56.67%	30%	13.33%
	Updating the database of materials price when change	80%	10%	10%	60%	23.33%	16.67%

Owners view

43.33% of respondents believe that Establishing categorized materials data base very necessary, 50% was somehow and 6.67% unnecessary and 66.67% of it usually used, 23.33% was occasionally and 10% rarely.

50% of respondents believe that creating local supplier data base very necessary, 26.67% was somehow and 23.33% unnecessary and 43.33% of it usually used, 33.33% was occasionally and 23.33% rarely,

30% of respondents believe that creating international supplier data base very necessary, 60% was somehow and 10% unnecessary and 40% of this usually used, 33.33% was occasionally and 26.67% rarely.

76.67% of respondents believe that updating creating materials price data base very necessary, 16.67% was somehow and 6.67% unnecessary and 36.67% of this usually used, 46.67% was occasionally and 16.67% rarely.

40% of respondents believe that updating the data base of local supplier very necessary, 43.33% was somehow and 16.67% unnecessary and 36.67% of this usually used, 50% was occasionally and 13.33% rarely.

66.67% Of respondents believe that updating the data base of international supplier very necessary, 16.67% was somehow and 16.67% unnecessary and 56.67% of this usually used, 30% was occasionally and 13.33% rarely.

80% of respondents believe that updating the data base of materials price when change occurs was very necessary, 10% was somehow and 10% unnecessary and 60% of this usually used, 23.33% was occasionally and 16.67% rarely.

Considering the necessity and degree of using of some mechanism in managing materials process in general, Table 4.3. illustrates that (80%) owners of the housing construction projects believe that updating the database for materials price when change occurs is the most important technique.

The results show general consistency between the necessity and usage degree of establishing database techniques and the necessity and usage degree of corresponding updating database techniques. The results show also consistency between the necessity and usage degree of each of these techniques.

the most important technique in establishing database group is "Creating materials price database" (76.67%) of the owners and the most important technique in updating database group is "updating the database for materials price when change occur" (80%) of owners. It is noticed that the most important tool in establishing database group and updating

database group is the tool that related to the prices of materials. This results may referred to the fact that in Addis Ababa housing construction project materials cost has most of the project cost.

Table (4.4) as consultant’s perception Mechanisms necessity degree and usage degree in managing construction materials

	mechanisms	Necessity degree			Usage degree		
		Very necessary%	Somehow necessary%	unnecessary %	usually%	occasionally %	rarely%
Establishing database	Establishing categorized materials database	50.00%	30%	20.00%	50.00%	30.00%	20%
	Creating local supplier database	60%	30.00%	10.00%	30.00%	40.00%	30.00%
	Creating international supplier database	40%	40%	20%	40%	30.00%	30.00%
	Creating materials price database	70.00%	20.00%	10.00%	40.00%	30.00%	30.00%
Updating	Updating the database of local supplier	30%	40.00%	30.00%	40.00%	30%	30.00%
	Updating the database of international supplier	40.00%	30.00%	30.00%	30.00%	40%	30.00%
	Updating the database of materials price when change occur	80%	10%	10%	60%	20.00%	20.00%

Consultants view

50% of respondents believe that Establishing categorized materials data base very necessary, 30% was somehow and 20% unnecessary and 50% of it usually used, 30% was occasionally and 20% rarely.

60% of respondents believe that creating local supplier data base very necessary, 30% was somehow and 10% unnecessary and 30% of it usually used, 40% was occasionally and 30% rarely.

40% of respondents believe that creating international supplier data base very necessary, 40% was somehow and 20% unnecessary and 40% of this usually used, 30% was occasionally and 30% rarely.

70% of respondents believe that updating creating materials price data base very necessary, 20% was somehow and 10% unnecessary and 40% of this usually used, 30% was occasionally and 30% rarely.

30% of respondents believe that updating the data base of local supplier very necessary, 40% was somehow and 30% unnecessary and 40% of this usually used, 30% was occasionally and 30% rarely.

40% of respondents believe that updating the data base of international supplier very necessary, 30% was somehow and 30% unnecessary and 30% of this usually used, 40% was occasionally and 30% rarely.

80% of respondents believe that updating the data base of materials price when change occurs was very necessary, 10% was somehow and 10% unnecessary and 60% of this usually used, 20% was occasionally and 20% rarely.

Considering the necessity and degree of using of some mechanism in managing materials process in general, Table 4.4 illustrates that (80%) consultants of the housing construction projects believe that updating the database for materials price when change occurs is the most important technique.

The results show general consistency between the necessity and usage degree of establishing database techniques and the necessity and usage degree of corresponding updating database techniques. The results show also consistency between the necessity and usage degree of each of these techniques.

Table 4.4 shows that the most important technique in establishing database group is "Creating materials price database" (70%) of the consultants and the most important technique in updating database group is "updating the database for materials price when change occur" (80%) of consultants. It is noticed that the most important tool in

establishing database group and updating database group is the tool that related to the prices of materials. This results may referred to the fact that in Addis Ababa housing construction project materials cost has the lion's share of the project cost.

Table (4.5) as contractor's perception Mechanisms necessity degree and usage degree in managing construction materials

	mechanisms	Necessity degree			Usage degree		
		Very necessary%	Somehow necessary%	unnecessary %	usually%	occasionally %	rarely%
Establishing database	Establishing categorized materials database	60%	26.67%	13.33%	66.67%	20%	13.33%
	Creating local supplier database	60%	33.33%	6.67%	46.67%	33.33%	20%
	Creating international supplier database	53.33%	40%	6.67%	40%	33.33%	26.67%
	Creating materials price database	80%	13.33%	6.67%	46.67%	40%	13.33%
Updating	Updating the database of local supplier	66.67%	26.67%	6.67%	60%	33.33%	6.67%
	Updating the database of international supplier	60%	33.33%	6.67%	53.33%	40%	6.67%
	Updating the database of materials price when change occur	86.66%	6.67%	6.67%	66.67%	20%	13.33%

Contractors view

60% of respondents believe that Establishing categorized materials data base very necessary, 26.67% was somehow and 13.33% unnecessary and 66.67% of it usually used, 20% was occasionally and 13.33% rarely.

60% of respondents believe that creating local supplier data base very necessary, 33.33% was somehow and 6.67% unnecessary and 46.67% of it usually used, 33.33% was occasionally and 20% rarely.

53.33% of respondents believe that creating international supplier data base very necessary, 40% was somehow and 6.67% unnecessary and 40% of this usually used, 33.33% was occasionally and 26.67% rarely.

80% of respondents believe that updating creating materials price data base very necessary, 13.33% was somehow and 6.67% unnecessary and 46.67% of this usually used, 40% was occasionally and 13.33% rarely.

66.67% of respondents believe that updating the data base of local supplier very necessary, 26.67% was somehow and 6.66 was unnecessary and 60% of this usually used, 33.33% was occasionally and 6.67% rarely.

60% of respondents believe that updating the data base of international supplier very necessary, 33.33% was somehow and 6.67% unnecessary and 53.33% of this usually used, 40% was occasionally and 6.67% rarely.

86.66% of respondents believe that updating the data base of materials price when change occurs was very necessary, 6.67% was somehow and 6.67% unnecessary and 66.67% of this usually used, 20% was occasionally and 13.33% rarely.

Considering the necessity and degree of using of some mechanism in managing materials process in general, Table 4.5. illustrates that (86.66%) contractors of the housing construction projects believe that updating the database for materials price when change occurs is the most important technique.

The results show general consistency between the necessity and usage degree of establishing database techniques and the necessity and usage degree of corresponding updating database techniques. The results show also consistency between the necessity and usage degree of each of these techniques.

Table4.5. shows that the most important technique in establishing database group is "Creating materials price database" (80%) of the contractors and the most important technique in updating database group is "updating the database for materials price when change occur" (86.66%) of contractors. It is noticed that the most important tool in

establishing database group and updating database group is the tool that related to the prices of materials. This results may referred to the fact that in Addis Ababa housing construction project materials cost has the lion's share of the project cost.

4.5.2 The necessity, degree of usage, and method of use of some mechanism in construction materials management

Table (4.6) as owner perception the necessity, usage and method of use some mechanisms for managing construction materials

no	list of mechanism	Necessity degree			Usage degree			Methods of use			
		Very necessary%	Somewhat necessary%	unnecessary%	usually%	occasionally%	rarely%	By using computerized form%	Recording by using form%	Recording without form%	Without recording%
1	Providing a list of materials in project(materials man-numbers of material-unit price)	86.67	8.89	4.44	71.875	21.875	6.25	67.57	32.43	-	-
2	Daily recording of using materials in project	82.61	13.03	4.35	63.33	23.33	13.34	45.95	45.95	1.7	5.4
3	Providing materials cards at site store(input-output-balance)	80.49	19.51	-	73.33	16.67	10	43.24	54.06	-	2.7
4	Providing material purchasing order(order number-material description-required quantity-price)	77.27	18.18	4.55	36.36	54.55	9.09	48.48	51.52	-	-
5	Recording the received material on the site(delivery number-supplier name-material description-material quantity)	77.27	27.73	-	75.86	17.24	6.9	61.54	38.48	-	-
6	Reporting the conditions of material in the project store(supplier name- order number quantity-input-output-balance)	76.31	21.05	2.63	55.17	24.14	20.69	41.38	41.38	-	17.24
7	Reporting the problems (wastage-thief and loss shortage in delivery)	76.32	21.05	2.63	35.71	39.29	25	22.22	62.96	3.7	11.11
8	Following up the prices in the market and recording the variation of prices	64.86	72.03	8.11	30.77	53.85	15.38	20	62.96	3.7	14.81
9	Following up the closure variations in using the market	63.64	27.27	9.09	25	45	30	19.23	61.54	3.85	15.38

Owners view

86.67% of respondents believe that providing a list of materials in projects (materials name, no of materials and unit price) was very necessary, 8.89% of somehow necessary and 4.44% of unnecessary, 71.88% of it usually used, 21.87% of occasionally use, 6.25% of rarely use this technique and 67.57% of them by using computerized form and 32.43% of them recording by using form.

82.61% of respondent believe that daily recording of using materials in project was very necessary, 13.03% of somehow necessary, 4.35% of unnecessary, 63.33% of it usually used, 23.33% of occasionally use and 13.34% of rarely and 45.95% of them by using computerized form and 45.95% of recording by using form, 1.7% of recording without form and 5.4% of without recording.

80.49% of respondent believe that providing material cards at site store (input-output-balance) was very necessary, 19.51% of somehow necessary, 73.33% of it usually used, 16.67% of occasionally use and 10% of rarely and 43.24% of them by using computerized form and 54.06% of recording by using form and 2.7% of without recording.

77.27% of respondent believe that providing materials purchasing order (order no-material description-required quantity-price) was very necessary, 18.18% of somehow necessary, 4.55% of unnecessary, 36.36% of it usually used, 54.55% of occasionally use and 9.09% of rarely and 48.48% of them by using computerized form and 51.52% of recording by using form.

77.27% of respondent believe that recording the received material on the site (delivery no-supplier name- materials description-material quantity) was very necessary, 27.73% of somehow necessary, 75.86% of it usually used, 17.24% of occasionally use and 6.9% of rarely and 61.54% of them by using computerized form and 38.48% of recording by using form.

76.31% of respondent believe that reporting the condition of material in the project store (supplier name-order no quantity-input-output-balance) was very necessary, 21.05% of somehow necessary, 2.63% of unnecessary, 55.17% of it usually used, 24.14% of occasionally use and 20.69% of rarely and 41.38% of them by using computerized form and 41.38% of recording by using form and 17.24% of without recording.

76.32% of respondent believe that reporting the problems (wastage-thief and loss shortage in delivery) was very necessary, 21.05% of somehow necessary, 2.63% of unnecessary, 35.71% of it usually used, 39.29% of occasionally use and 25% of rarely and 22.22% of them by using computerized form and 62.96% of recording by using form, 3.7% of recording without form and 11.11% of without recording.

64.86% of respondent believe that following up the prices in the market and recording the variation of prices was very necessary, 27.03% of somehow necessary, 8.11% of unnecessary, 30.77% of it usually used, 53.85% of occasionally use and 15.38% of rarely and 20% of them by using computerized form and 62.96% of recording by using form, 3.7% of recording without form and 14.81% of without recording.

63.64% of respondent believe that following up the closure variations in using the market was very necessary, 27.27% of somehow necessary, 9.09% of unnecessary, 25% of it usually used, 45% of occasionally use and 30% of rarely and 19.23% of them by using computerized form and 61.54% of recording by using form, 3.85% of recording without form and 15.38% of without recording.

In the housing construction projects most of the owners believe that 86.67% consider that using providing a list of materials in project (materials mane-numbers of material-unit price) is necessary, 71.875%of owners usually use this technique, and 67.57% of them listing materials by using a computerized form. Other observation, the relatively least important technique in managing materials is following up the closure variations in using the market where 63.64% of respondents consider it necessary and 25% of them usually use it.

Table (4.7) as consultant perception the necessity, usage and method of use some mechanisms for managing construction materials

no	list of mechanism	Necessity degree			Usage degree			Methods of use			
		Very necessary ^o %	Somehow necessary ^o %	unnecessary ^o %	usually ^o %	occasionally ^o %	rarely ^o %	By using computerized form ^o %	Recording by using form ^o %	Recording without form ^o %	Without recording ^o %
1	Providing a list of materials in project(materials name-numbers of material-unit price)	83.54	13.02	3.44	70.34	24.41	5.25	69.54	30.46	-	-
2	Daily recording of using materials in project	81.23	14.42	4.35	62.33	25.33	12.34	44.95	44.95	2.7	6.2
3	Providing materials cards at site store(input-output-balance)	81.49	18.51	-	70.33	18.67	11	45.24	53.06	-	1.7
4	Providing material purchasing order(order number-material description-required quantity-price)	73.27	20.18	6.55	34.36	55.55	10.09	49.48	50.52	-	-
5	Recording the received material on the site(delivery number-supplier name-material description-material quantity)	72.27	27.73	-	74.86	17.24	7.9	62.54	37.48	-	-
6	Reporting the conditions of material in the project store(supplier name-order number quantity-input-output-balance)	75.31	21.05	3.64	56.17	23.14	20.69	40.38	40.38	-	19.24
7	Reporting the problems (wastage-thief and loss shortage in delivery)	77.32	20.05	2.63	37.71	40.29	26	21.22	63.96	3.7	11.11
8	Following up the prices in the market and recording the variation of prices	63.86	74.03	7.11	31.67	52.12	16.21	22	63.46	3.7	14.84
9	Following up the closure variations in using the market	63.64	27.27	9.09	25	45	30	19.23	61.54	3.85	15.38

Consultants view

83.54% of respondents believe that providing a list of materials in projects (materials name, no of materials and unit price) was very necessary, 13.02% of somehow necessary and 3.44% of unnecessary, 70.34% of it usually used, 24.41% of occasionally use, 5.25% of rarely use this technique and 69.54% of them by using computerized form and 30.46% of them recording by using form.

81.23% of respondent believe that daily recording of using materials in project was very necessary, 14.42% of somehow necessary, 4.35% of unnecessary, 62.33% of it usually used, 25.33% of occasionally use and 12.34% of rarely and 44.95% of them by using computerized form and 44.95% of recording by using form, 2.7% of recording without form and 6.4% of without recording.

81.49% of respondent believe that providing material cards at site store (input-output-balance) was very necessary, 18.51% of somehow necessary, 70.33% of it usually used, 18.67% of occasionally use and 11% of rarely and 45.24% of them by using computerized form and 53.06% of recording by using form and 1.7% of without recording.

73.27% of respondent believe that providing materials purchasing order (order no-material description-required quantity-price) was very necessary, 20.18% of somehow necessary, 6.55% of unnecessary, 34.36% of it usually used, 55.55% of occasionally use and 10.09% of rarely and 49.48% of them by using computerized form and 50.52% of recording by using form.

72.27% of respondent believe that recording the received material on the site (delivery no-supplier name- materials description-material quantity) was very necessary, 27.73% of somehow necessary, 74.86% of it usually used, 17.24% of occasionally use and 7.9% of rarely and 62.54% of them by using computerized form and 37.48% of recording by using form.

75.31% of respondent believe that reporting the condition of material in the project store (supplier name-order no quantity-input-output-balance) was very necessary, 21.05% of somehow necessary, 3.63% of unnecessary, 56.17% of it usually used, 23.14% of occasionally use and 20.69% of rarely and 40.38% of them by using computerized form and 40.38% of recording by using form and 19.24% of without recording.

77.32% of respondent believe that reporting the problems (wastage-thief and loss shortage in delivery) was very necessary, 20.05% of somehow necessary, 2.63% of unnecessary, 37.71% of it usually used, 40.29% of occasionally use and 26% of rarely and 21.22% of them by using computerized form and 63.96% of recording by using form, 3.7% of recording without form and 11.11% of without recording.

63.86% of respondent believe that following up the prices in the market and recording the variation of prices was very necessary, 25.63% of somehow necessary, 8.11% of unnecessary, 31.67% of it usually used, 52.12% of occasionally use and 16.21% of rarely and 22% of them by using computerized form and 63.46% of recording by using form, 3.7% of recording without form and 14.84% of without recording.

63.64% of respondent believe that following up the closure variations in using the market was very necessary, 27.27% of somehow necessary, 9.09% of unnecessary, 25% of it usually used, 45% of occasionally use and 30% of rarely and 19.23% of them by using computerized form and 61.54% of recording by using form, 3.85% of recording without form and 15.38% of without recording.

As consultants opinion 83.54% consider that using providing a list of materials in project (materials mane-numbers of material-unit price) is necessary, 70.34% of Consultants usually use this technique, and 69.53% of them listing materials by using a computerized form. Other observation, the relatively least important technique in managing materials is following up the closure variations in using the market where 63.64% of respondents consider it necessary and 25% of them usually use it.

Table (4.8) as contractor perception the necessity, usage and method of use some mechanisms for managing construction materials

no	list of mechanism	Necessity degree			Usage degree			Methods of use			
		Very necessary%	Somewhat necessary%	unnecessary%	usually%	occasionally%	rarely%	By using computerized form%	Recording by using form%	Recording without form%	Without recording%
1	Providing a list of materials in project(materials mane-numbers of material-unit price)	89.23	7.43	3.34	72.46	20.56	6.98	68.78	31.22	-	-
2	Daily recording of using materials in project	81.09	14.56	4.45	65.36	21.3	13.34	46.95	46.95	1.7	4.4
3	Providing materials cards at site store(input-output-balance)	79.87	20.13	-	72.33	17.67	10	44.44	53.06	-	3.5
4	Providing material purchasing order(order number-material description-required quantity-price)	78.25	17.2	4.55	36.2	54.75	9.05	48.48	51.52	-	-
5	Recording the received material on the site(delivery number-supplier name-material description-material quantity)	77.27	27.73	-	75.86	17.24	6.9	61.54	38.48	-	-
6	Reporting the conditions of material in the project store(supplier name- order number quantity-input-output-balance)	76.31	21.05	2.63	55.17	24.14	20.69	41.38	41.38	-	17.24
7	Reporting the problems (wastage-thief and loss shortage in delivery)	76.32	21.05	2.63	35.71	39.29	25	22.22	62.96	3.7	11.11
8	Following up the prices in the market and recording the variation of prices	64.86	72.03	8.11	29.77	56.85	13.38	20	62.96	3.7	14.81
9	Following up the closure variations in using the market	64.54	24.27	9.19	27	44	29	19.23	62.54	4.85	13.38

Contractors view

89.23% of respondents believe that providing a list of materials in projects (materials name, no of materials and unit price) was very necessary, 7.43% of somehow necessary and 3.34% of unnecessary, 72.46% of it usually used, 20.56% of occasionally use, 6.98% of rarely use this technique and 68.78% of them by using computerized form and 31.22% of them recording by using form.

81.09% of respondent believe that daily recording of using materials in project was very necessary, 14.56% of somehow necessary, 3.34% of unnecessary, 65.36% of it usually used, 21.30% of occasionally use and 13.34% of rarely and 46.95% of them by using computerized form and 46.95% of recording by using form, 1.7% of recording without form and 4.4% of without recording.

79.87% of respondent believe that providing material cards at site store (input-output-balance) was very necessary, 20.13% of somehow necessary, 72.33% of it usually used, 17.67% of occasionally use and 10% of rarely and 44.44% of them by using computerized form and 53.06% of recording by using form and 3.7% of without recording.

78.25% of respondent believe that providing materials purchasing order (order no-material description-required quantity-price) was very necessary, 17.20% of somehow necessary, 4.55% of unnecessary, 36.20% of it usually used, 54.75% of occasionally use and 9.05% of rarely and 48.48% of them by using computerized form and 51.52% of recording by using form.

77.27% of respondent believe that recording the received material on the site (delivery no-supplier name- materials description-material quantity) was very necessary, 27.73% of somehow necessary, 75.86% of it usually used, 17.24% of occasionally use and 6.9% of rarely and 61.54% of them by using computerized form and 38.48% of recording by using form.

76.31% of respondent believe that reporting the condition of material in the project store (supplier name-order no quantity-input-output-balance) was very necessary, 21.05% of somehow necessary, 2.63% of unnecessary, 55.17% of it usually used, 24.14% of occasionally use and 20.69% of rarely and 41.38% of them by using computerized form and 41.38% of recording by using form and 17.24% of without recording.

76.32% of respondent believe that reporting the problems (wastage-thief and loss shortage in delivery) was very necessary, 21.05% of somehow necessary, 2.63% of unnecessary, 35.71%

of it usually used, 39.29% of occasionally use and 25% of rarely and 22.22% of them by using computerized form and 62.96% of recording by using form, 3.7% of recording without form and 11.11% of without recording.

64.86% of respondent believe that following up the prices in the market and recording the variation of prices was very necessary, 27.03% of somehow necessary, 8.11% of unnecessary, 29.77% of it usually used, 56.85% of occasionally use and 13.38% of rarely and 20% of them by using computerized form and 62.96% of recording by using form, 3.7% of recording without form and 14.81% of without recording.

64.54% of respondent believe that following up the closure variations in using the market was very necessary, 24.27% of somehow necessary, 9.19% of unnecessary, 27% of it usually used, 44% of occasionally use and 29% of rarely and 19.23% of them by using computerized form and 62.54% of recording by using form, 4.85% of recording without form and 13.38% of without recording.

4.5.3 Construction materials management challenges

Table (4.9) represents material management challenges shows that in housing construction project

no	Challenges	Owners		Consultants		Contractors	
		RII	Rank	RII	Rank	RII	Rank
1	Failure to order on time which delays the projects	0.74	2	0.8	1	0.8	1
2	Delivery at the wrong time which interrupts the work schedule	0.76	1	0.73	2	0.75	2
3	Over ordering	0.63	5	0.73	2	0.75	2
4	Wrong materials or error in direction of materials requiring re-work	0.69	4	0.73	2	0.63	4
5	Theft of materials from delivery into production	0.63	5	0.68	3	0.62	5
6	Double handling of materials because of inadequate material	0.71	3	0.63	4	0.7	3

Owners view

The major challenges of materials management was delivery at the wrong time which interrupted the work schedule has been ranked by the owner respondents in the first position with RII= 0.76. It was the most factors to challenge material management system in housing construction projects. These were suffered from difficult political and economic situation.

Failure to order on time which delays the project has been ranked by the owner respondents in the second position with $RI= 0.47$.this factor

Double handling of materials because of inadequate material has been ranked by the owner respondents in the third position with $RII= 0.71$.this also the main problem in housing construction projects. Because it was lead to material deterioration and occupied the space of the storage. It also leads to unavailability of the storage for the store the other necessary materials so to provide another storage these consequence may suffered extra cost.

Wrong materials or error in direction of materials requiring re-work has been ranked by the owner respondents in the fourth position with $RII= 0.69$.

Theft of materials from delivery into production and over ordering has been ranked by the owner respondents in the fifths position with $RII=0.63$.

Consultants view

Failure to order on time which delays the projects was ranked by the consultant respondents in the first position with the $RII=0.8$.

A delivery at the wrong time which interrupts the work schedule, over ordering and wrong materials or error in direction of materials requiring re-work has been ranked by the consultant respondents in the second position with $RII= 0.73$.

Theft of materials from delivery into production has been ranked by the consultant respondents in the third position with $RII= 0.68$.

Double handling of materials because of inadequate material has been ranked by the consultant respondents in the fourth position with $RII= 0.63$.

Contractors view

Failure to order on time which delays the projects has been ranked by the contractor respondents in the first position with RII= 0.8.

Deliveries at the wrong time which interrupts the work schedule and over ordering has been ranked by the contractor respondents in the second position with RII= 0.75.

Double handling of materials because of inadequate material has been ranked by the contractor respondents in the third position with RII= 0.7.

Wrong materials or error in direction of materials requiring re-work has been ranked by the contractor respondents in the fourth position with RII= 0.63.

Theft of materials from delivery into production has been ranked by the contractor respondents in the fifth position with RII= 0.62.

Comparison between clients, consultants and contractors

Table (4.10) comparison between owners, consultants and contractors for material management challenges

no	Challenges	Owners		Consultants		Contractors	
		RII	Rank	RII	Rank	RII	Rank
1	Failure to order on time which delays the projects	0.74	2	0.8	1	0.8	1
2	Delivery at the wrong time which interrupts the work schedule	0.76	1	0.73	2	0.75	2
3	Over ordering	0.63	5	0.73	2	0.75	2
4	Double handling of materials because of inadequate material	0.71	3	0.63	4	0.7	3

Failure to order on time which delays the projects has been ranked by the consultants and contractors in the first position and by the owners in the second position. This is more challenge for consultants and contractors than owners.

Delivery at the wrong time which interrupts the work schedule has been ranked by the owners in the first position and by the consultants and contractors in the second position.

This is the most challenge for the owners but less challenge for the consultants and contractors.

Over ordering has been ranked by the consultants and contractors in the second position and by the owners in the fifth position. This is more challenge for consultants and contractors than owners.

Double handling of materials because of inadequate material has been ranked by the owners and contractors in the third position and by the consultants in the fourth position.

4.5.4 Factor causes increase waste on site

Table (4.11) represents the factors related to on site practice which cause increase waste on construction site.

no	Factor causes increase waste on site	Owners		Consultants		Contractors	
		RII	Rank	RII	Rank	RII	Rank
1	Material damage on site	0.733	1	0.725	1	0.783	1
2	Existence of unnecessary material on site	0.7	2	0.65	4	0.67	4
3	Production quantity greater the required	0.65	4	0.625	5	0.65	5
4	Thief and vandalism	0.63	5	0.675	3	0.67	4
5	Poor quality of material	0.7	2	0.7	2	0.7	2
6	Poor storage of material	0.68	3	0.65	4	0.65	5
7	Lack of material control on site	0.68	3	0.675	3	0.68	3
8	Using excessive quantities of material	0.63	5	0.65	4	0.65	5

Owners view

Material damage on site has been ranked by the owner respondents in the first position with RII= 0.733. This factors causes increase waste on site.

Existence of unnecessary material on site and poor quality of material has been ranked by the owner respondents in the second position with RII= 0.7.unnecessary material damp on site it damage and deteriorate so, this factors causes increase waste on site.

Poor storage of material and lack of material control on site has been ranked by the owner respondents in the third position with RII= 0.68. This factor also causes of increase waste on site because materials if not properly stored it damage and if not control it generate a waste on site.

Production quantity greater the required has been ranked by the owner respondents in the fourth position with RII= 0.65.

Thief and vandalism and using excessive quantities of material has been ranked by the owner respondents in the fifth position with RII= 0.63.

Comparison between clients, consultants and contractors

Table (4.12) Comparison between owners, consultants and contractors for factor causes increase waste on site

no	factor causes increase waste on site	owners		consultants		contractors	
		RII	rank	RII	rank	RII	rank
1	material damage on site	0.733	1	0.73	1	0.785	1
2	poor quality of material	0.7	2	0.7	2	0.7	2
3	lack of material control on site	0.68	3	0.68	3	0.68	3
4	existence of unnecessary material on site	0.7	2	0.65	4	0.67	4

Material damage on site has been ranked by the owners, consultants and contractors respondents in the first position. This is the main causes of waste increase for the three parties. This consequence also to create material shortage and addition cost on the projects.

Poor quality of material has been ranked by the owners, consultants and contractors respondents in the second position. This is more important for all parties because in housing construction projects give prior to material quality.

Lack of material control on site has been ranked by the owners, consultants and contractors respondents in the third position. All parties emphasize for material control on site because if not material controller on site it might be material damage.

Existence of unnecessary material on site has been ranked by the owner respondents in the second position, but by the consultants and contractors respondents in the fourth position. This is more concerned for owners because it is a supplier in housing construction projects.

4.5.5 Material handling cause waste increase on construction site

Table (4.13) Construction Material handlings on site

no	Material handlings	Owners		Consultants		Contractors	
		RII	Rank	RII	Rank	RII	Rank
1	Improper material handling on site	0.67	3	0.7	2	0.733	1
2	Duplication of material on site	0.72	1	0.675	3	0.7	2
3	Insufficient instruction about material handling on site	0.69	2	0.775	1	0.67	3

Owners view

Duplication of material on site has been ranked by the owner respondents in the first position with RII= 0.72. This is the main causes waste on site because some materials to damp on site at long time it might be damaged.

Insufficient instruction about materials handling on site has been by the owner respondent in the second position with RII= 0.69. This was the lack of information and communication between the parties involved to the housing construction projects.

Improper material handling on site has been by the owner respondents in the third position with RII= 0.67. So improper handling material which means improper position may causes waste increase.

Consultants view

Insufficient instruction about material handling on site has been ranked by the consultant respondents in the first position with RII= 0.775. This is the main responsibility for consultants to give instruction about material handling on site for contractors.

Improper material handling on site has been ranked by the consultant respondents in the second position with RII= 0.7.

Duplication of material on site has been ranked by the consultant respondents in the third position with RII= 0.675.

Contractors view

Improper material handling on site has been ranked by the contractor respondents in the first position with RII= 0.733. The contractors believe that in construction material management give to prior to material handling because if not proper material handling on site it create wastage.

Duplication of material on site has been ranked by the contractor respondents in the second position with RII= 0.7. This is over material damping on site occupied the space for damping another needed materials.

Insufficient instruction about material handling on site has been ranked by the contractor respondents in the third position with RII= 0.67. This is less important for contractors because they believe that knew how to material handled on site without any instruction from others.

Comparison between owners, consultants and contractors

Table (4.14) Comparison between owners, consultants and contractors for material handling cause material waste on construction site

no	Material handlings	Owners		Consultants		Contractors	
		RII	Rank	RII	Rank	RII	Rank
1	Improper material handling on site	0.67	3	0.7	2	0.733	1
2	Duplication of material on site	0.72	1	0.675	3	0.7	2
3	Insufficient instruction about material handling on site	0.69	2	0.775	1	0.67	3

Improper material handling onsite has been ranked by the owner respondents in the third position, by the consultant respondents in the second position and by the contractor respondents in the first position. This the most important for the contractors, while for the

owners and consultants less because owners distribute material for the contractors, so the contractors responsible for material on site after received from the owners.

Duplication of material on site has been ranked by the owner respondents in the first position, by the consultant respondents in the third position and by the contractor respondents in the second position. Duplication of material on site is main cause of waste as owners view, however less cause as consultants and contractors view.

Insufficient instruction about material handling on site has been ranked by the owner respondents in the second position, by the consultant respondents in the first position and by the contractor respondents in the third position.

4.6 Factors Affecting effectiveness material management on construction projects

Table (4.15) Factors affecting effective material management on site

No	Factors affecting effective material management on site	Owners		consultants		contractors	
		RII	Rank Order	RII	Rank Order	RII	Rank Order
1	Design changes	0.74	2	0.75	3	0.767	1
2	Lack of proper work planning and scheduling	0.725	4	0.725	4	0.717	4
3	Inefficient workforce	0.758	1	0.825	1	0.767	1
4	Fraudulent practice / negligence and corrupt practice	0.692	6	0.725	4	0.667	6
5	Lack of security personnel	0.708	5	0.675	5	0.683	5
6	Waste on construction site	0.733	3	0.775	2	0.75	2
7	Storage facility	0.725	4	0.675	5	0.733	3

Owners view

Inefficient work force has been ranked by the owner respondents in the first position with RII= 0.758.

Design changes have been ranked by the owner respondents in the second position with RII= 0.74.

Waste on construction site has been ranked by the owner respondents in the third position with RII= 0.733.

Lack of proper work planning and scheduling and storage facility has been ranked by the owner respondents in the fourth position with RII= 0.725.

Lack of security personnel has been ranked by the owner respondents in the fifth position with RII= 0.708.

Fraudulent practice/negligence and corrupt practice has been ranked by the owner respondents in the sixth position with RII= 0.692. This is a little affect the effectiveness of material management in housing construction projects because the construction material purchased by head office based on the requisition with open bid.

Consultants

Inefficient work force has been ranked by the consultants in the first position with RII= 0.825.

Waste on construction site has been ranked by the consultants in the second position with RII=0.775.

Design changes has been ranked by the consultants in the third position with RII= 0.75.

Lack of proper work planning and scheduling and Fraudulent practice/negligence and corrupt practice has been ranked by the consultants in the fourth position with RII= 0.725.

Lack of security personnel and storage facility has been ranked by the consultants in the fifth position with RII= 0.675.

Contractors view

Design changes and inefficient work force has been ranked by the contractor respondents in the first position with RII= 0.767. Because design changes lead to re-work and inefficient work force also impact material management on site. Inefficient work force the same as owners and consultants but Design changes more emphasize.

Waste on construction site has been ranked by the contractor respondents in the second position with RII= 0.75.

Storage facility has been ranked by the contractor respondents in the third position with RII= 0.733.

Lack of proper work planning and scheduling has been ranked by the contractor respondents in the fourth position with RII= 0.717.

Lack of security personnel has been ranked by the contractor respondents in the fifth position with RII= 0.683.

Fraudulent practice/negligence and corrupt practice has been ranked by the contractor respondents in the sixth position with RII= 0.667.

Comparison between owners, consultants and contractors

Table (4.16) Comparison between owners, consultants and contractors for factors affecting effective material managements on site

No	Factors affecting effective material management on site	Owners		consultants		contractors	
		RII	Rank Order	RII	Rank Order	RII	Rank Order
1	Inefficient workforce	0.758	1	0.825	1	0.767	1
2	Design changes	0.74	2	0.75	3	0.767	1
3	Lack of proper work planning and scheduling	0.725	4	0.725	4	0.717	4
4	Lack of security personnel	0.708	5	0.675	5	0.683	5

Inefficient work force has been ranked by the owners, consultants and contractors respondents in the first position. This factor is the most important for them because it affects material management and productivity of the projects.

Lack of proper work planning and scheduling has been ranked by the owners, consultants and contractors respondents in the fourth position. However, for all parties, Lack of proper work planning and scheduling is less affect material management, because nothing work done without work planning and scheduling in the housing construction projects.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

The research has examined materials management on building construction sites.

Findings show that in the housing construction projects material procure to use open bid, Because of to prevent corruption and directly purchase from the manufacturer to remove supply chain transactional cost.

Procure materials for construction site by head office with site requisition, its best practice of materials procurements for construction sites effective materials management.

In Addis Ababa housing construction projects almost all the respondents agreed to the actual construction materials used equal with the planned materials except electric fitting and sanitary fitting.

the most important technique in establishing database group is "Creating materials price database" (76.67%) of the owners, (70%) of the consultants and (80%) of contractors the and most important technique in updating database group is "updating the database for materials price when change occur" (80%) of owners and consultants and (86.67%) of contractors. It is noticed that the most important tool in establishing database group and updating database group is the tool that related to the prices of materials.

These results may referred to the fact that in Addis Ababa housing construction project above 50% of the project cost was materials cost.

in the housing construction projects most of the owners believe 86.67% consider that using Providing a list of materials in project(materials mane numbers of material - unit price) is necessary, 71.875% of owners usually use this technique, and 67.57% of them listing materials by using a computerized form. Other observation, the relatively least important technique in managing materials is following up the closure variations in using

the market where 63.64% of respondents consider it necessary and 25% of them usually use it.

As consultants opinion 83.54% consider that using providing a list of materials in project (Materials mane- numbers of material - unit price) is necessary, 70.34% of consultants usually use this techniques, and 69.53% of them listing materials by using a computerized form. Other observation, the relatively least important technique in managing materials is following up the closure variations in using the market where 63.64% of respondents consider it necessary and 25% of them usually use it.

As contractor's opinion 89.23% consider that using providing a list of materials in project (materials mane- numbers of material - unit price) is necessary, 72.46% of contractors usually use this technique and 68.78% of them listing materials by using a computerized form. Other observation, the relatively least important technique in managing materials is following up the closure variations in using the market where 64.54% of respondents consider it necessary and 27% of them usually use it. 86.48% respondent in Addis Ababa housing construction projects believes using providing a list of materials in project (materials mane- numbers of material - unit price) is necessary, 71.56% of usually use it and 68.63% of using computerized form.

Most of the parties involved in housing construction projects interested using some techniques in construction material management system.

Providing a list of materials in project (materials mane- numbers of material - unit price)

Daily recording of using materials in projects

Providing material cards at site store (input-output-balance)

Reporting the condition of material in the project store (supplier name-order number quantity-input-output-balance)

Following up the price in the market and recording the variation of prices.

The most challenges of material managements in housing construction projects was delivery at the wrong time which interrupted the work schedule and failure to order on time which delays the projects.

Material damage on site has been ranked by the owners, consultants and contractors respondents in the first position. This is the main causes of waste increase for the three parties. This consequence also to create material shortage and addition cost on the projects.

Poor quality of material has been ranked by the owners, consultants and contractors respondents in the second position. This is more important for all parties because in housing construction projects give prior to material quality.

Lack of material control on site has been ranked by the owners, consultants and contractors respondents in the third position. All parties emphasize for material control on site because if not material controller on site it might be material damage.

In material handling all parties was different view, so Duplication of material on site has been ranked by the owner respondents, Insufficient instruction about material handling on site has been ranked by the consultants and Improper material handling onsite has been ranked by the contractors in the first position.

Inefficient work force has been ranked by the owners, consultants and contractors respondents in the first position. This factor is the most important for them because it affects material management and productivity of the projects.

5.2 Recommendations

For owners

The owners should be better to assign material engineer for effective material management with controlling material quality and ordering and delivering at the right time by using their effort.

The owner should be to develop human resource in construction industry through proper and continuous training program about material management system.

The owners should be create Awareness and accountability within the organization

The materials are also often stacked as per the specification of the vendor or manufacturer.

Relevant IS Codes (IS: 4082: recommendations on stacking and storage of construction materials at site) specifications are also followed. E.g.: As per IS: 4082,

The materials should not be affected by impurities or atmospheric agencies.

Materials like cement should must be stored in covered sheds and stacked on timber raised platforms.

Reinforcing bars should be stacked yards away from moisture to prevent rusting and also away from oil and lubricants. Bars of different classification, sizes and lengths should be stored separately to facilitate issues.

For Consultants

Consultants should be awareness creation how to stacking and storage materials as per specification for contractors

Consultants should be control material handling on site and given sufficient instruction about material handling on site for contractors

There should be a centralized material management team co-ordination between the site and the organization.

Proper control, tracking and monitoring of the system is required.

Awareness and accountability should be created within the organization

For contractors

Contractor should make provisions for training of site personnel in order to improve their efficiency for effective material management

Contractors should ensure the use of skilled craftsmen for their works and provide efficient supervision with professionals to ensure effective material management on building construction sites

Contractors should be provide proper material handling on site to waste minimization

The materials are also often stacked as per the specification of the vendor or manufacturer.

Relevant IS Codes (IS: 4082: recommendations on stacking and storage of construction materials at site) specifications are also followed. E.g.: As per IS: 4082,

The materials should not be affected by impurities or atmospheric agencies.

Materials like cement should must be stored in covered sheds and stacked on timber raised platforms.

Reinforcing bars should be stacked yards away from moisture to prevent rusting and also away from oil and lubricants. Bars of different classification, sizes and lengths should be stored separately to facilitate issues.

Additional recommendation for the three parties

These parties should be used for material schedule a program/application of (MSP, CPM/PERT) to better material management

Recommendations for further studies

It is recommended to study on the same title factor related to time, cost and quality in Addis Ababa housing construction projects to fulfill the rest.

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ANNEXES

Annex 1

Questionnaire

Part1: Personal information

Use the symbol (√) for the entire questions.

Sex:

Female male

Age:

Below31 31-50 above 50

Education level:

12complete Diploma BSc/BA Degree MSc/MA Degree
Doctorate and above

Work experience on building construction:

Two Three Four above Four

Part 2: questions related to construction materials procurement practices

1. as in your experiences is there different methods of construction materials procurement practices? Yes or no,

If your answer yes, list there:

1. -----
2. -----
3. -----

2. In your company the construction materials purchasing method

No	method	
1	Head office provision with site requisition	
2	Head office provision without site requisition	
3	Direct purchase by project manager/ site engineer	

Part 3: questions related to materials consumption

Use the symbol (√) for the entire questions. The number stated is represent, 4= strongly agree, 3= agree, 2= disagree and 1= strongly disagree

1. As your experiences in your project all the planned materials quantity is the meet with the actual materials used?

no	list of construction materials	planned(estimation) material meet with actual material consumed								
		owners			consultants			contractors		
		under	equal	above	under	equal	above	under	equal	above
1	Cement									
2	Aggregate									
3	Sand									
4	Reinforcement bar									
5	Pipes									
6	Tiles									
7	Electric fitting									
8	Sanitary fitting									
9	Blocks (HCB)									
10	Pre-cast									
11	Roofing materials									
	Average									

Part4: questions related to construction materials management mechanism

Mechanisms necessity degree and usage degree in managing construction materials

	mechanisms	Necessity degree			Usage degree		
		Very necessary%	Somehow necessary%	unnecessary%	usually%	occasionally%	rarely%
Establishing database	Establishing categorized materials database						
	Creating local supplier database						
	Creating international supplier database						
	Creating materials price database						
Updating	Updating the database of local supplier						
	Updating the database of international supplier						
	Updating the database of materials price when change						

The necessity, usage and method of use some mechanisms for managing construction materials

no	list of mechanism	Necessity degree			Usage degree			Methods of use			
		Very necessary%	Somehow necessary%	unnecessary%	usually%	occasionally%	rarely%	By using computerized form%	Recording by using form%	Recording without form%	Without recording%
1	Providing a list of materials in project(materials mane-numbers of material-unit price)										
2	Daily recording of using materials in project										
3	Providing materials cards at site store(input-output-balance)										
4	Providing material purchasing order(order number-material description-required quantity-price)										
5	Recording the received material on the site(delivery number-supplier name-material description-material quantity)										
6	Reporting the conditions of material in the project store(supplier name- order number quantity-input-output-balance)										
7	Reporting the problems (wastage-thief and loss shortage in delivery)										
8	Following up the prices in the market and recording the variation of prices										
9	Following up the closure variations in using the market										

Challenges of Construction materials management

no	Challenges	Client		Consultants		Contractors	
		RII	Rank	RII	Rank	RII	Rank
1	Failure to order on time which delays the projects						
2	Delivery at the wrong time which interrupts the work schedule						
3	Over ordering						
4	Wrong materials or error in direction of materials requiring re-work						
5	Theft of materials from delivery into production						
6	Double handling of materials because of inadequate material						

Material waste on site

no	Factor causes increase waste on site	Client		Consultants		Contractors	
		RII	Rank	RII	Rank	RII	Rank
1	Material damage on site						
2	Existence of unnecessary material on site						
3	Production quantity greater the required						
4	Thief and vandalism						
5	Poor quality of material						
6	Poor storage of material						
7	Lack of material control on site						
8	Using excessive quantities of material						

Material handling

no	Material handlings	Client		Consultants		Contractors	
		RII	Rank	RII	Rank	RII	Rank
1	Improper material handling on site						
2	Duplication of material on site						
3	Insufficient instruction about material handling on site						

Part5. Related to factors affecting effective material management on site

No	Factors affecting effective material management on site	clients		consultants		contractors	
		RII	Rank Ord	RII	Rank Ord	RII	Rank Ord
1	Design changes						
2	Lack of proper work planning and scheduling						
3	Inefficient workforce						
4	Fraudulent practice / negligence and corrupt practice						
5	Lack of security personnel						
6	Waste on construction site						
7	Storage facility						

Annex 2

Sample of construction materials



Toilet WC

improper way lay down

Of reinforcement bar



Proper ways stay of pre-cast

reinforcement bar



Aggregate

HCB



Reinforcement bar