Assessment of Construction Material Management Practice in Federal Housing Corporation Projects

Msc. Thesis in construction management

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DECLARATION

Declaration by candidate

I, Huda Ahmed declared that this research thesis entitled **"Assessment of construction material management practice: The case of Federal Housing Corporation Projects at Addis Ababa"** submitted to department of Infrastructure Technology Management is my original work and has not previously been presented for a degree at EiABC or any other university.

This thesis is my original work and has not been presented for a degree in any other university

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Declaration by Supervisor

I confirm that the work in this thesis was completed by the candidate under my supervision.

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CERTIFICATE OF APPROVAL

This thesis is submitted to Ethiopian Institution of Architecture, Building Construction, and City Development (EiABC) and to department of Infrastructure Technology Management in partial fulfillment of the requirements for the degree of Master of Science in Construction Management.

Title of Thesis

Assessment of construction material management practice: The case of Federal Housing Corporation Projects at Addis Ababa, Ethiopia

By Huda Ahmed

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Acronyms

BOQ= Bill of quantity

CM= Construction material

CMM= Construction material management

CMMP= Construction material management practice

FHC= Federal Housing Corporation

GDP=Growth domestic population

IBM= Information building model

MoWUD=Minster of works and urban development

RII= Relative important index

SPSS= Statistical package for the social science

UK= United Kingdom

UN= United nation

US= United state

$= Dollar symbol

Abstract

Material management practice involves planning, procuring, transporting, logistics, inspection, receiving, storage, and controlling material usage in construction projects. Ineffective management, poor procurement, delayed delivery, inadequate storage, and poor control systems can negatively impact project budget and completion time. The study evaluates construction material management practices at Federal Housing Corporation projects, focusing on planning, procurement, transport, logistics, handling, storage, inspection, wastage control, challenges, stakeholder involvement, and identifying best practices, aiming to provide direction for future projects. This study involved questionnaires and document reviews to gather data from contractors, clients, site counter engineers, and FHC-hired consultants involved in FHC projects. The study reveals current practices in material handling, inventory control, and material tracking, but also highlights challenges such as market fluctuations, incomplete design, local trafficking, and wastage. Stakeholders like owners, contractors, and consultants are involved in material delivery, quality planning, and schedules. Consultants focus on continuous inspections and follow-ups for material and work progress. Finally, the study suggests that effective material management techniques improve overall handling, site delivery, and prevent unexpected price variations from impacting project budget and completion time.

Keyword: Material, material management practice, construction project, FHC projects

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Chapter 1: Introduction

1.1 General Introduction

The construction industry is a vast and comprises owners, planners, supervisors, and contractors Gebruz (2017), together they are responsible for planning, executing, and evaluating construction works including physical infrastructure, road construction, water supply, and sanitation works. (Asmara , 2015).

The construction industry significantly contributes to national, social, and economic development, as recognized by various researchers, including Ofori (2015) and Turin (1973), Ofori (1990), and Hillebrandt (2000). Thus, construction is the largest contributor to global development, accounting for 12-25% of GDP and 58% of Ethiopia's annual budget. (Asmara , 2015) According to Global construction industry (2021) report, US construction GDP reached $908 billion in second quarter of 2021, equivalent to 4.3% of GDP.

Even if the construction sector significantly contributes to infrastructure development but also generates significant waste, impacting on project costs, profitability, and environment safety. (Mohamed, 2021) UK and Australia contribute over 50% and 20-30% respectively. (Agyekum, 2012) Material wastage significantly impacts project costs, with 30-70% of project costs being material and 30-40% being labor. (Khyomesh, 2011) And in Ethiopia, construction materials account for 57% of the total budget, emphasizing the importance of effective management. (Addise, 2005).

Material management in the construction industry is crucial for organizing and controlling activities, but many projects in developing countries face time and cost overruns, as in Ethiopia, the construction industry has many of the same problems. (Abadir, 2011) As Blackridge (2023) report, highlights failures in construction due to factors such as cost overruns, project delays, poor communication, poor planning, lack of organization, and unplanned document control and schedule issues.

According to Adams (1997), Long (2004) and others, Poor management skills among contractors, poor contract terms, lack of organizational capacity, fluctuating material costs, and unforeseen events contribute to poor project performance in developing countries, with over 65% of project budget spent on material procurement.

1.2 Statement of the problem

Although Ethiopia's construction industry is booming, effective construction materials management still needs to be improved. According to a study Abraham (2016) about 70% of construction projects do not have a responsible body for construction materials management. And Assegedech (2016) reveals that material costs account for over 50% of housing project costs in Addis Ababa, with 80% failures due to late material orders and 75% due to incorrect delivery.

The Ethiopian construction industry, particularly in Addis Ababa, often employs experience-based and traditional methods for materials management, leading to high costs and poor product quality. (Asmara , 2015) In related Semma (2021) pointed out that about 76 % of wastage that happened at federal housing corporation projects was because of material handling and storage factors. Similarly, studies Bhavshar (2016) have identified poor construction material management attributed to factors like low-quality materials, shortages, transportation issues, storage, inventory, waste utilization, and management systems. And Dakhli (2018) evaluates issues related to transportation and delivery, storage and inventory of materials, waste utilization, and management systems. Those are concerned on construction material management practices.

Even if Semma (2021) revealed about wastage minimization techniques and their causes, he did not discuss the practice of construction material management at each stage of the construction process. And other researcher pointed out that, causes of poor construction material management arise from improper practice of construction material at construction projects, and then this research is conducted to know management practice of construction material at FHC projects.

Hence this study aims to address gaps in previous research by assessing current construction material management practices and identifying challenges at FHC projects. It focuses on construction materials, the largest cost driver in construction projects, and identifies best practices of construction material management for FHC projects.

1.3 Aim and objective of the study

1.3.1 General objective

The main objective of this research is to Assess Construction material management practice in federal housing corporation projects.

1.3.2 Specific objectives

Pursuant to the above main objective, the study will have the following specific objectives;

1. To assess current construction material management practice at selected Federal Housing Corporation Projects.
2. To identify key challenges of construction material management practice at FHC projects.
3. To identify best practice of construction material management at FHC projects.
4. To assess role and responsibility of key stakeholders in related to construction material management practice at FHC projects.

1.4 Scope and limitation of the study

The scope of the study on construction material management practices within Federal Housing Corporation (FHC) projects focuses specifically on Addis Ababa, Ethiopia. This geographical and organizational specificity is crucial, as it allows for an in-depth examination of material management practices within a significant sector of the Ethiopian construction industry.

The research is methodologically constrained to a case study approach that is only focused at FHC projects due to time constraint, utilizing qualitative and quantitative data collection methods, including questionnaires, observations, and document reviews. This methodological choice enables a comprehensive understanding of the current practices and challenges faced in material management. However, focusing on FHC projects also implies limitations; the findings may not universally apply to all construction projects in Ethiopia or other developing countries, where varying organizational structures and resource availability could influence material management practices differently.

Moreover, the study explicitly acknowledges its limitations regarding time and financial resources, which restrict the breadth of its analysis. While this focus allows for a detailed exploration of specific practices, it may overlook broader systemic issues affecting material management across the entire construction sector in Ethiopia. While the study's scope is well-defined and relevant, it is essential to recognize the inherent limitations associated with its focus on FHC projects in Addis Ababa. Future research could expand on these findings by exploring material management practices in a broader array of construction contexts, thereby enhancing the generalizability of the insights gained from this study.

1.5 Research Process & Structure

The research on construction material management practices is systematically organized into distinct chapters, each serving a specific purpose that contributes to the overall coherence and clarity of the study. The organization reflects a logical progression from introductory concepts to detailed analysis and conclusions, essential for academic rigor.

Chapter One - General Introduction

The first chapter serves as an introduction, outlining the research background, problem statement, and objectives. This foundational section effectively establishes the context for the study, highlighting the importance of material management in the Ethiopian construction industry. The chapter sets the stage for the subsequent analysis by clearly stating the research gap and objectives, ensuring readers understand the investigation's relevance.

Chapter Two – Literature Review

The second chapter's comprehensive literature review covers various aspects of construction material management, including planning, procurement, logistics, and waste management. This chapter synthesizes existing research and identifies challenges specific to the Ethiopian context. However, while the literature review is thorough, it could benefit from a more critical engagement with the sources, particularly in discussing the applicability of international practices to local conditions. This would enhance the depth of analysis and provide a more nuanced understanding of the challenges faced.

Chapter Three – Research Design and Methodology

This chapter explains the methodology and approach adopted to carry out the research, which is an essential element in achieving the research aim and objectives. It presents different methodological approaches, their justifications, the processes involved, and types of tools used in the research. The activities include how to select a data source, sampling and techniques, data collection and procedures used, and the method of analysis; the way how to conduct a reliable and valid test will be discussed in detail.

Chapter Four – Results and Discussion

The fourth chapter presents and discusses the results, analyzing the findings in relation to the research questions. This section effectively connects empirical data with theoretical frameworks, although a more critical interpretation of the results could provide deeper insights into the implications of the findings.

Chapter Five - Conclusion and Recommendation

Finally, the fifth chapter concludes the study with recommendations for practice and future research. This organization facilitates a clear understanding of the research process and emphasizes the practical implications of the findings, making the study relevant to practitioners in the field. Overall, while the organization of the research is logical and coherent, enhancing critical engagement in the literature review and providing more robust methodological justifications would further elevate the study's academic contribution.

Chapter 2: Literature Review

2.1 Introduction

The objective of this chapter is to identify the applicability of past studies on assessment of construction material management practice, which undertake a research review of various kinds of literature related to components of construction material management practices (planning, procurement, transporting and logistics, receiving and inspection, handling and storage and waste control) and their challenges on material management practices.

2.2. Construction material management

Construction, defined by the UN Statistics Division as cost-effective activities involving the erection, renovation, repair, or expansion of fixed assets like buildings, land improvements, and technical structures. (Central Statistical, 2008/09) Hence the construction business is complex and fragmented; relying on appropriate personnel, tools, materials, and financial flow is required to complete projects on time and on budget. (Flanagan, 2009)

In related Richard (2000), discussed construction is the process of building various projects with the use of labor, supplies, and equipment. Moreover, a number of additional duties, such as delivery, management, and supervision, are needed to complete the project successfully. Material described by Baily (1982) is goods obtained from sources outside the organization that are utilized to make a finished product. Similarly, materials defined by Stukhart (1995) are things that are employed in the manufacturing process, such as equipment, parts, accessories, and raw materials.

Material management involves planning, assessing, tracking, purchasing, transporting, storing, and controlling materials to minimize waste and optimize profitability by decreasing material costs (Ballot, 2006) (Narimah., 2013). In the related construction material department, we are in charge of organizing the planning, sourcing, buying, moving, storing, and controlling of materials in the best possible way to deliver a predetermined service to the client at the lowest possible cost. (Okeke, 2020)

Cost of material management can make up between 30 to 80% of the overall cost of building in this context, Kini (1999) points out material and equipment expenditures account for 50–60% of the total project costs. Similarly Stukhart (1995), argues materials with a value of 50 to 60% are

an important part of any project. Then material management is crucial for material scheduling, ordering, managing deliveries, warehousing, purchasing, receiving, and storing. (Donyavi, 2009)

2.3 Benefits of Construction Material Management

Since planning and scheduling have a direct impact on the project's cost and time, material management is essential for construction projects to operate efficiently. (Mustapa, 2012) Material management is essential in construction, project planning, and execution to guarantee timely procurement and inventory control, hence preventing losses, shortages, and delays in the material flow process. (Pataskar, 2013)

According to Bernold (1991), enhanced material management practices diminish overall material costs, optimize material handling, minimize duplicate orders, guarantee the availability of materials in requisite quantities on-site, foster improved supplier relationships, decrease material surpluses, streamline on-site material storage, enhance project schedules, improve quality control, and facilitate superior cash flow management. In related to this Navon (2004) revealed that the main benefits of an efficient material management and control system are increased productivity and avoidance of delays; estimates of productivity gains are between 8% and 12%.

Similarly, material management in construction projects is essential for efficient planning, procurement, delivery, stock storage, waste control, quality assurance, good relationships with dealers and consumers, increased departmental efficiency, cost reduction, time saving, and project economy. Then to achieve optimal construction projects, coordination and harmony among material management staff and employees from other departments within the organization are crucial. (Sachin, 2016)

Therefore, effective material management is essential since ineffective planning, shortages, identification errors, transshipment, and inappropriate storage can cause delays and lower production. (Jose, 2004)

Effective materials management involves planning, purchasing, inventory control, quality control, and departmental efficiency with secondary tasks including standardization, make-and-buy decisions, coding, and forecasting. (Gulghane, 2015)

An effective management system is crucial for a construction company's success, with advanced systems potentially increasing labor productivity by 6% and saving labor costs by 4-6%. Materials management involves planning, controlling, and ensuring proper material and equipment procurement. (Mohammed, 2004), (Absalom, 2014)

The construction industry is increasingly recognizing the importance of comprehensive, integrated materials management to enhance operational efficiency and reduce costs due to material shortages, high interest rates, and rising prices. (Adewuyi, 2013) From this perspective, a material manager's role is economical, aiming to minimize material costs while achieving company goals, and they must balance profit with customer expectations, ensuring costs do not exceed revenue.

2.4 Components of Construction Material Management

Construction material management involves integrating, organizing, and managing components to ensure material accessibility. (Mohamed, 2021)

For this reason researchers have developed six basic components, according to (Kanimozhi, 2014) and (Khyomesh, 2011)

1. Material estimation, budgeting, planning, and programming. (Planning stage)
2. Purchasing and procurement. (procurement stage)
3. Transportation and logistics (Logistic stage)
4. Receiving and inspection(inventory control stage)
5. Material handling and storage (handling stage)
6. Waste management (waste control stage)

Likewise from (ECPMI, 2019) manual there are around seven different components of construction material management practice as shown below.

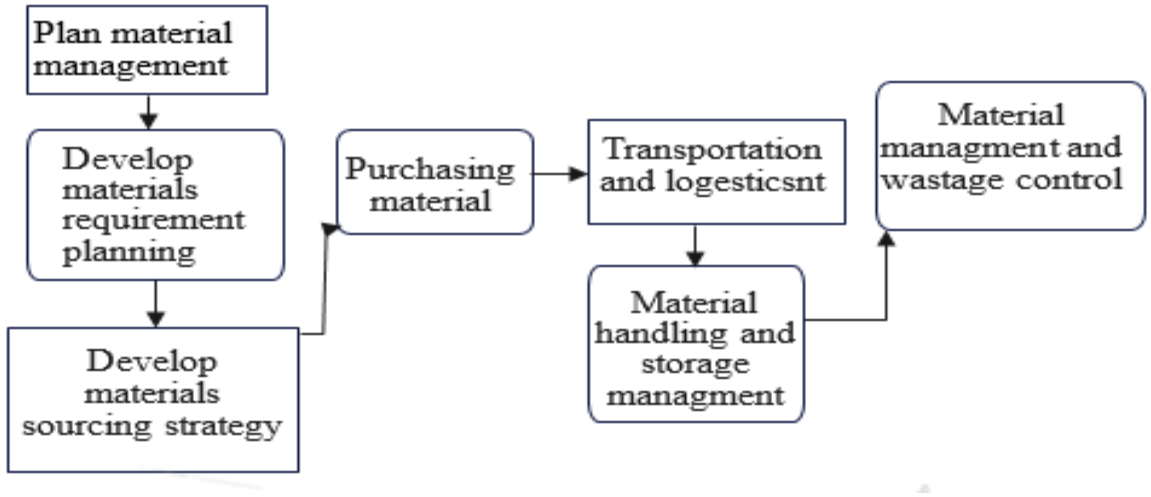


Figure 2. 1Components of construction material management

This study adapted from Khyomesh (2011) approach for discussing components of construction material. Because it is clear and easy to grasp the procedures of construction material management practice, it is suitable for this research.

2.4.1 Material planning

A material management plan is a crucial document in construction projects, guiding teams in developing comprehensive planning and understanding the most economical construction methods to meet customer requirements. (René, 2022)

Planning construction material management involves identifying and developing material requirements, procuring, managing, and using materials. It determines the approach and effort required for construction projects, typically performed once at the beginning and updated at new points. (ECPMI, 2019)

Material planning is an essential procedure that establishes parameters for following tasks and profoundly influences project planning. (Stukhart, 1995) It involves establishing and maintaining records, determining target inventory quantities, and scheduling. (Kasim, 2010) Scheduling the entire material program is essential to meeting the project timetable. Indeed, planning and scheduling are significant in terms of increasing productivity, profit and facilitating the timely completion of construction projects. (Phu, 2014) In this regard there is web-based material planning and control model to show any deficit in the quantities of specific construction materials through periodical short texting systems or by e-mail. (René, 2022)

Planning access and material entry routes at construction sites is crucial for effective materials management. (Kasim, 2005) The BOQ is a common criterion used for identifying major construction materials based on drawings, bills of materials, and specifications. (Gulghane, 2015)

Paul (2017) States that construction planning coordinates construction units' flow through pre-planned functioning and material plans, creating a schedule for material ordering and matching it with actual construction activities. Chandler (1978) Define schedule as a schematic of resource requirements for ordering materials, including quantities, waste allowance, and availability for fixed rate, delivery date, and costs. Materials should not be ordered directly from the contract invoice; it serves as a guide for contractors to determine contract prices, producing a material schedule for purchasers and calculating bulk and imported costs. (Azodoh, 2022)

Accordingly, various companies can have different material planning levels; some can have micro and macro planning levels, with four main types on construction sites: time, cost, materials, and labor. (Gulghane, 2015) And for each level, plans should be revised as often as possible to monitor if work is progressing as planned (Khyomesh, 2011). A materials management plan creates a schedule for project components and calculates lead times, using four essential pieces of information: (ECPMI, 2019)

- Master schedule,
- Bill of materials,
- Cycle times and material needs at each stage and,
- Supplier lead times.

Building materials plans require careful consideration of factors like project size, scope, location, cash flow requirements, owner philosophy, approval, project participants, inspections, bidders, and supplier list. (ECPMI, 2019)

Material ordering involves important questions like the quantity, quality, and location of materials, and that information is revealed from contract documents. Ordering systems can be synchronous, pre-planned, periodic, or non-periodic. (Hemishkumar, 2015) Materials can be

ordered from the architect or builders, contributing to construction planning and quality control. (Azodoh, 2022)

Tanko (2017) The material planning process involves maintaining records of plant parts to determine inventory levels and delivery frequency, improving material flow, preventing shortages and non-delivery, and guiding subsequent activities, significantly impacting project planning.

Efficient material planning enhances company productivity, profits, and construction project completion by avoiding delays and reducing activity times, ultimately leading to improved service. (Wong, 1997)

Improper planning of building materials is a major issue in construction, influenced by factors like time spent, relationships, alternative plans, management time, correction intervals, and control of construction methods. This 40% of time lost on construction sites is due to improper management, lack of materials when needed, poor material identification, and inadequate storage. (Haddad, 2006).

Companies are enhancing efficiency and productivity through effective materials planning systems. This can lead to cost savings and timely availability of materials, but often lacks clear accountability and communication, hindering successful construction. (Adnan, 2009)

2.4.2 Material Procurement

Procurement involves purchasing materials, equipment, labor, and services for a project. (Barrie, 1992) Procurement is the initial stage in the material delivery process, involving contractor appointment and preparation of contract documents. (Mohamed, 2021) And aiming to provide high-quality materials at the right time, place, and price. (Kaur, 2016) :

- To efficiently procure goods at a low cost,
- Ensure high-quality products,
- Ensure fast delivery,
- To distribute workload efficiently
- To optimize inventory management through scientific procedure

Materials procurement management significantly impacts project time and cost, affecting decisions during supervision, planning, and scheduling phases, as noted by (Mustapa, 2012).

The procurement function in a construction company aims to purchase materials and services from the right source, at the right time, in the right quality, quantity, and price. (Kasim, 2010) The procurement department supports project teams in completing tasks within budget and schedule, and procurement managers ensure the best quality of subcontractors and materials at the lowest possible cost. In small construction companies, the owner typically handles all procurement and purchasing functions. (Benton, 2010).

Preliminary investigations for material procurement sources involve floating enquiry indents, processed by material procurement personnel, who invite quotations and samples of materials when applicable. (Phu, 2014)

According to Lamer (2007) purchasing is a fundamental business function that directly impacts profitability and job profits. It involves acquiring raw materials, consumables, and equipment, which are essential for cost reduction and business management. Every business is managed or controlled through the coordination and integration of the following six functions: (Azodoh, 2022)

- Conception, design ideas
- Funding,
- Workforces,
- Acquiring resources,
- Alteration materials into assets,
- Delivery of goods, as well as industrial relations

Purchase requisitions are documents detailing material requirements for warehouses, prepared by the warehouse manager and sent to the purchasing department and planning department for special out-of-stock purchases. (Saleh, 2008).

The purchasing department aims to avoid cheap purchases and prioritize quality, sometimes purchasing good materials in bulk at lower prices, but misuse and waste of resources can occur.

(Frank, 2010) There are various situations described for misuse and waste of resources, including:

- Buying incorrectly,
- Excessiveness,
- Buying too little,
- Uneconomical purchases,
- Material loss,
- Theft ,
- Damage,
- Waste, and
- Imbalanced purchase

Purchasing and procurement aim to obtain materials at the lowest cost while maintaining quality. (Haddad, 2006). In general, purchasing involves understanding requirements, selecting suppliers, and negotiating prices, and products are classified into large and small purchases. (ECPMI, 2019)

To procure high-quality materials, various stages are required to tender materials from various suppliers as shown below:

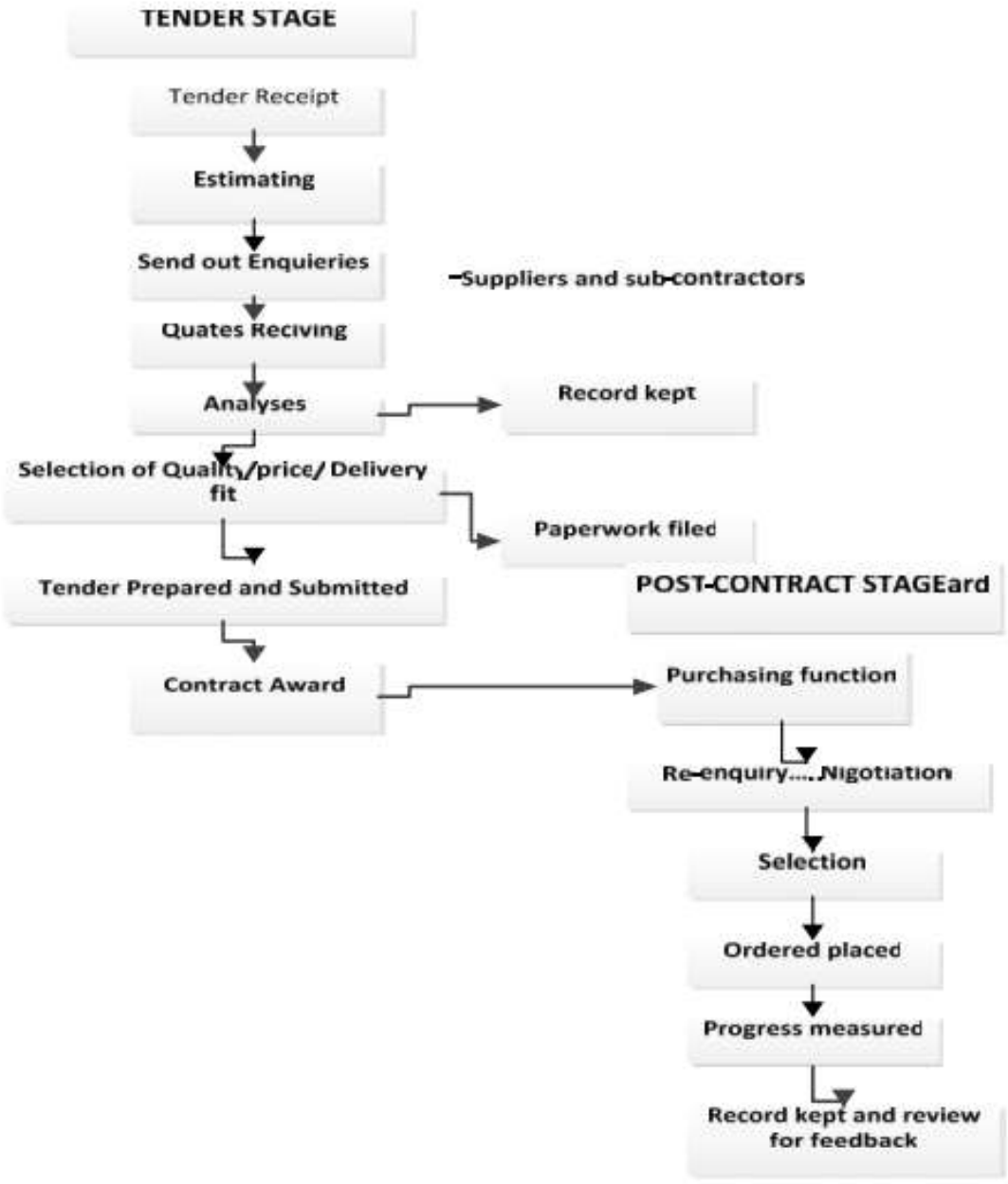


Figure 2. 2 Typical Purchasing Procedure for construction firm (Canter, 1993)

The purchasing group in large organizations includes analysts, transportation specialists, and senior management, with the purchasing department responsible for planning external production and executing some or all purchasing functions. (Lamer, 2007)

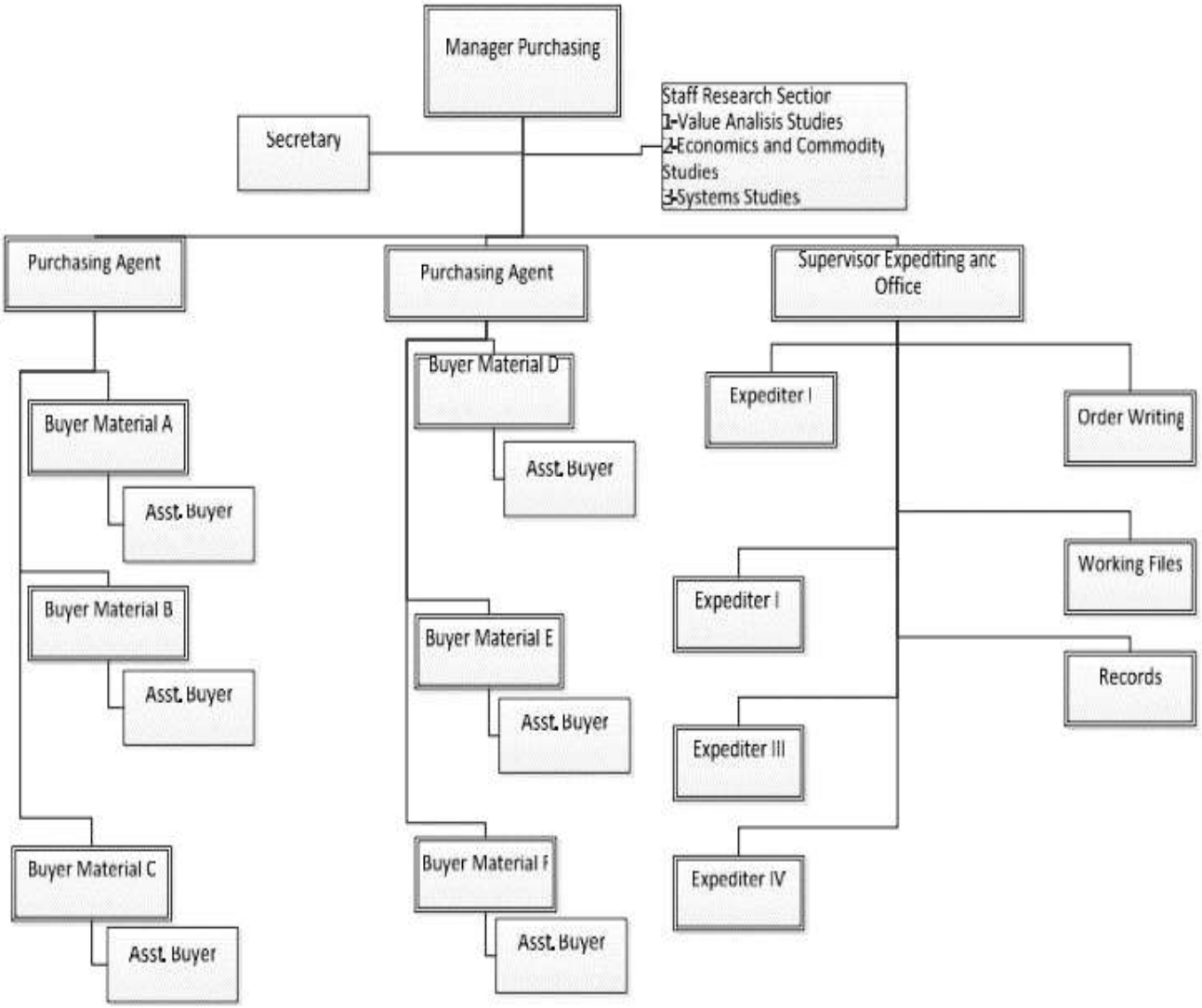


Figure 2. 3 Department for typical construction firm (source: Lee and Debtor (1985)

Maintaining data on supplier names, prices, completed purchases, and purchase dates is crucial for reducing purchasing costs and ensuring time and cost control in construction projects (Kebede, 2016). Recording purchasing data includes:

- Filing outstanding contracts,
- Maintaining a goods receipt and invoice book,
- Requesting quotations and purchase orders,
- Registering purchase orders
- Breakdown of purchasing costs by department..

A failure in the purchasing process or in overseeing and organizing the buying functions listed by Canter (1993) could result in:

- Over-ordering,
- Over-payment for materials (inadequate administration procedures);
- Loss of benefits (lack of skilled negotiating procedures);
- Lack of knowledge (when and where the best service/source might be available at any particular time

2.4.3 Material Transportation and Logistics

Material transportation involves the safe and cost-effective transportation of construction materials from one location to another via vehicles, ships, and aircraft. (Gulghane, 2015) The efficient movement of trucks, people, and materials has a considerable impact on the effective utilization of labor and production in building projects. (Phu, 2014)

The American Council for Logistics Management defines logistics as "the efficient and cost-effective management of the flow and storage of raw materials, semi-finished products, and related information". Similarly, the logistics concept in construction projects enhances coordination and communication, particularly in materials flow control, ensuring efficient material management and efficient site access and routing. (Stukhart, 1995)

Material handling information is crucial for the safe transportation of materials, as broken or rotten materials halt work progress due to a lack of materials. (Gulghane, 2015) Coordinating transportation and logistics activities with engineering, procurement, and construction schedules is crucial for the timely delivery of construction materials, as schedule delays can have significant financial impacts. (ECPMI, 2019)

Based on (ECPMI, 2019) transportation and logistics process involves:

- Identifying material origin,
- Quantifying cargo,
- Determining export port,
- Determining delivery terms,
- planning insurance,
- Evaluating transportation costs, and

- Managing logistics from the destination port to the project site.

The logistics concept in construction projects aims to enhance coordination and communication between project participants, particularly in material flow control, addressing issues like supply delays and waste in storage, handling, and transportation. (Naoum, 1998).

The distribution of materials significantly impacts construction project costs and time, with logistics issues including incorrect timing, quality, and lack of information, shortages, storage space, and wasted effort in searching for materials on site. (Kasim, 2005)

2.4.4 Receiving and inspection material (Inventory stage)

According to Naoum (1998), the goods receiving system includes areas like external suppliers, goods receiving processing time, and materials management. The processing time starts with shipping documents being stamped and updated in the materials management system, ensuring timely delivery.

An important aspect of materials receiving is the verification of materials' sources and meeting purchase order specifications; it can avoid costs and increase profitability. (Daniel, 2019)

Material receipt issues are a metric that indicates discrepancies in material delivery data, potentially leading to inaccuracies in project management databases if not addressed. The average duration from a Purchase Order (PO) to the receipt of materials is calculated by dividing the duration from issue to receipt by the total number of receipts. (Saleh, 2008)

The receiving system from internal departments involves sending purchase orders, supplier receipts, and waybills before materials arrive on site, allowing store managers to schedule material release. Handover notes and return receipts are common. According to Sundaresan (2011) the problems can be categorized into:

- Issued to consuming departments
- Issued to external suppliers for processing or transformation.

Building materials are issued at construction sites based on project progress and need, with costs incurred based on production programs. Work instructions list material quantities for components, ensuring automatic consumption control. (Alwi, 2002).

Materials management in organizations is similar to inventory management, with computerized systems enhancing consistency and completeness. Automated systems incorporate master production schedules, inventory records, and product components. (Mustapa, 2012)

Inventory records determine order requirements, including quantity and forecast demand. Reordering is recommended for low stock or items below standard. A material requirements system automates record keeping and helps project managers understand purchase requirements. Low stock may require reordering. (Madhavi, 2013)

Inventory control is a crucial part of material management, ensuring timely and necessary inventory supply to prevent unnecessary investment. (Pataskar, 2013).

2.4.5 Material handling and storage

Material storage refers to the effective and methodical management of building materials and components during construction, ensuring enough space, protection, and control. (Phu, 2014)

Material handling involves the cost-effective movement and storage of materials through appropriate methods and equipment, including procurement, inventory, manufacturing, and field service, requiring special attention to cost reduction. (Kasim, 2005).

The choice of material handling equipment significantly enhances production processes, labor utilization, volume, and system flexibility. These routine tasks on construction sites significantly impact project cost and schedule. (Johnston, 1981)

Proper handling and storage of materials are crucial for maintaining their quality and preventing loss of profits due to theft, damage, waste, and low stock, as highlighted by (Haddad, 2006), (ECPMI, 2019), (Kasim, 2005). For this reason the process of loading and unloading of material should not be carried out in the rain; it is also advised that the storage area should be closed, clean, and dry with good air circulation and should be stacked on pallets for certain materials, not more than a certain safe height to prevent dampness and so on. (Keith, 2015)

Excessive materials can cause difficulties for managers, increasing production and project costs to address this, managers must find alternative storage methods, which may require reprocessing, and ensure proper handling and storage of materials, especially from suppliers. (Polit, 1999).

Early material purchases can lead to capital and interest expenses, rot or theft during storage, delays, and additional costs. Special care is needed for construction site storage to prevent waste, loss, and damage, and to address material supply problems due to inadequate equipment. (Mahmoud, 2012).

Material flow on a construction site involves transporting materials from the site entrance to the final installation area, using models like site entrance, storage areas, staging areas, assembly areas, installation areas, and disposal areas. (Donyavi, 2009)

To properly manage a warehouse, the following steps should be implemented (ECPMI, 2019)

- Receive materials and equipment on site,
- Conducting a total count and inspection,
- Storing and protecting materials,
- Transporting materials, equipment, tools, and consumables from the warehouse to construction workers or subcontractor personnel,
- Reporting all warehouse processes.

In this context Johnston (1981) material handling should be planned simultaneously with other activities on the construction site. Success is achieved through the following actions:

- Understand the situation
- Packaging forms should be discussed in advance.
- Control of delivery sequence.
- Use correct equipment.
- Keep tight control of all operations

According to Joy (1990), material handling on the construction site can be broadly divided into the following steps:

- Unloading from wagons/trucks and stacking in the warehouse and transporting from there to the warehouse construction site, unloading at the construction site, moving heavy contract materials, lifting etc. and
- Light and medium inventory

2.4.6 Material waste management (Waste control)

Waste in the construction industry refers to discrepancies between estimated and actual consumption of items, negatively impacting project delivery efficiency. (ECPMI, 2019) Based on Shen (2004) waste is the difference between delivered and accepted materials.

Waste control, according to Prabu (2006), is a method to guarantee that all supplies, including raw materials, processed materials, assembly components, consumables stores, general stores, maintenance supplies, spare parts for ongoing activity, and completed goods, are available when needed.

All construction projects can expect surplus and waste material at various stages, making control of these materials crucial for successful material management. (Phu, 2014) Material waste can be minimized through proper waste management, including design, procurement, and operations. (ECPMI, 2019) A zero-waste attitude and efficient use of materials can reduce material purchases and waste production, saving on material and waste disposal costs. (Kasim, 2005).

Material waste is a significant issue in the construction industry, affecting both industry efficiency and the environmental impact of construction projects. (Gulghane, 2015) Construction project waste is caused by inefficient design, procurement, storage, and implementation. Reducing waste necessitates careful consideration of material minimization and improved utilization throughout the design and construction phases. (Mohamed, 2021)

As per (Johnston, 1981) material waste due to material handling problems is due to one or a combination of the following factors:

- Unskilled workmanship
- Construction and design errors
- Excessive material use
- Breakage
- Poor storage
- Crime

2.5 Challenges of material management practice

The issue with materials management lies in the absence of recent and relevant information, leading to a disregard for the significance of monitoring material flows and data. (Navon, 2004) In each building phase, various factors contribute to the inadequate implementation of construction material management practices.

Materials management involves measurements, procurement, logistics, administrative and financial payment, and waste disposal, with obstacles like mismatched orders, lack of training, improper management, and communication issues. (Donyavi, 2009)

Construction site issues include delays, over-ordering, incorrect materials, theft, double handling, and logistics issues like missing materials, lack of information, and wasted effort that have happened (Donyavi, 2009). In any case, inadequate material handling and management at construction sites can profoundly affect project cost, duration, and quality. (Fethi, 2013)

In construction activities, poor material management techniques result in decreased production and delays. As a result, as indicated in table 2.1 below, numerous researchers are finding out about the difficulties associated with building material management practices at various stages of construction.

Table 2. 1Challenges on construction material management practices

Author/year	Findings on challenges of construction material planning practice
(Kayiranga, 2020)	• Inconsistent resource availability leads to increased labor hours for materials management, with foremen spending up to 20% of their time searching for items and 10% tracking and expediting orders. • Forgotten material to be orders • Absence of defined material quantities
(Arijeloye, 2016),	• Works are not properly planned nor scheduled, • Money flow to the contractors destruction for clear planning, • Noncompliance of arrival material type and amount with the specifications
(Mohamed, 2021)	• Undefined scope, a lack of communication, insufficient drawings, non-standard specifications, and • Lack of knowledge of what and when the material is needed.
(René, 2022)	• Material price fluctuations.
	Findings on challenges of construction material procurement practice
(Navon R., 2005)	• Managed supplies without a list of purchases. • Inadequate awareness of material supply and inappropriate scheduling on site.
(González, 2010)	• Materials are not easily accessible. • Material expenses are higher than planned.
(Majrouhi, 2012)	• Materials have been provided within inaccurate quantities or inappropriate qualities.
(Vipin, 2019)	• procurement of materials that do not meet the stated quality
	Findings on challenges of construction material transportation and logistics practice
(Okeke, 2020),	• Lack of consideration for making material deliveries at scheduled dates and times.

(Kasim, 2010)	• Access issues for supplying materials to the location.
(Dakhli, 2018)	• Traffic jams in urban areas, lack of space and logistic issues • Delayed delivery of materials to the site
	Findings on challenges of construction material receiving and inspection practice
(Okeke, 2020),	• delay in receiving materials on sites • Inadequate procedures for material testing, inspection, and documentation
(Kayiranga, 2020)	• Lack of calculating the amount of material required, • Insufficient material inspection based on ordered quantities. • Inadequate tracking of material supply on-site , and • There is a lack of a baseline for determining the quality of material.
	Findings on challenges of construction material storage and handling practice
(René, 2022)	• surplus, lack of storage space , • Lack of keeping adequate buffer stock in case of delay in receiving materials, • Lack of planning of sites to indicate the main storage area and stockpiles, • Lack of coordination for movement of plant handling materials
(Santelices, 2019)	• Poor material supervision, material exposure to harsh weather, • An abundance of material on site are
(Kasim, 2010)	• Operational limitations due to security issues
(Phu, 2014),	• Theft, robbery and vandalism of material
	Findings on challenges of construction material wastage control practice
(Navon, 2004).	• Poor material management on construction sites
(Okeke, 2020)	• In adequate protection of materials
(Karoriya, 2018)	• lack of competent planning and management for materials

Similarly Bamidele (2016) pointed out problems associated with materials management in construction projects are:

- Negligence
- Inadequate storage space
- Late delivery of ordered materials
- Incompetent suppliers
- Access issues
- Material damage during transportation hinder progress
- Lack of security guards
- Improper storage of materials
- Difficulties in material inspection
- Rejection of materials due to non-compliance with specification
- Disputes and conflict between subcontractors
- Lack of proper work planning and schedule
- Cash flow issues
- Burglary, theft and vandalism
- Material shortages during construction and sudden fluctuations in material prices

Likewise in Ethiopia, research on the management of materials has been done as Sori (2021) identified factors affecting the management of building construction materials in construction projects, including appropriate storage, congested sites, weather conditions, supervision, material reporting, frequency of returns, and storekeeper employment.

Additionally, Kebede (2016) study on defense construction company materials reveals that improper issuance, sourcing, and uses of material significantly impact practice of construction material management at building sites. Similarly, as Semma (2021) finding at Federal Housing Corporation projects, design changes, transportation damage, improper material storage, poor quality of material, and improper procurement schedules contribute to construction materials wastage, impacting project cost, time, productivity, and sustainability.

2.6 Involvement of stakeholders in construction material management practice

Stakeholders in construction projects are interconnected through formal or informal relationships, legal contracts, and direct interests, ensuring they are never isolated. (Al-Khafai, 2009).

The client initiates construction projects, funding, defining goals, and implementation. However, their requirements are often unclear and may change due to organizational structure, strategy, and environment. Most project errors are due to vague and uncertain client requirements, like incomplete designs and delayed building permits, possibility to management contracts, construction management contracts, or design management contracts for complex projects. (Al-Khafai, 2009)

Interpersonal relationships in construction can lead to disputes if mistakes, inconsistencies, or contract clarity occur. These issues can result in poor work, resource shortages, and delayed payments, ultimately affecting the company's cash flow and potentially terminating contractual relationships between clients, contractors, subcontractors, and suppliers. (Al-Khafai, 2009)

According to Latham (2007) the problems were summarized as follows:

- Customer dissatisfaction.
- Poor performance
- Hostility, entitlement culture
- Absence of profit margins.
- Intense lobbying

Walker (2001) studies found that the client or their representative holds the most influence over design and procurement decisions, while the contractor bears most cost risk in traditional cost-reimbursable procurement approaches. In Build Own Operate Transfer (BOOT) projects, the contractor has significant influence. The dominant supplier, controlled by the contractor, is responsible for ordering materials. The order must include details about required quantity, delivery date, site receipt, and general conditions. (Al-Khafai, 2009) Reliable materials and equipment supply is crucial in construction projects, as insufficient or defective supplies can cause delays, interruptions, or even halt the project. (Al-Khafai, 2009)

Table 2. 2 Example of construction project stakeholder's role and related impact on CMM practices **(Al-Khafai, 2009)**

Categories	**Individuals/groups**	**Objectives and roles**	**Impact on CMM practices**
Clients	Private clients	Ensure the project will support the organization's strategy. Ensure the organization's resources will be used economically and effectively Learn skills, earn wages, work on the frontline Link between the client and consultants, ensure the project is completed successfully in terms of quality, time and cost Provide financial support; maximize return with minimized risk Purchase the construction product	On Procurement phase Monitoring and controlling the work progress
	Public clients	Serve public interest based on the organization's strategic objectives Consume what is delivered in order to satisfy functional and basic needs Allocates funds to the project Ensures that public funds will be used properly Link between the client and the consultants, ensure the project completed successfully in terms of quality, time and cost	Planning and procurement phase On Receiving inventory's
Project professionals (in-house/ out-of-house)	Architect	Develops the design of the project; produces drawings and specification; ensures that a project is implemented within cost and time, and according to quality control	Planning phase
	Quantity surveyor	Advises client on financial and budgetary matters; assists in preparing tender documents; examines and reports	Wastage minimization through all work progress

		upon tenders; monitors costs during construction and seeks to understand valuation and measurement; assesses the legitimacy of claims from contractors and prepares financial accounts	
	Structural engineer	Designs all structural calculations and elements; designs building structure; ensures statutory compliance	
	Other consultants	Assistance in developing the brief; advice on special studies and surveys for design development; collaboration with the design team to develop design and cost control; advice on developing drawings, specifications and other tender documents; prepare design drawings; monitor work on site with regard to quality, cost and time; attending commissioning and acceptance testing and completion of relevant work; assist in valuations and the settlement of accounts	On planning, procurement , material handling and storage and wastage control practices
Contractors/suppliers	Main contractor	Carries out and completes the work designed by consultants to meet time, cost and quality objectives; supervises and manages operations on site; sometimes assists in design; coordinates and supervises all sub-contract work, materials and suppliers	Related with transportation, handling, storage and wastage minimization process
	Sub-contractors	Carry out work assigned by main contractors	
	Suppliers	Supply, install and commission the hardware that constitutes the finished building (e.g. materials suppliers, equipment suppliers and manufacturers	Transportation and inventory delivery

Project managers must effectively manage stakeholder interests throughout the project management process, a principle that can be applied across borders for successful outcomes (Sutterfi eld, 2006)

2.7. Domestic construction material management practice

Various studies conducted in Ethiopian about construction material management from different perspectives. Among these, (Meberatie, 2023), (Abraham, 2016) , (Kebede, 2016), (Assegedech, 2016), (Semma, 2021) and (Asmara , 2015) are listed.

Table 2. 3 Prior study in the area of construction material management practice in Ethiopia

Title	Author /Year	Objective	Main findings
An Assessment of Managing and Minimizing Procedures of Construction Materials Wastage: The Case of Federal Housing Corporation Building Project Located, Addis Ababa, Ethiopia	(Semma, 2021)	Identify key causes of construction material wastage on FHC Impacts of construction material wastage	• Design change & revision, • Damage during transportation, • Wrong storage of materials, • wrong handling of materials, • Poor quality of materials, and • Poor schedule to procurement the materials are the major contributing factors for construction materials wastage • Impact on construction cost, construction time, and productivity and sustainability aspects
Assessment on the Housing Development Construction Materials Management System: Case Study in Addis Ababa housing construction Projects	(Assegedech, 2016)	Identify method of material procurement practice in construction projects To compare the planned materials	• 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

		with actual materials used in construction projects	materials used equal with the planned materials except electric fitting and sanitary fitting. Construction material management challenges • For Addis Ababa housing construction project above 50% of the project cost was materials cost • Failure to order on time which delays the projects account 80% • Delivery of material at the wrong time which interrupts the work schedule accounts 75%
Study of contractor's material management in private building construction projects- As study of selected building sites, in Addis Ababa.	(Mahlet, 2016)	To understand current material management practice To explore problem faced in managing material on construction site	• 70% of the site under study has no existing material management department Most problems facing through material management practices are • Incomplete drownings and detail missing accounts 90%. • Late delivery of material • Un availability of required materials within required amount • No proper schedule of material, limited storage area.

Similarly, Abdu (2015) pointed out in Addis Ababa that 70% of respondents believe that performance indicators for construction material management are rarely used. In a related survey at Bahir Dar University, it was discovered that 80% of respondents viewed the lack of understanding of construction material management systems as the primary barrier to the use of computerized systems. (TENI, 2013)

Despite the fact that numerous investigations were carried out locally to find out construction material management practices at different projects, the following are the gaps identified.

Table 2. 4 summary of gap identification

No	Author/year	Research gap
1.	(Asmara , 2015)	The most important causes of construction waste on building construction projects were determined by the researcher. But excludes all methods of material management, such as preparation, acquisition, shipping, handling, and storage.
2.	(Abdu, 2015)	The most performance measure for material management process on building projects determined, however excluded practice and challenges of construction material management at building sector, (how to plan, procure, transport logistics, receive & inspect, store & handle, waste control).
3.	(Mahlet, 2016)	The study conducted current material management practice of contractors at private building construction sectors at Addis Ababa. Hence its scope was limited and cannot generalize.
4	(TENI, 2013)	The study focused only on local practice of construction materials management in selecting companies of Bahir Dar town, scope limited
5	(Assegedech, 2016)	Determine method and mechanism of material management system in construction project and factors affecting effective material management at Addis Ababa Housing Development Construction Projects (condominium), nevertheless not discuss about all construction stages (planning, procurement, transportation, receiving, storage and wastage) and limited scope
6	(Semma, 2021)	Finding out causes of material wastage and determine wastage minimize method at federal Housing Corporation projects, but not incorporate about method of construction material management practice in each stage (planning, procurement, transportation, receiving, storage and wastage control)

Even if there are studies on individual developers in the city of Addis Ababa and other parts of Ethiopia, most of the researches focus on specific targets or groups of construction sectors at minimal scope. Therefore, it is not sufficient to generalize about material management practice based on existing research.

Hence as discussed by Semma (2021), there are different factors related to construction material management issues that contributing to construction material wastage at FHC projects. Then to minimize these challenges, there needs to have good practice of construction material management at FHC.

As a result, the researcher wants to focus on material management because materials are such a large portion of construction budget consumption, lowering procurement prices increases the chances of lowering overall project expenses; therefore, the presence of good material management practices for construction projects can minimize project cost and the required time consumption.

Chapter 3 - Research Design and Methodology

3.1 Introduction

Research involves problem definition, hypothesis formulation, data collection, evaluation, deductions, conclusions, and testing. (Woody, 1923) And according to Alok (2011) "Research methods encompass techniques and methods used for conducting research, while methodology is the comprehensive approach to solving problems."

With this understanding, this chapter explains the methodology and approach adopted in carrying out the research, which is an essential element in achieving the research aim and objectives. It presents different methodological approaches, justifications, processes involved, and types of tools used in the research. The activities included how to select a data source, sampling and techniques, data collection and procedures, and other listed below.

3.2 Research Design

The research started with problem identification, which has been done through literature review, informal interviews with employers in the sector, and pilot observation. As an output of this step, assessment of construction material management practice in the Federal Housing Corporation was identified as a potential problem to be studied.

Upon identifying the research area, an extensive literature investigation started to understand the research issue and its objectives that were concentrating on construction material management practices and their challenges.

The review process includes different journals and articles, books, internet sources, and archival documents. The document search was mainly intended to investigate construction material management practices and their challenges in related to the whole process of construction and participant stakeholders.

The subsequent step to attain the study purpose is to identify specific sites, designate them as case studies, and examine them comprehensively using various methodologies, including interviews, observations, questionnaires, and data review procedures. Upon obtaining the desired data, checking and sorting of data has been done. This was followed by analysis to obtain the

result and thorough discussions in order to draw a conclusion and to forward recommendations based on the findings of the study.

The overall study approach is summarized in Figure 3.1 below. The figure explains how the entire study is planned and implemented to achieve the research objectives in the research processes.

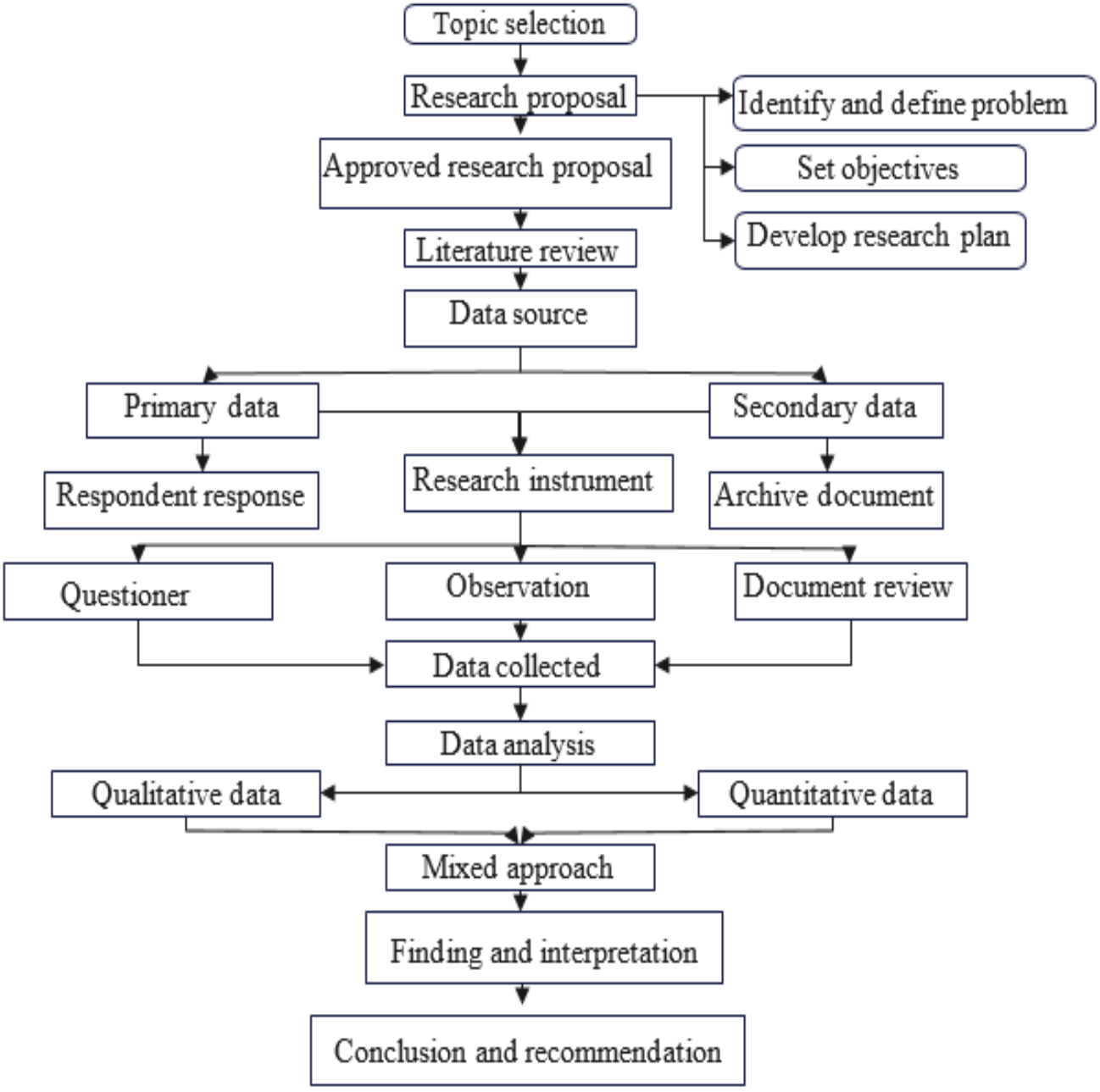


Figure 3. 1Research Methodology

3.3 Source of data and Research approach

3.3.1 Source of data

Gathering data can be accomplished through a primary source (the researcher is the first person to obtain the data) or a secondary source (the researcher obtains the data that has already been collected by other sources, such as data disseminated in a scientific journal). (Victor, 2019)

Two types of data sources are used in this research: both primary and secondary. The secondary data was collected through an extensive literature review from various sources comprising reference books, journals, and websites. The primary data source is collected through a questionnaire, interview, and direct observation.

3.3.2 Research approach

This research considers both quantitative and qualitative approaches in order to get an in depth and detailed study concerned with construction material management practices at FHC projects.

3.4 Population and Sampling Techniques

3.4.1 Target population

The population for this study was stakeholders which are involved in selected active Federal Housing construction projects, which include 40 contractors, 25 consultants, and 35 clients (FHC), which is a total of 100 population size. The contractors and consultant companies had valid registration according to the Ministry of Urban Development and Construction (MoWUD) which participated in Federal Housing Corporation (FHC) projects.

3.4.2 Sampling method

In this study, the researcher used probability sampling techniques. Since the researcher needed a limited number of people who could serve as primary data sources for the questionnaires. This allows ensuring every construction party in the projects is represented in the sample.

3.4.3 Sample size

In this study, respondents were selected based on their experience in building construction, knowledge and involvement in the company who have enough information on the projects progress. The research samplings focussed on projects which is constructing by FHC projects in Addis Ababa. Currently the company has five ongoing building construction projects in Addis Ababa city. Thus are projects of Kokobe Tsibha 2B+G+10 mixed-use apartments at Kebena,

Msrak Atekalay 2B+G+9 mixed-use used apartment found around Msrak Atekalay school, 2B+G+20 mixed used apartment at piyasa, Gerji village at Gergi, and Bole friendship 2B+G+9 mixed used apartment at Bole. All projects are at a different stage of construction. Therefore the respondent sample of the study will take from each building project which is currently involved on projects. The researchers will take samples from each projects; project manager; site engineer, office engineer, consultants (consultant representative) and owner (owner representative), procurement directors, assistant project managers, so that the researcher has to determine 30 contractor, 30 owner representative and 20 consultants from each of five active selective projects which is eighty representatives population.

The required sample size for the research for each party involved in the survey was determined statistically using the following expression, which is used to determine a finite population in research methodology.

$$n = \frac{N}{1 + N(e)2}$$

Where:

n= sample size

N= Finite population size

e= level of significance (or limit of tolerable error)

1= unite (a constant value)

And (Chuan, 2006), recommended 5% as an acceptable margin of error for categorical data and 3% for continuous data. Based on this, the researcher desired a 5% level of significance and 95% probability that the sample is distributed in the same way as the population. From that point of view, the researcher population size is around 100.

$$n = \frac{N}{1 + N(e)2}$$

Where:

n= sample size

N= Finite population size= 100

e= level of significance (or limit of tolerable error) = 5%=0.05

1= unite (a constant value)

n = N/ 1+N (E) 2

n= 100/ 1+100(0.05)^2

n=100/1.25

n= 80

Then distributed sample size is became 80.

3.5 Method of data collection

In this research, methods of data collection include a literature review, a questionnaire, and site visits. This means data was obtained using two different methods. Namely, site visits or observations and questionnaires, which are referred to as primary sources of data, and literature reviews as secondary data. Site visits involved observations where the researcher sought to find out how materials management works, how they are planned, procured, transported, and logged; how they are received and inspected; how they are handled and stored; and how waste is controlled.

3.5.1 Collection of data through questionnaires

To design a questionnaire, first it needs to identify various material management practices, their challenges, the effects of stakeholder involvement in material management practice. The study asks on a variety of things, including issues like material management practices in different stages, challenges of material management practice, and the involvement of stakeholders in material management practice at each stage on Federal Housing Corporation projects. All items in the questionnaire are arranged in a form of Likert items on a scale ranging from 1 to 5.

A survey is used to gather demographic data or opinions about people. In this research, a questionnaire was taken to the persons concerned with a request to answer the questions in person and returned. The respondents have to answer the questions on their own. In this research, the questionnaire contains four different sections, including the demography of respondents.

- **Questionnaires survey section A** In this section, the background of the participants is identified, like the organization they are working for, their current work position, their educational qualifications, and their work experience in the construction industry.

- **Questionnaires survey section B** The first and the third objective of the study was to assess current construction material management practices of Federal Housing Corporation projects and to identify best practice of construction material management at FHC projects. The material management practices identified by other researchers are discussed in the literature review. This information helped to formulate the questions for this section.
- **Questionnaires survey section C** in related objective two the study was done to identify key challenges faced in material management practices of Federal Housing Corporation projects. The challenges of material management practices identified by researchers are also discussed in the literature review. This information helped to formulate the questions for section C.
- **Questionnaires survey section D** The fourth objective of the study was to assess the role of key stakeholders involvement in construction material management practice. The role of key stakeholders in construction material management practices considered by other researchers is discussed in the literature review. This information helped to formulate the questions for section D

3.5.2 Collection of data through Direct Observation

Deribsa (2018) asserts that by investigating and comprehending the background of the operations, researchers can build a comprehensive grasp of a topic by observing operations and activities. In this research, direct observation was used in which the observer watches rather than takes part in the activities focused on. The researcher got formal observations in the project sites; casual observations were applied for this research, and during these site visits an interview was conducted.

3.6 Data analysis and presentation method

3.6.1 Data analysis

The data collected using the questionnaire sections A, B, C, and section D (background information, current material management practice, challenges of construction material management practice, and involvement of stakeholders in FHC projects) to display the gatherer data in frequency, percentage, RII (relative important index), mean, tables, graphs and charts, and the obtained data was analyzed using descriptive statistics of SPSS software.

The reason for selecting a relative importance index is because it clearly presents which factor is more significant than the others in order to rank those factors correspondingly based on their weight. Analysis of data consists of calculating the Relative Importance Index (RII) and ranking the factors in each category based on the result.

$$RII = \frac{1\,n1+ 2n2 +3n3+4n4+5n5}{A*N}$$

Where, RII = Relative Importance Index,

n1, n2, n3, n4, n5 = Number of respondents answer each factor

1, 2, 3, 4, 5 = weight given for each factor (ranging from 1 to 5),

A = highest weight (i.e. 5 in our case),

N = total number of respondents.

Raja (2018) Stated that based on the relative importance index rank obtained from analysis, the capabilities were classified as five important levels that are transformed from RII values:

- High level (H) ($0.8 \leq RII \leq 1$),
- High-medium level (H–M) ($0.6 \leq RII \leq 0.8$),
- Medium level (M) ($0.4 \leq RII \leq 0.6$),
- Medium-low level (M-L) ($0.2 \leq RII \leq 0.4$) and
- Low level (L) ($0 \leq RII \leq 0.2$)

3.6.2 Research Reliability

In any research results, the issues of reliability and validity are important confidence measures. Cronbach's alpha is one of the most commonly accepted measures of reliability. It measures the internal consistency of the items in a scale. It indicates that the extent to which the items in a questionnaire are related to each other. The normal range of Cronbach's coefficient alpha value ranges between 0-1 and the higher values reflect a higher degree of internal consistency. Different authors accept different values of this test in order to achieve internal reliability, but satisfactory value is required to be more than 0.6 for the scale to be reliable (Stephanie, 2016).

Chapter Four – Results and Discussion

4.1 Introduction

This chapter deals with the analysis of data obtained from different respondents that was collected through questionnaires. The method used is discussed in chapter three. The collected data from the questionnaires were presented, interpreted, analyzed, and discussed through tables, charts, and graphs in detail to justify the material management practice of FHC projects.

4.2 Reliability test

Before doing an analysis based on the questionnaire's answers, a reliability study using Cronbach's Alpha was done to make sure the questions were reliable. As discussed by Zikmund (2010) Alpha Coefficient range, α Level of Reliability, became

- 0.80 to 0.95 = Very Good Reliability
- 0.70 to 0.80 = Good Reliability
- 0.60 to 0.70 = Fair Reliability

In this research value of Cronbach's alpha was determined to know reliability of questions as shown below in Table 4.1.

Table 4. 1 value of reliability test

Reliability Statistics	
Cronbach's Alpha	**N of Items**
.914	**117**

As shown in Table 4.1 the Cronbach's alpha coefficient was calculated from a total number of 117 requested questions, and its value of Cronbach's Alpha is 0.914. This indicates, based on Stephanie (2016) the result ensures the reliability of the questionnaire. And according to Zikmund (2010) the value of alpha below 0.6 is considered poor. Alpha coefficient values from 0.6 to 0.7 are considered fair. Furthermore, if the alpha coefficient is from 0.7 to 0.8, the reliability is good, and there is very good reliability for the alpha coefficient between 0.8 and

0.95. According to Table 4.1, the Cronbach's Alpha coefficient of reliability of the study has a value of 0.914, which is considered very good reliability.

4.3 Respondent background and response rate

4.3.1 Response rate

This study is conducted through a questionnaire survey. This section shows the results, analysis and discussion of questions obtained from different Federal Housing Corporation construction projects.

As a sample size total of eighty (80) questionnaires were dispersed: about 30 questionnaires for owners, 30 questionnaires for contractors, and 20 questionnaires were distributed to consultants. Out of those distributed questionnaires, 75 were returned, and the remaining 5 questionnaires were discarded since they were not completed or returned. Thus, the response rate of the questionnaires is 75 (93.75%), which is considered appropriate for study. The response rate to the questionnaires is displayed in Table 4.2 below.

Table 4. 2 Summary of questionnaire distributed and responded

Category	**Questionnaire distributed**		**Questionnaire returned**	
	Number	**Percentage**	**Number**	**Percentage**
Owner	30	37.5%	28	35%
Contractor	30	37.5%	29	36.25%
Consultant	20	25%	18	22.5%
Total	80	100%	**75**	**93.75%**

4.3.2 Respondent background

It is necessary to analyze the demographic profile of the respondents to validate the reliability of the data collected. A description of the characteristics of the target population gives some basic information about the sample population involved in the study. Accordingly, the respondents were asked to provide information about which company they represent, their work position at

the project, their educational background, and their year of work experience in the construction industry.

The following Table 4.3 summarizes this information's classification of company, position of work, level of education and work experience

Table 4. 3 Summary of respondent background

	Frequency	Percent
Company name		
Owner/Client	29	38.7
Contractor	28	37.3
Consultant	18	24
Total	**75**	**100**
Your position		
Project manager	16	21.3
Resident Engineer/Supervisor	27	36
Client Engineer	24	32
Others (office Engineer)	8	10.7
Total	**75**	**100**
Level of education		
Master's Degree	29	38.7
Bachelor Degree	43	57.3
Others (PHD)	3	4
Total	**75**	**100**
Work experience		
1-5	9	12
6-10	19	25.3
11-15	29	38.7
More than 15	18	24
Total	**75**	**100**

As indicated in Table 4.3 the questionnaire paper was distributed through different stakeholders that participated on project of FHC. That is owner accounts 29 respondents with 38.7% of total

respondents, contractor takes 37.3% percentage with 28 respondents and consultant accounts 18 respondents with 24% of total response. Then those three pillar stakeholders are participated and its distribution relatively fair.

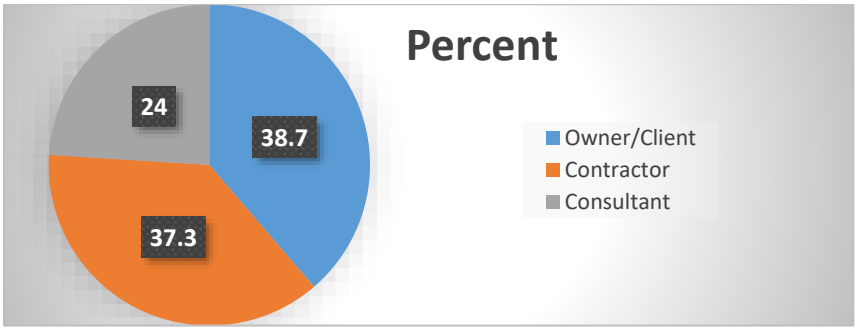


Figure 4. 1 Percentage of company name

Secondly, positions of respondents were divided into four categories. Based on the collected data the main stream of the respondents are resident engineer/supervisor that is from contractor side act as site engineer and for consultant act as supervisor with 27 respondents and 36 % percentage of the total respondents. And client engineer takes 32% percentage with 24 respondents. Next is project manager with 16 respondents representing 21.3% of respondents, and lastly, other position namely like supplier, procurement department directors, office Engineers that makes quantity surveyors has the lowest number of 8 respondents with percentage of 10.7%. In general all most all types of engineer professionals participated on data collection process.

Thirdly, the qualifications of the respondents were divided into four categories. Based on the collected data, the majority of the respondents have Bachelor's degrees. Their number was 43 respondents, which accounts for 57.3% of the overall number of the respondents. This was followed by those who have master's degrees, with 29 respondents, and they account for 38.7%. The number of respondents who have other levels of education, that is, PhD degrees, was only 3 respondents, which accounts for 4%. Diploma holders were 0 respondents with 0% of total respondents. Then the respondents who participated in this study have higher education levels and are knowledgeable.

Fourthly, the questionnaire has also asked about the experience of the respondents. Based on the collected data, most respondents have experience of 11-15 years in the construction industry.

Their number is 29 respondents, and their percentage is 38.7%. Followed by 6-10 years of working experience in the construction industry with a number of 19 respondents, and their percentage accounts for 25.3%. And then more than 15 years of work experience respondents account for 18 responses, with 24% of total respondents. Finally, the number of respondents who have experience of 1-5 years was 9 respondents, and their percentage was 12%. From those, it can be concluded that on FHC Projects, most professionals had 11-15 year work experience with 38.7% of from total.

4.4 Current Practice of Material Management at FHC Projects

The main objective of this section is to understand material management practices at FHC projects. To achieve this objective, respondents were asked about current material management practices within group of questions for each stage of construction project. This study analyzes the findings of each stage based on similar research's paper done about material management practices.

Hence, to know the practicability level of each activity, the average mean index scale value is needed to be considered. Then by Likert's (1932) discussion, there are different average mean index scale values as shown below:

- $1.0 \leq$ Average Index < 1.50 = Strongly Disagree
- $1.50 \leq$ Average Index < 2.50 = Disagree
- $2.50 \leq$ Average Index < 3.50 = Neither agree nor disagree
- $3.50 \leq$ Average Index < 4.50 = Agree
- $4.50 \leq$ Average Index < 5.00 = Strongly agree

Table 4. 4 Current practice of construction material management at FHC projects

No	Current practice of CMM at FHC projects	Mean	Rank in group	Over all Rank
	1. Current practice of planning			
1.1	There is clear planning and scheduling system in practice of construction material delivery, storage and handling system and work execution process	3.24	5	22
1.2	When construction material planning done it considered factors related to availability of material, supplier status and other related issues	3.37	4	18
1.3	There is proper interaction with other departments (like purchaser & logistics) to avoid shortage of material)	3.64	3	13
1.4	There is dedicated construction material planning department that follow and organize the project material	3.71	2	11
1.5	Required type and quantity of material determined based on specification before the specific work started	4.07	1	3
	2. Current practice of procurement			
2.1	There is a quality check before material purchased	3.11	4	24
2.2	There are supply chain and joint venture agreements with suppliers	3.28	3	20
2.3	There is responsible department who makes check and balance that purchased material is as requested	3.83	2	8
2.4	Materials purchase based on material ordered plan	3.92	1	6
	3. Current practice of Transportation & Logistics			
3.1	Supplier direct deliver the purchased material	3.49	4	15
3.2	The requested material arrive on time on required place	3.49	4	15
3.3	There is own transportation and logistics	3.56	3	14
3.4	Purchased materials transported and distributed through required location properly	3.80	2	9
3.5	There is department that responsible for follow the purchased	3.96	1	5

	amount of material is fully delivered			
	4. Current practice of Received & Inspection practice			
4.1	Count delivered amount of material and record on stock card. (Inventory control)	4.11	1	2
4.2	This department announce to planning department to be requested before the required material became empty	4.03	2	4
4.3	There is a responsible department that inspect the delivered materials are based on requested quality and type	3.76	3	10
4.4	There is control system and coordination work with material planning department	3.56	4	14
4.5	There is proper checking and balancing system	3.40	5	17
4.6	If there is any fluctuation related to material ordered and deliver with quality or amount, it became assess and identify the responsible department to make correction	3.25	6	21
	5. Current practice of handling & storage			
5.1	There is store keeper responsible for material handling	4.23	1	1
5.2	Construction materials have their own storage place	4.03	2	4
5.3	There is periodically assessment done to create accountability	3.69	3	12
5.4	Placed material properly based on their physical and chemical property's	3.35	4	19
	6. Current practice of material wastage control			
6.1	There are proper management that follow the effective use of material	3.84	1	7
6.2	Give more attention for quality and usage of material in proper quantity	3.48	2	16
6.3	There is check and balance system with corresponding department	3.20	3	23
6.4	There is waste control mechanism stating from planning	2.96	4	25
6.5	They use latest technologies to minimize wastage	2.64	5	26
	Total average mean	**3.586**		

Valid N(list wise) =75

4.4.1 Discussions on Current Material Management practice at FHC projects

The first objective is to identify the current practice of construction material management at FHC projects. Among all the questions that have been asked in this section, it is obvious that the average mean of all answers is 3.586, which is located under the "Agree" category of mean, which led to the following findings: The findings related to the current practice of construction material management at FHC projects on the planning of material management was positive from respondents where most of them agreed that the importance of determining required type and quantity of material before the specific work is started. Perdomo (2004) Stated that, material requirement planning should start immediately after receiving drawing and BOQ. And based on Kasim (2010) a material planning is an initial process that must be performed precisely to determine what materials are needed and when they will be needed, which has a significant impact on the project schedule.

Secondly, the highest practicable activity is that the presence of a dedicated material planning department that follow and organize the project material. This finding supported by researcher Stukhart (1995) a material planning provides guidelines for all subsequent activities and can have a significant impact on project planning. Stukhart (1995) And Gulghane (2015) indicated important parts of the overall material management process especially the planning process which are the task of identification and determination of required materials, set up and maintain the materials records, which includes quantification, ordering and scheduling of material.

Furthermore, the finding regarding the procurement of material management at FHC projects was also positive, as most of the respondents responded to the importance of materials purchase based on the material ordered plan and the presence of a responsible department for check and balance of the purchased material, as it ranged in agreed categories with mean values of 3.92 and 3.83, respectively. And for activities of supply chain and joint venture agreements and the presence of quality checks before material purchases, neither agree nor disagree with mean score values of 3.28 and 3.11, respectively. This finding argues with Payne (1996) procurement organizes the purchase of materials and planning their delivery to suppliers, and based on ECPMI (2019) identification and selection of suppliers and price negotiations based on different parameters can minimize costs while respecting required quality. In related to the goal of

procurement in materials management is to provide high-quality materials at the right time and place, and at the agreed price. (Kasim, 2010)

Similarly, the finding related to material transportation and handling management practice is positive. Hence the presence of a department that is responsible for following the purchased amount of material that is fully delivered and materials transported and distributed through the required location properly, with mean values of 3.96 and 3.80, respectively, which lays in the agree category. As revealed by Kasim (2005), (2010) there is evidence that the distribution of materials is one of the main issues that affecting the cost and time of construction projects. Additionally, based on respondents presence of their own transportation and logistics services for construction materials to transport at FHC projects, there is a mean value of 3.56 with the agree category, which will minimize wastage and extra costs of materials. As ECPMI (2019) pointed out, a properly developed and executed transportation and logistics plan will significantly increase the chances of timely delivery of construction materials. Lastly, based on respondents, the task of requested material arriving on time at the required place and the supplier directly delivering the purchased material shows a mean value of 3.49, with neither agreed nor disagree. Accordingly Gulghane (2015) construction materials need to be transported safely to the construction site within the scheduled time and at a reasonable cost. Based on Kasim (2005), (2010) the main problems in terms of logistics are wrong timing and wrong quality of materials arriving at the construction site.

Additionally, the finding related to material receiving and inspection practices were also positive. Most respondents agreed on the count delivered amount of material and record on the stock card. (Inventory control), announcement to the planning department to be requested before the required material became empty, presence of the responsible department that inspects the delivered materials based on requested quality and type, and work with the material planning department There is a control system, and coordination with a mean value of 4.11, 4.03, 3.76, and 3.56, respectively, lies in the agree category. As stated by Daniel (2019), an important aspect of materials receiving is to verify the source of the delivered goods and ensure that they meet the specifications contained in the purchase order, and as discussed by Madhavi (2013) if stock is low, reordering is recommended with a material requirements system; much of the detailed record keeping is automated, and project managers are aware of purchase requirements. Based

on the use of automated materials requirements planning systems, master production schedules, inventory records, and product components are incorporated; it can identify its type and quality of material delivered (Mustapa, 2012).

Similarly, activities of proper checking and balancing systems, and if there is any fluctuation related to material ordered and delivered with quality or amount, it becomes necessary to assess and identify the responsible department to make correction ranges on neither agree nor disagree with the mean value of 3.4 and 3.25, respectively, which shows not fully satisfied with the practice of those activities.

Moreover, the finding related to storage, stock, and waste control material management, as well as previous practice of material management, was also positive. Most respondents agreed on the presence of a storekeeper responsible for material handling, and materials have their own storage place; there is periodically assessment done to create accountability, Placed material properly based on their physical and chemical properties with mean score value of 4.23, 4.03, 3.69, and 3.35 respectively. This finding argue with different scholars, accordingly storage of materials at construction sites requires special care to avoid waste, loss, and damage of materials that will affect the operation of the construction project for this reason presence of store keeper is a good practice. Mahmoud (2012) and Polit (1999) pointed out arrangements must be made to properly handle and store materials, once they are received particular attention must be given to the flow of materials. If construction materials has no continues assessment and not taken care of, materials may rot or be stolen during storage (Hemishkumar, 2015), (Naoum, 1998). Then this periodical assessment is vital practice to create accountability.

As well, the respondents agreed the importance of the waste control of material which is the presence of proper management that follows the effective use of material, gives more attention to quality and usage of material in proper quantity, occurrence of check and balance system with the corresponding department score mean value of 3.84, 3.48 and 3.2 respectively, which all agree on the practice of those activities at FHC projects. While the practice of waste control mechanisms starting from planning and use of the latest technologies to minimize wastage was laid on neither agree nor disagree range with mean score values of 2.96 and 2.64, respectively. Which shows the practice was not fully applicable at FHC projects. This finding argues with researchers that effective material planning can reduce waste and contribute directly to increased

profits and productivity. Waste reduction can be achieved by adopting a zero waste attitude Gulghane (2015) indicated material waste as a major cost aspect of construction, where he compared the Dutch and Brazilian construction industries. Almost 30% of material purchased has been wasted, and material waste is coming from several sources such as design, procurement, storing, and implementation. Similarly Semma (2021) studied wastage minimization techniques at FHC projects and determined the cause of wastage was poor material management practices.

4.5 Challenges of material management practices at FHC projects

The second objective of this study is to identify key challenges of construction material management. To achieve this objective, the respondents were asked to rank the most challenging faced material management practice through six stages of FHC projects using a five-point Likert scale. And the result is evaluated by a statistical formula for each factor by using the relative importance index and rank as discussed in chapter three.

According to the analysis in Table 4.5 below, the major challenges of construction material management practice at FHC projects range between high to medium levels of challenges.

The highest challenges of CMM practice are at the planning stage of market fluctuation and planning variation in material usage, which were ranked by the respondents at the first position with RII = 0.837. The second was at the procurement stage, with unexpected market fluctuation with RII = 0.803. And the third was also from the planning stage, with incomplete design and specification with RII = 0.792.

Similarly from rank 4 up to 10, its RII range on H-M rank level challenges from different stages of construction projects, like the transportation and handling stage rank 4 (RII = 0.771) and rank 6 (RII = 0.747), for wastage control stage ranks at 5 with RII = 0.763 and rank 7 of RII = 0.739, additionally for planning stage rank 8 & 9 with RII = 0.736 & 0.731, respectively, and lastly from the top of 10 challenges of CMM practices was at the receiving and inspection stage rank 10 with RII = 0.723. Generally, as respondents, most challenges occur at the planning stage of FHC construction projects. And based on the result of their relative importance index of those top ten challenges of CMM practices, it was in a higher and high to medium level, which is between the intervals $0.8 \leq RII \leq 1$ & $0.6 \leq RII \leq 0.8$, which

implies that great attention is needed on those factors in order to mitigate those major challenges of FHC projects.

Table 4. 5 Challenge faced on material management practices at FHC projects

No	1. Challenge on material management practices at FHC projects	RII	Rank	Rank level
1	Market fluctuation and planning variations in material usage	0.837	1	H
2	Unexpected market fluctuation	0.803	2	H
3	Incomplete design and specification	0.792	3	H-M
4	Local trafficking situation became difficult	0.771	4	H-M
5	Less accountability for occurrence of wastage	0.763	5	H-M
6	Late delivery of material and logistics distributions	0.747	6	H-M
7	Absence of plan in each stage of construction project work for waste control	0.739	7	H-M
8	Lack of fully organized planning department for material and	0.736	8	H-M
9	Interest of client not properly defined	0.731	9	H-M
10	Use less traditional data for recorded system (limited time saving and date quality recorded)	0.723	10	H-M
11	Un availability of transportation facilities as required	0.717	11	H-M
12	Less check and balancing system	0.707	12	H-M
13	Poor planning and uncoordinated planning	0.699	13	H-M
14	Lack of proper storage for different construction materials	0.693	14	H-M
15	Occurrence of theft and loss of material	0.691	15	H-M
16	Occurrence of unexpectedly shortage of material	0.688	16	H-M
17	High cost for loading and unloading materials	0.683	17	H-M

18	Absence of communications with planner. (fragmented work)	0.68	18	H-M
19	No possibility to return surplus material to supplier	0.675	19	H-M
20	Unavailable of required quantity of material when required	0.672	20	H-M
21	Lack of standard quality of material on market	0.672	20	H-M
22	Improper placing of construction material	0.643	21	H-M
23	No assurance for quality of material from supplier	0.627	22	H-M
24	Un planned and improper usage of material	0.608	23	H-M
25	Un safe and un clean storage place	0.605	24	H-M
26	Unbalanced material delivered with respect to requested amount	0.595	25	M
27	Less awareness about wastage control practices	0.589	26	M
28	Less precaution taken for material transportation	0.584	27	M
29	Purchasing low quality material because of finance shortage	0.571	28	M
30	Less awareness of professionals about material handling	0.552	29	M

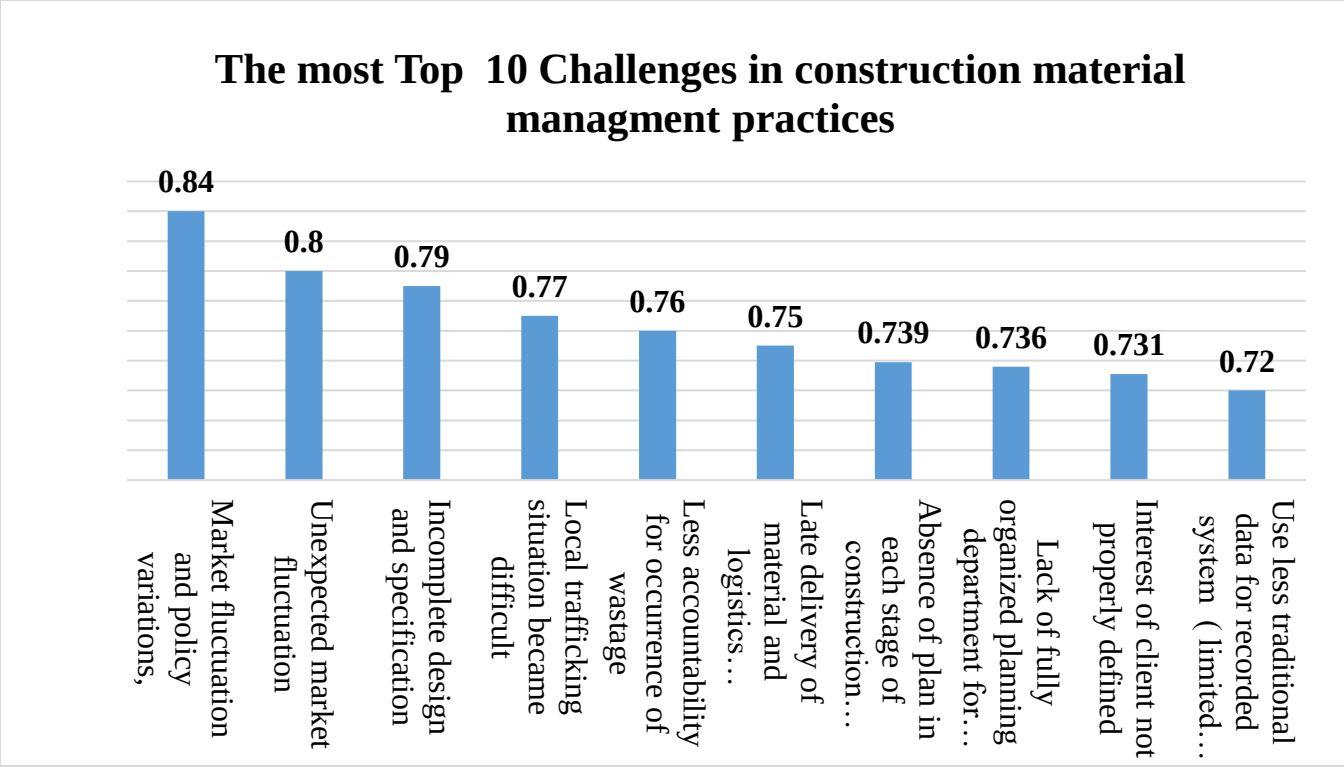


Figure 4. 2 The most top ten challenges of construction material management practices

4.5.1 Discussion on major challenges of construction material management practice at FHC projects

From the results, the overall challenge of CMM practice with the relative importance index (RII) was computed for each factor to identify the level of most significant challenges. Based on the ranking, the top ten most significant challenges or factors for poor construction material management practices at Federal Housing Corporation Projects were discussed below:

1. **Market fluctuation and planning variation in material usage (RII=0.837):** the primary challenges of construction material management practice at FHC projects were market fluctuation and policy variation with RII of 0.837 as per the respondent at a high rank level. When the construction material management plan is done it considers policy and current market conditions. Then fluctuations of market and policy variation will cause unexpected time delay and increase project cost. This finding argues with Rene (2022) stated that material price fluctuation affects project cost and completion time.
2. **Unexpected market fluctuation (RII=0.80):** the second major challenge is unexpected market fluctuation with an RII of 0.80; the level of rank is high, and it shows that it highly

affected the project work progress through unexpected increased project cost. And most respondents agree on its effect on project work progress. That is for construction work; materials are purchased based on a planned budget; however, if there is an unexpected market fluctuation, the project cost becomes affected, and the work progress becomes delayed. And this finding, also shared by Rene (2022) from Gonzalez (2010) point out one of the challenges of construction material management is material cost becoming expenses as compared to planned value.

3. **In complete design and specification (RII= 0.79):** The third main challenge is incomplete design and specification; hence, to plan the required type and quantity of material, full documents must be available. If there is an incomplete design and specifications, a shortage of material, and an unwanted type of material, it will be purchased, which causes project costs to be over budgeted and delays in work progress. Similarly as discussed by Arieloye (2016) and Mohamed (2021) identified construction material management issues include noncompliance with specifications for arriving material type and amount, an undefined scope, a lack of communication, insufficient drawings, and non-standard specifications..
4. **Local trafficking situation became difficult (RII= 0.77):** Fourthly, difficulties of local trafficking became the main challenges in FHC projects with a respondent value of RII = 0.77, which is to execute the project work at good speed; the requested amount of material need to be deliver at required time and at required place. For this purpose good trafficking of transportation system has high influence. It may cause project work progress became delayed. Likewise Kasim (2010) and Dakhli (2018) argue on challenges of transportation are access issues for supplying materials to the location and traffic jams in urban areas, lack of space and logistic issues delayed delivery of materials to the site respectively.
5. **Less accountability for occurrence of wastage (RII= 0.76):** according to the respondents, the fifth-ranked difficulty of practice in construction material management at FHC is less accountability for occurrence of wastage with an RII of 0.76. One way to minimize project cost is minimizing wastage of construction material. Hence, construction material consumes a high percentage of project cost; great attention must be given to material usage. For this reason, the presence of accountability for wastage of material is a crucial issue. As discussed by Navon (2004) and Okeke (2020) poor material management on construction sites and inadequate protection of materials are challenges to material wastage control practices. Then

if there is less accountability for the occurrence of wastage, those challenges become exaggerated and will affect project cost.

6. **Late delivery of material and logistics distribution (RII=0.75):** based on respondents challenges of late delivery of material and logistics distribution, ranked at six with an RII of 0.75. In clear understanding, late delivery of material directly affects project duration, and it may also affect project cost because of the time value of money. This challenge, also shared by other researchers like Okeke (2020) stated that delay in receiving materials on site is one of the challenges in construction projects and will affect project activity through delaying the work progress.
7. **Absence of plan in each stage of construction project work for waste control (RII=0.739):** as discussed in the literature review, part of waste control practice must have great attention to minimize project cost. Then one of the solutions to minimize wastage is to develop a good planning system for how to use material in each stage of construction. Then obviously the absence of material planning will affect project cost and time. As figured out by Rene (2022) there are similar challenges in construction practices, like lack of planning of sites to indicate the main storage area and stockpiles and lack of coordination for movement of plant handling materials, which affect the total project cost and completion time.
8. **Lack of fully organized planning department for material (RII=0.736):** The practice of planning the material department is to plan what type, quantity, and quality of material is required, when it can be ordered and delivered, and how to use materials properly Stukhart (1995) and other related activities are worked out. Hence, the absence of this organized department affects all project work progress. As revealed by Rene (2022) in Kayiranga (2020) and Arijeloye (2016), journal forgotten material orders and the absence of defined material quantities and works that are not properly planned or scheduled became challenges in the absence of an organized planning department.
9. **Interest of client not properly defined (RII=0.731):** To plan the overall work progress, including material consumption, the client interest must be well defined. Otherwise it became difficult to set a work plan. In this related Mohamed (2021) argues that undefined scope and lack of communication became challenges in construction work progress

10. **Use less traditional data for recorded system (limited time saving and date quality recorded) RII=0.72:** Based on respondents from the top ten challenges of FHC projects, the last one is the use of traditional data for recorded systems (limited time saving and date quality recorded) with an RII of 0.72. For recording data correctly and within a short period of time, having modernized software is very important. However, traditional recording data may cause data differences and be less accurate. And also it affects the target of project work. As pointed out by Okeke (2020) one of the challenges of construction work practice is inadequate procedures for material testing, inspection, and documentation, and also Kayiranga (2020) stated that insufficient material inspection based on ordered quantities and inadequate tracking of material supply on-site happen because of the data recording system.

In addition, unavailability of transportation facilities, less check and balancing system, poor and uncoordinated planning, lack of proper storage for different construction materials, occurrence of theft, loss of material, and unexpectedly shortage of material, high costed for loading and unloading materials, absence of communications with planner (Fragmented work), no possibility to return surplus material to supplier, unavailable of required quantity of material when required, lack of standard quality of material on market, no assurance for quality of material from supplier, un planned and improper usage of material, un safe and un clean storage place, ranking from 11^{th} to 24^{th} at H-M ranking level. And unbalanced material delivered with respect to the requested amount, less awareness about wastage control practices, less precaution taken for material transportation, purchasing low-quality material because of finance shortage, and less awareness of professionals about material handling rank from 25^{th} to 29^{th} at a medium ranking level.

These findings address the cause of inadequate material management practice at Federal Housing Corporation construction projects, and the majority of respondents "agreed" with the above-listed reasons.

4.6 Best practice of construction material management at FHC projects

The third objective of this study is to identify best practice of construction material management at FHC projects. To achieve this objective, respondents were asked about current material management practices within group of questions for each stage of construction project. This study analyzes the best practicable practice from the finding.

Based on Table 4.4 above, the highest ranking of the current practice of construction material management in Federal Housing Corporation projects is identifying the presence of a storekeeper responsible for material handling, which indicates the importance of a responsible person for material handling with the mean score value of 4.23. Based on the average mean index, the mean score value range of $3.5 \leq$ Average Index < 4.5, which is under agree category. That means most of the respondents are agree the presence of store keeper for material handling practice.

The second rank in the current practice of construction material management in FHC projects is counting the delivered amount of material and record on stock card. (Inventory control) with mean score value of 4.11. This indicates that the importance of recording material quantity to know availability of material when it is required and most of respondent agree for necessity of recording stock quantity.

The third ranking is, required type and quantity of material determined before the specific work started with an average mean score of 4.07. This shows importance of determination of required material before started the work. And the fourth rank of current practice of material management in FHC construction projects is receive and inspection department announce to planning department to be requested before the required material became empty and the presence of storage place for construction materials with equal score of mean 4.03. The fifth rank is the occurrence of department that responsible for follow the purchased amount of material is fully delivered with an average score of mean 3.96. Based on the average mean index, the mean score value ranges of $3.5 \leq$ Average Index < 4.5, which is under agree category

For other remaining rankings, which are from rank 6 up to 14, as shown in Table 4.4 below, lay down under the agree category of a range of $3.5 \leq$ Average Index < 4.5. Then most respondents agree the practice of materials purchase based on material ordered plan (3.92), occurrence of proper management that follow the effective use of material (3.84) and presence of responsible department who makes check and balance that purchased material as requested (3.83),purchased materials transported and distributed through required location properly(3.80), there is a responsible department that inspect the delivered materials are based on requested quality and type (3.76), There is a dedicated material planning department that follow and organize the project material (3.71), there is periodically assessment done to create accountability (3.69), there is proper interaction with other departments (like purchaser & logistics) to avoid shortage

of material) (3.64), there is own transportation and logistics and control system and coordination work with material planning department (3.56).

In a related discussion based on (Likert, 1932) discussion the respondent ranks from 15 up to 26 laydown at range of 2.5 ≤ Average Index < 3.5 as shown in Table 4.4 above, which is neither agree nor disagree. That means activities are in some extent practicable but not fully satisfied as required.

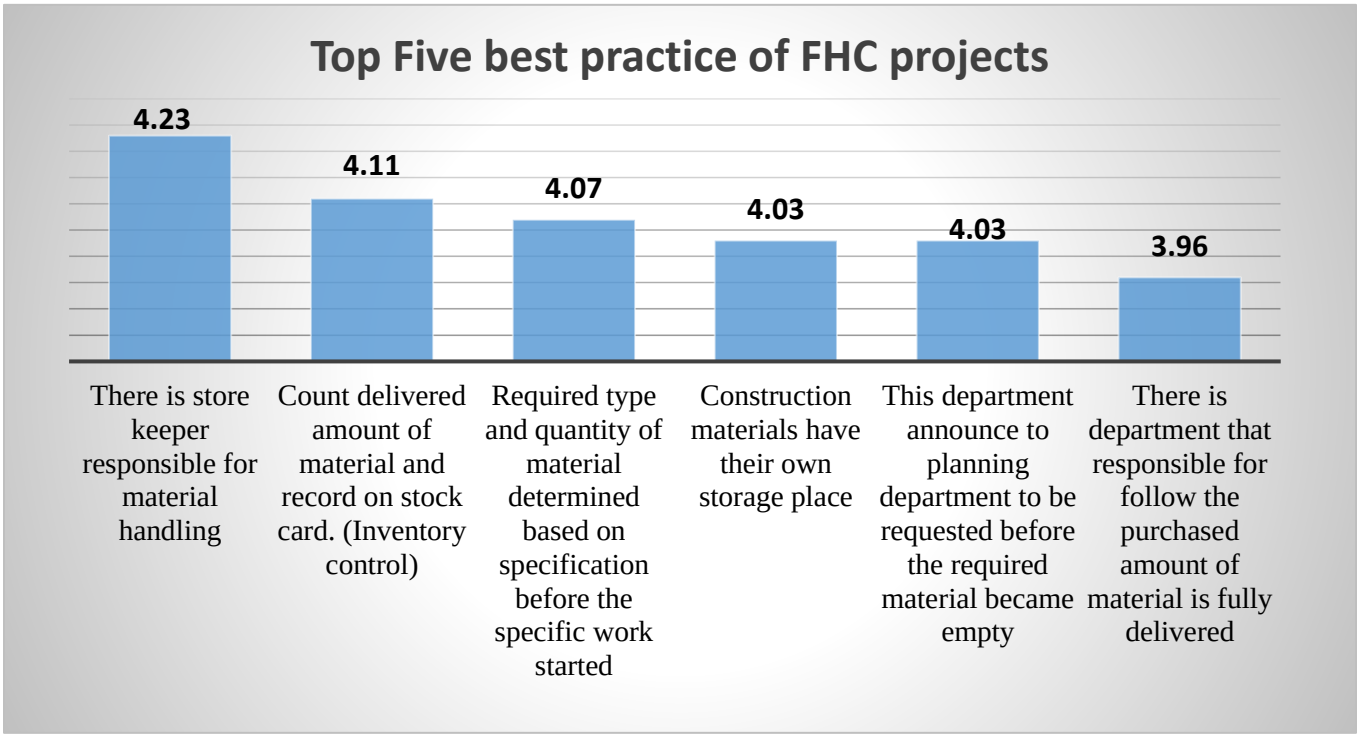


Figure 4. 3 The Top five best practice of FHC projects

4.7 Involvement of stakeholders

The research's fourth goal was to pinpoint the role of stakeholders at FHC projects in construction material management practice. Hence, in the construction industry, there are different stakeholders with different levels of involvement for different stages of construction projects, then considering 18 tasks in six different stages of construction projects to identify which task is best for involved stakeholders (owner, contractor, or consultant). In this respect, the respondents were asked to rank the involvement of stakeholders using five-point' scales as shown in Table 4.6 below.

Table 4. 6 Involvement of key stakeholders at FHC construction projects

Factors considered in construction material management practice at FHC projects	Level of involvement for key stakeholders								
	Owner			Contractor			Consultant		
	RII	Rank	Rank level	RII	Rank	Rank level	RII	Rank	Rank level
Assigned responsible party for materials	0.86	1	H	0.8	4	H	0.59	14	M
Procure high quality of material based on specification	0.85	2	H	0.72	10	H-M	0.6	13	M
Deliver material on time with good protection	0.85	2	H	0.77	7	H-M	0.65	10	H-M
Arrange transportation and logistics system for materials	0.84	3	H	0.78	6	H-M	0.59	14	M
Having proper relation and communication with suppliers	0.82	4	H	0.77	7	H-M	0.63	12	H-M
Check materials are properly stored	0.82	4	H	0.82	2	H	0.85	3	H
Prepare proper storage place avoid deterioration	0.81	5	H	0.79	5	H-M	0.64	11	H-M
Make check and controlling work progress	0.75	6	H-M	0.8	4	H	0.86	2	H
Make check and balancing system for	0.73	7	H-M	0.8	4	H	0.83	5	H

construction materials									
Check quality of material procured	0.72	8	H-M	0.75	8	H-M	0.83	5	H
Check the procured material quantity and quality based on requested format	0.71	9	H-M	0.81	3	H	0.84	4	H
Protect materials from improper usage	0.71	9	H-M	0.78	6	H-M	0.81	7	H
Evaluate material planning is based on reality and workable	0.7	10	H-M	0.73	9	H-M	0.85	3	H
Make continues inspection and follow up for material	0.68	11	H-M	0.77	7	H--M	0.89	1	H
Prepare periodical work progress report based on usage of construction material	0.67	12	H-M	0.77	7	H-M	0.83	5	H
Prepare proper schedule and work plan progress	0.65	13	H-M	0.83	1	H	0.82	6	H
Plan the required quantity and quality of material based on specification and drowning	0.63	14	H-M	0.83	1	H	0.77	9	H-M
Prepare wastage minimization techniques	0.59	15	M	0.79	5	H-M	0.78	8	H-M

According to the analysis in Table 4.6 above, the major involvement of stakeholders in construction material management practice at FHC projects ranges between high to medium level.

The top five highest involvement of owners in CMM practice based on respondents was at the material storage and handling stage of the assigned responsible party for material ranked at the first position with RII = 0.86. The second was at the procurement stage of procuring high-quality material based on specifications and at the transportation stage, delivering material on time with good protection with RII = 0.85. Thirdly was also from transportation and logistics, the stage of transporting material safely to the project with RII = 0.84. And then at the fourth rank, check materials are properly stored at handling and storage stages with RII = 0.82, and also at the procurement stage, having proper relations and communication with suppliers shows RII = 0.82. Lastly, according to respondents, the task of preparing a proper storage place to avoid deterioration at the storage stage ranked fifth with RII = 0.81. All those top five involvements of the owner lay on a high rank level.

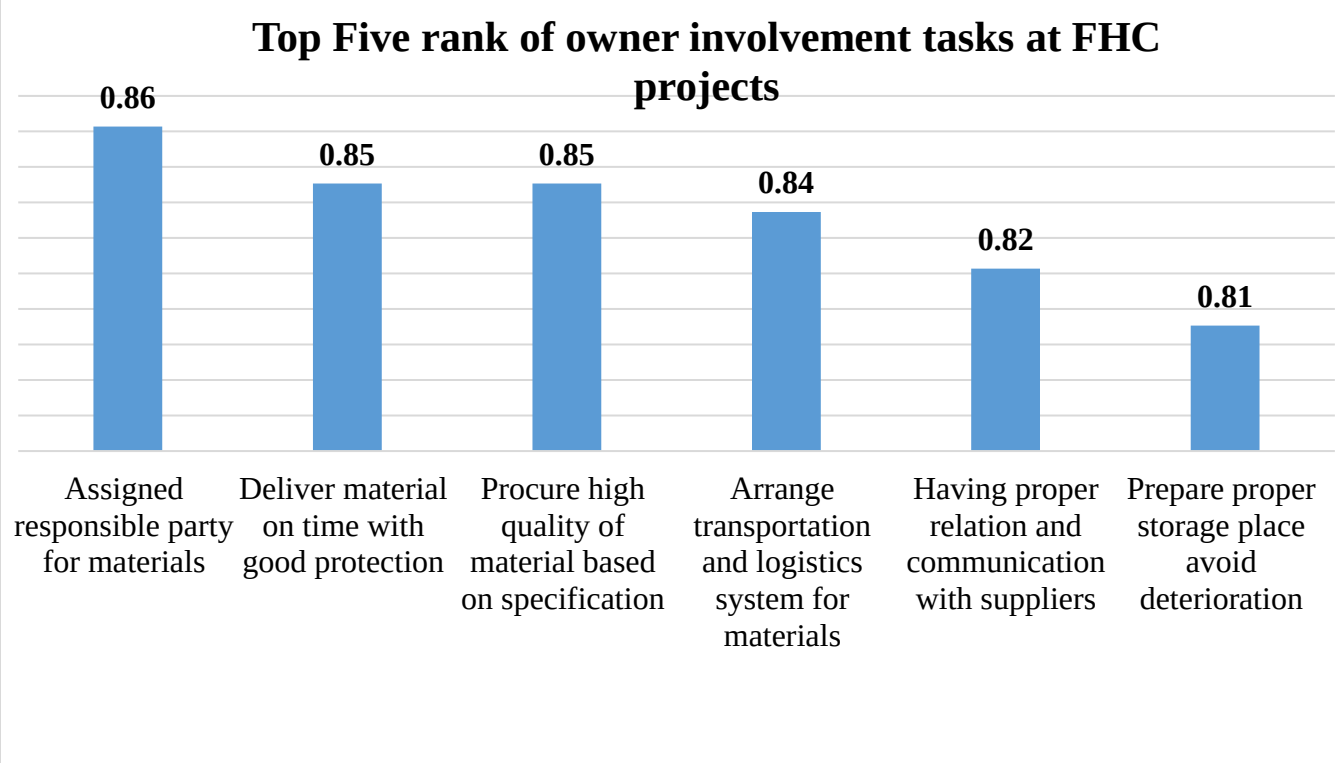


Figure 4. 4 Top five rank of owner involvement tasks at FHC construction projects

From rank six (6) up to fourteen (14), its RII ranges lay on the H-M rank level from different stages of construction projects, and at last, on rank fifteen (15), tasks of preparing wastage minimization techniques lay on the medium rank level with RII = 0.59. In general, at FHC, project owners/clients have very great involvement in material handling and storage, the procurement stage, and the transportation and logistics stages.

Likewise, based on respondents, the top five highest involvements of contractors in CMM practice at FHC projects was identified. The first task was from the planning stage of the plan, the required quantity and quality of material based on specification and drawing, and prepare a proper schedule and work plan progress with RII = 0.83. Secondly, checking materials are properly stored from the material handling and storage stage with RII = 0.82. And at rank three, the respondent agrees on tasks of checking the procured material quantity and quality based on the requested format from the procurement stage with RII = 0.81. Then after that, at rank four, there are three different tasks: material receiving and inspection stage, material storage and handling stage, and material wastage control stage of make check and balancing system for construction materials; assign a responsible party for materials; and make check and control work progress, respectively, with RII = 0.80. Finally, the top five activities the contractor was involved in were preparing a proper storage place to avoid deterioration and preparing wastage minimization techniques from the material storage and handling stage and the material wastage control stage, respectively, ranked at five with RII = 0.79.

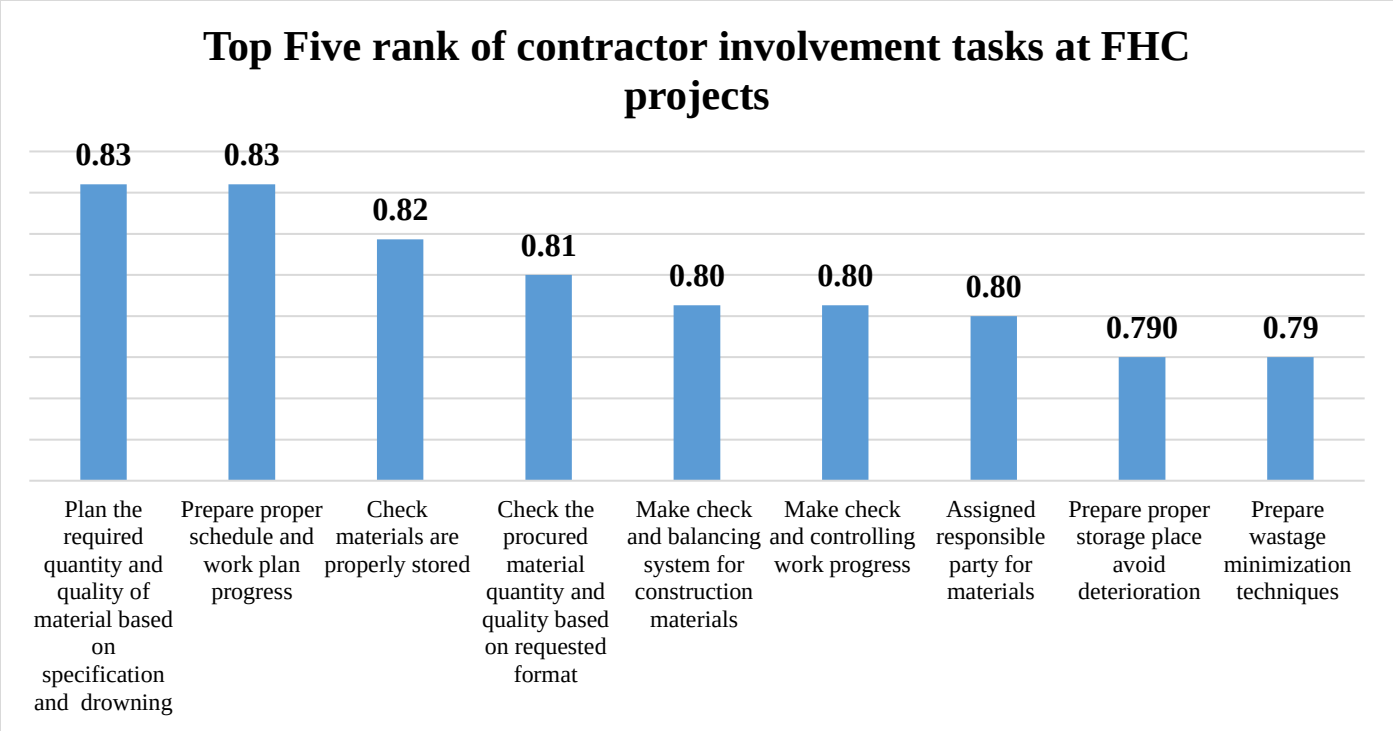


Figure 4. 5 Top five rank of contractor involvement tasks at FHC projects

From rank sixth up to tenth ranges on the H-M rank level and tasks of preparing periodical work progress reports are based on the usage of construction material, having proper relations and communication with suppliers, delivering material on time with good protection, and making continuous inspections and follow-ups for material ranked seventh with RII of 0.77. And tenth rank was to procure high quality of material based on specification with RII=0.72.

In general, from the findings, the contractor participated in all construction stages. Highly focused on the planning stage, and somehow on the procurement, storage of material stage, wastage control, and receiving and inspection stage of materials are included.

Similarly, the involvement of consultant also identified based on respondents, which are activities of make continues inspection and follow up for material from receiving and inspection stage ranked at first stage with RII of 0.89. Next to this, at material wastage control stage tasks of make check and controlling work progress ranked secondly with RII=0.86. Then at rank three check materials are properly stored and evaluate material planning is based on reality and workable from material storage and planning stage with RII= 0.85. Fourthly check the procured material quantity and quality based on requested format from procurement stage with RII= 0.84.

And lastly from the best top five activities of consultants at FHC projects hold make check and balancing system for construction materials from material receiving and inspection stage, check quality of material procured from procurement stage and Prepare periodical work progress report based on usage of construction material from planning stages was ranked at five with RII= 0.83.

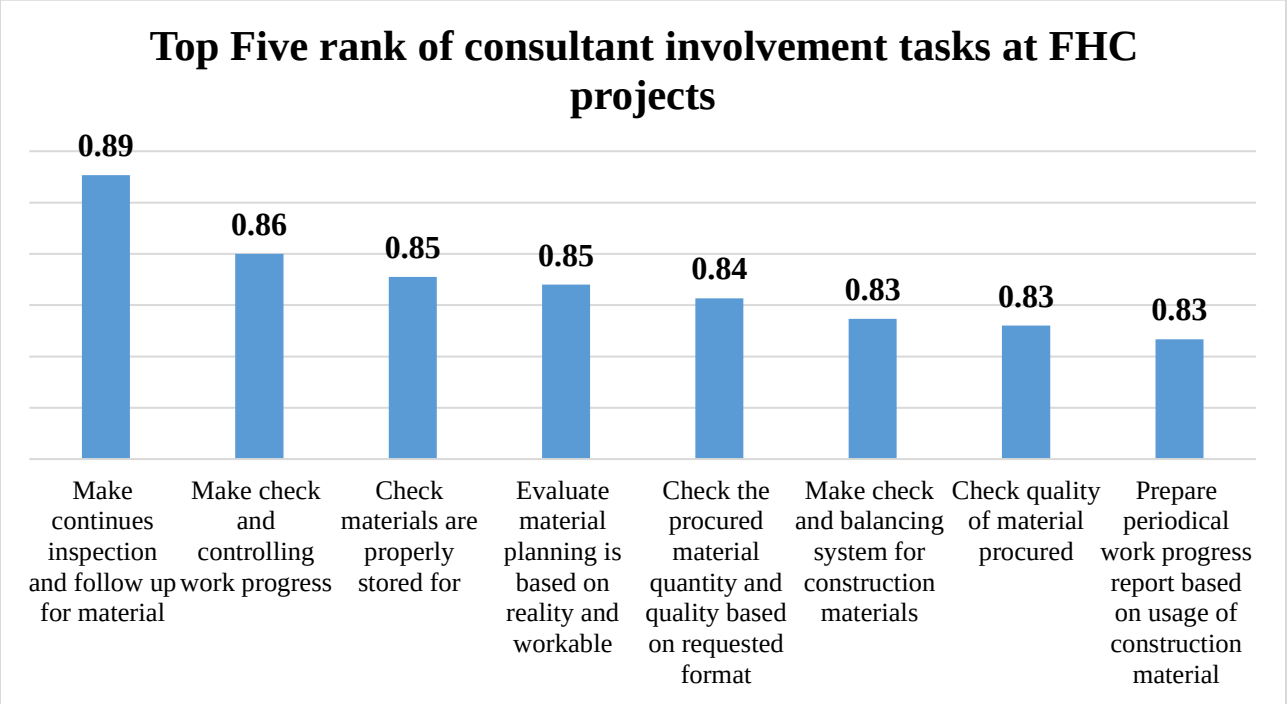
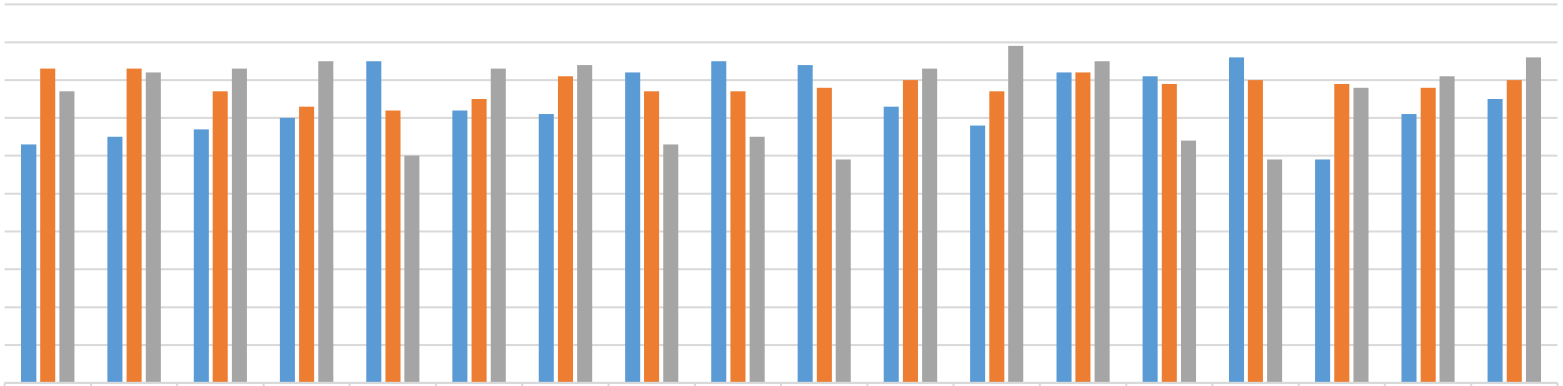


Figure 4. 6 Top five rank of consultant involvement tasks at FHC projects

Additionally, ranks six and seven of preparing a proper schedule and work plan progress and protecting materials from improper usage show high rank levels with RII = 0.82 and 0.81, respectively. From rank eight (8) up to twelve (12), its RII range lay on the H-M rank level from different stages of construction projects, and based on respondents, ranks of thirteen up to fourteen show a medium rank level.

In general, most consultant involvement lay at monitoring and controlling work progress of the construction projects.



	Plan the required quantity and quality of material based on specification and drowning	Prepare proper schedule and work plan progress	Prepare periodical work progress report based on usage of construction material	Evaluate material planning is based on reality and workable	Procure high quality of material based on specification	Check quality of material procured	Check the procured material quantity and quality based on requested format	Having proper relation and communication with suppliers	Deliver material on time with good protection	Arrange transportation and logistics system for materials	Make check and balancing system for construction materials	Make continues inspection and follow up for material	Check materials are properly stored	Prepare proper storage place avoid deterioration	Assigned responsible party for materials	Prepare wastage minimization techniques	Protect materials from improper usage	Make check and controlling work progress
Owner RII	0.63	0.65	0.67	0.7	0.85	0.72	0.71	0.82	0.85	0.84	0.73	0.68	0.82	0.81	0.86	0.59	0.71	0.75
Contractor RII	0.83	0.83	0.77	0.73	0.72	0.75	0.81	0.77	0.77	0.78	0.8	0.77	0.82	0.79	0.8	0.79	0.78	0.8
Consultant RII	0.77	0.82	0.83	0.85	0.6	0.83	0.84	0.63	0.65	0.59	0.83	0.89	0.85	0.64	0.59	0.78	0.81	0.86

Figure 4. 7 Involvement of stakeholder at FHC construction project

4.7.1 Discussion on major involvement of stakeholders in CMMP at FHC projects

The main role and involvement of the owner at FHC projects was assigning a responsible party for materials; hence to protect construction material from theft and deterioration, presence of store keeper is important. This role also shared by Al-khafai (2009), that one of the responsibility of owner for the project work is ensure the organization's resources will be used economically and effectively, then to ensure and protect materials from theft, deterioration and improper usage responsible party is required. That is one of role of store keeper is checking materials are properly stored. In related owners have responsibility to procure high quality of material based on specification and having proper relation and communication with suppliers have advantage to purchase good quality of material and deliver material on time with good protection to the site. This means owner are responsible for procure high quality of material and deliver material to the site with specific time to achieve project completion time and good working quality. As stated by Walker (2001) client or their representative has the most influence in shaping the working relationship and to give procurement route decisions. Additionally procurement manager (owner) must identify the most qualified supplier and become an expert on the materials and services to be purchased. (Benton, 2010)

Contractor is one of the key stakeholders in construction projects; in FHC projects, contractors also have different responsibilities. Among them, they plan the required quantity and quality of material based on specifications and drawings and prepare a proper schedule, and work plan progress became the first rank. That means to execute the project work progress, the first task is identifying the required type and quantity of material for project activity and preparing a schedule to know the completion time of the project. Based on Al-khafai (2009) discussion materials can be ordered by the architect or the contractor. And also Walker (2001) points out the contractor bears most of the cost risk in a traditional cost-reimbursable procurement approach and does not make the design decisions. As a construction expert Ghinn (2023) revealed, "Program is king!" That being said, contractors need always to be on top of the latest project updates. Tracking changes to the program can be easier today with the help of construction software, but it can still be a big challenge if a contractor works simultaneously on multiple projects.

Then after contractors at FHC projects are involved in checking the procured material quantity and quality, it is based on the requested format. Even if the owner was responsible for purchasing good quality of material, the contractor also has the responsibility to check that the purchased material is based on required quality and quantity, because executing a building project with the best quality is given to the contractor and will be accountable by default for construction work. Likewise, contractors on FHC projects are responsible for checking that materials are properly stored to protect them from damage. This will affect project work progress by cost and time. Contractors also have the responsibility for work progress becoming smooth and of good quality. For this reason, the contractor is responsible for preparing a proper storage place to avoid deterioration and preparing wastage minimization techniques.

Consultants have great responsibility for different stages of construction projects at FHC. Based on finding involvement of consultants mainly focused on checking work progress of construction projects, make checks and control work progress are listed. As Al-khafai (2009) revealed, ensuring project implementation within cost and time and according to quality control. Hence, consultants are responsible for achieving completion of project work in time with a budget and with good quality.

In related to findings, tasks of checking materials are properly stored and evaluating material planning is based on reality and workability; check the procured material quantity and quality based on the requested format; make a check and balancing system for construction materials; check the quality of material procured and Prepare a periodical work progress report based on the usage of construction materials are became the responsibilities of consultants. This idea is also shared by Al-khafai (2009) monitor work on site with regard to quality, cost and time; attending commissioning and acceptance testing and completion of relevant work; assist in valuations and the settlement of accounts are taken by consultants.

Generalization from this finding mostly client/owner-involved at the start of projects on material procurement, transportation, and storage stages. That is the main task to start the project work and to execute the work progress smoothly. In related to this for contractors, they participate in all stage of construction work progress. That is based on this finding they are focused on the planning stage and the procurement stage to check that the required materials are fully purchased with the required quality. And also for consultant's involvement, based on findings their

responsibility mostly focuses on monitoring and checking all work progress of the project. Mostly focus on the quality of work.

For this reason, the integration of stakeholders is very necessary to project work going smoothly and achieving project goals and finalizing its work on budget and on time.

4.8 Site observation

Site observation affords the researcher to gain first-hand and actual information to understand what is going on in the practice of material management at FHC construction projects.

The field survey and observation revealed that project engineers, managers, and supervisors in the construction project recognized and valued the importance of material management. In theory, they knew what to accomplish, but certain programs' full practical implementation and usage on the ground were called into question.

The following pictures also show what was observed in different construction projects at FHC. From the site observation, the researcher was able to find out that most of the respondents answers were based on actual project work progress. That is for storage of material; there is clear placing and a good storekeeper person. But there was also some problem related to material wastage handling practices.

The storage of materials somewhat agrees with what was found in the literature review part of this study. For example, cement is placed in a clean and enclosed storage place. However, rebar, RHS, and aggregates are not stored in a clean and protected from moisture and exposed to resting and wasted. The result of site observation is consistent with the finding of Mahlet (2016) which showed the congestion of the site due to unavailability of space and the reinforcement bars being exposed to moisture.

Figure 4. 8 Storage place for cement (taken by researcher)

Figure 4. 9 Placing of H-frame and RHS (Taken by researcher)

Figure 4. 10 Placing of aggregate and sand at site

Figure 4. 11 Storage of HCB on site

Figure 4. 12 Wastage of HCB material

2B+G+20 mixed used apartment piyasa

Kokobe Tsibha 2B+G+10 mixed used apartment

Chapter Five – Conclusion and recommendation

This chapter includes conclusions and recommendations on the current practice of construction material management at FHC projects. The first objective of this study was to assess current construction material management practices at FHC projects. And the second was to identify challenges of construction material management practice, and thirdly to identify best practice and lastly to assess the role of key stakeholders in related to construction material management practice

To achieve those objectives, the study used a questionnaire and observations as a research instrument and analysed it based on descriptive statistics by using SPSS software through generating mean, relative importance index, and rank methods of analysis to find out the result. The result obtained in this process has been presented and discussed in chapter four. In this chapter the major finding of the research, which has been discussed before, will be briefly summarized in accordance with the objectives of the research

5.1 Conclusion

The outcome of this study analysis can have great significance for the construction industry, especially for FHC projects. Different construction companies have different practices related to construction material management, then as the first objective of this study, assessing current practice of FHC projects related to construction material management through six construction stages (planning, procurement, transportation and logistics, receiving and inspection, storage and handling, and lastly wastage control practice) is done based on considering **29** potential factors. Then respondents were requested to rate these factors based on a five Likert scale to know the status of FHC projects and to identify best practice of FHC projects that was objective three of this study. From those factors;

- Presence of a storekeeper responsible for material handling
- Practice of counting delivered amount of material and record on stock card. (Inventory control),
- Required type and quantity of material determined before the specific work started,
- Receive and inspection department announce to planning department to be requested before the required material became empty,
- Construction materials have their own storage place and,

- Availability of responsible department to follow the purchased amount of material is fully delivered, are the top five best ranked practices at FHC projects related to construction material management.

The second objective was to identify key challenges of CMMP at FHC projects. Even if there are many challenges in practicing of construction material management, the study only considered **30** challenges. These challenges are grouped into six different construction stages, and they were ranked according to the Relative Importance Index. The most challenging are:

- Market fluctuation and planning variation in material usage,
- Unexpected market fluctuation,
- In complete design and specification,
- Local trafficking situation became difficult,
- Less accountability for occurrence of wastage,
- Late delivery of material and logistics distribution,
- Absence of plan in each stage of construction project work for waste control ,
- Lack of fully organized planning department for material,
- Interest of client not properly defined ,
- Use less traditional data for recorded system (limited time saving and date quality recorded) are top 10 challenges on construction material management practice at FHC projects.

The last objective of this study focuses on the role of key stakeholders in construction material management practices. According to stakeholder involvement, three stakeholders are considered (owner, contractor, and consultant). Those stakeholders' roles in construction material management practice were assessed through six categories (planning, procurement, transportation and logistics, receiving and inspection, storage and handling, and lastly, waste control practice). Even if the role of those stakeholders is many in this study, only **18** practices were considered through the above-listed six categories of construction project stages. From this mostly;

- The owner's role and responsibility are involved at the procurement, transportation, and logistics stages, and

- Contractor's roles are almost at all stages of construction projects, especially in the planning stage. And finally
- Consultants' role and responsibility are involved in monitoring and controlling practice.

5.2 Recommendation

According to the findings above in Federal Housing Corporation projects, the following points can be recommended by the researcher in order to minimize challenges in construction projects:

For Planning;

- Check presence of full documentation (design, specifications) before starting work,
- Develop best strategy for material planning in all construction stages.
- Create awareness about the applicability of material planning strategy and its usage.

For procurement stage;

- Consider the variation of previously constructed material costs versus the present
- Develop a spending strategy to mitigate the effects of inflation by identifying the necessity of money to be spent.
- Price your services reasonably.
- Foster a good relationship with suppliers
- Purchase materials in bulk by developing a good storage place.

For transportation and logistics stage;

- Develop a good strategic plan for material transportation, identify peak hours of local traffic time, and arrange when materials are to be ordered and transported.
- Using a proper logistic strategic plan includes coordinating the goods and activities required across the project. This is a vital practice in ensuring logistics are carried out within the relevant legislation safety standards. It can also be used to model, visualize, and optimize inventory management.

For received and inspection stage

Hence the following recommendation needs to develop a traditional data-recorded system.

- Use different software like ClickUp AI (Gantt chart view), OrangeScrum for resource allocation, and Clockify as a time tracking tool. (Evan, 2024)
- Collect data more computerized rather than on paper
- Trained worker on handling data

For handling, storage and wastage control stage

- Develop the best wastage minimization strategic plan for each construction stage (like using optimized resources, reusing scrap metal, improving quality control, and monitoring and following up on work progress frequently).
- Create awareness for workers about wastage control techniques.
- Use good work methodology for project activities.
- Assign a responsible department or person for wastage minimization practice.

Mitigation efforts are essential to minimize damages due to major problems. Earlier analysis on challenges of construction material management practice is important as it suggests the appropriate action or method to diminish its effect.

Recommendations for future studies

Further research on construction material management practice should be done in order to develop guidelines, or methods of minimizing the effects of construction material cost on project budget. Furthermore, similar research should be performed in various projects and various places. In order to provided that more reliable data, it is required to carry out studies for each specific type of construction projects, including highways, dam construction projects, utilities and etc.

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Annex: A

ADDIS ABABA UNIVERSITY

School of Post Graduate Studies

Ethiopian Institute Of Architecture, Building Construction and City Development

Questionnaire survey

On

Assessment of construction material management practice in Federal Housing Corporation projects

By

Huda Ahmed

Advisor

Tadesse Ayalew (PHD)

For the partial fulfillment of Msc. Degree in Construction management

June, 2024

A. Objective

The objective of this research is to Assess Construction material management practice in federal housing corporation projects.

B. Purpose of the survey

The purpose of this survey is to obtain data for the specified research conducted as a partial fulfillment of the MSc. Degree in Construction Management at Addis Ababa University, Ethiopian Institute of Architecture, Building Construction and City Development (EiABC). The data obtained from the survey will be held confidential and it is used for only academic purposes. The identity of respondents will remain anonymous. The data obtained will not be linked to the participant's name. If you have any questions or require further information, please contact me through the provided address.

Thank you in advance for your participation.

Huda Ahmed

Mobile phone number +251—921-568546

Email address: hudaa2562@gmail.com

Respondent background				
1. Your company/ organization	**Client/ owner**	**Contractor**	**Consultant**	**Others (Please specify)**
2. Your position in the company	**Project manager**	**Resident Engineer/Supervisor**	**Client Engineer**	**Others (Please specify)**
3. Your level of education	**Master's Degree**	**Bachelor degree**	**Diploma**	**Others (Please specify)**
4. Your experience	**1-5**	**6-10**	**11-15**	**More than 15**

Part I. Assess current practice of construction material management practice at Federal Housing Construction projects.

Considering the federal housing construction, please rate your answer by marking (X or √) under each preference.

Current Material management practices	**Strongly agree (5)**	**Agree (4)**	**Neutral (3)**	**Dis agree (2)**	**Strongly disagree (1)**
Phase I. Assess current practice in each phase of project related to material management practices					
planning stage					
There is a dedicated material planning department that follow and organize the project material					
Required type and quantity of material determined before the specific work started					
When material planning done it considered factors related to availability of material, supplier status and other related issues					
There is proper interaction with other departments (like purchaser & logistics) to avoid shortage of material)					
There is clear planning system in practice of material delivery, storage and handling system and work execution process					
procurement stage					
Materials purchase based on material ordered plan					
There is responsible department who makes check and balance that purchased material is as requested					
There is a quality check before material purchased					
There are supply chain and joint venture agreements with suppliers					
Transportation and Logistics stage					
There is own transportation and logistics					
Supplier direct deliver the purchased material					
There is department that responsible for follow the purchased amount of material is fully delivered					
The requested material arrive on time on required place					
Purchased materials transported and distributed through required location properly					
Receiving and inspection stage					
There is a responsible department that inspect the delivered materials are based on requested quality and type					
If there is any fluctuation related to material ordered and deliver with quality or amount, it became assess and identify the responsible department to make correction					

There is proper checking and balancing system					
Count delivered amount of material and record on stock card. (Inventory control)					
There is control system and coordination work with material planning department					
This department announce to planning department to be requested before the required material became empty					
Handling and storage stage					
Construction materials have their own storage place					
There is store keeper responsible for material handing					
Placed material properly based on their physical and chemical property's					
There is periodically assessment done to create accountability					
Wastage control					
They use latest technologies to minimize wastage					
There are proper management that follow the effective use of material					
There is waste control mechanism stating from planning					
Give more attention for quality and usage of material in proper quantity					
There is check and balance system with corresponding department					
Part II. Challenge faced in each stage related to construction material management practices Please indicate most challenges of each factor by ticking the appropriate boxes.					
Challenge faced in each stage **Planning stage**	**Strongly agree (5)**	**Agree (4)**	**Neutral (3)**	**Dis agree (2)**	**Strongly dis agree (1)**
Poor planning and uncoordinated planning					
Market fluctuation and policy variations,					
Lack of standard quality of material on market					
Interest of client not properly defined					
Incomplete design and specification					
Lack of fully organized planning department for material and					
procurement stage					
Unavailable of required quantity of material when required					
Purchasing low quality material because of finance shortage					
Unexpected market fluctuation					
Absence of communications with planner. (fragmented work)					
No possibility to return surplus material to supplier					
No assurance for quality of material from supplier					
Transportation and logistics stage					
Less precaution taken for material transportation					
Local trafficking situation became difficult					
Late delivery of material and logistics distributions					

High coasted for loading and unloading materials					
Un availability of transportation facilities as required					
Receiving and inspection stage					
Unbalanced material delivered with respect to requested amount					
Use less traditional data for recorded system (limited time saving and date quality recorded)					
Less check and balancing system					
Occurrence of unexpectedly shortage of material					
Handling and storage stage					
Lack of proper storage for different construction materials					
Un safe and un clean storage place					
Improper placing of construction material					
Occurrence of theft and loss of material					
Less awareness of professionals about material handling					
Waste control stage					
Less awareness about wastage control practices					
Un planned and improper usage of material					
Absence of plan in each stage of construction project work for waste control					
Less accountability for occurrence of wastage					

Part III. To assess role and responsibility of owner, contractor and consultant in related to construction material management practice, please rate your response in the scale of 1-5 based on the level of involvement of each party at each stage															
Level of involvement	**Owner**					**Contractors**					**Consultants**				
Activities on construction projects	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Planning stage															
Plan the required quantity and quality of material based on specification and drowning															
Prepare proper schedule and work plan progress															
Prepare periodical work progress report based on usage of construction material															
Evaluate material planning is based on reality and workable															
Procurement stage															
Procure high quality of material based on specification															
Check quality of material procured															
Check the procured material quantity and quality based on requested format															
Having proper relation and communication with suppliers															
Transportation and logistics stage															
Deliver material on time with good protection															
Arrange transportation and logistics system for materials															
Receiving and inspection stage															
Make check and balancing system for construction materials															
Make continues inspection and follow up for material															
Handling and storage stage															
Check materials are properly stored															
Prepare proper storage place avoid deterioration															
Assigned responsible party for materials															
Waste control stage															
Prepare wastage minimization techniques															
Protect materials from improper usage															
Make check and controlling work progress															

Thank you very much for completing the questionnaire

Annex B

Goggle form link

- https://docs.google.com/forms/d/e/1FAIpQLSf0FfNKjR2L3PF8DGWIkCXKLditkZm4xIvq1Ys4w6sRdrWMTg/viewform?usp=sf_link

Annex C: Publication Article (Manuscript)

Assessment of Construction Material Management Practice in Federal Housing Corporation Projects

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Abstract:

Material management practice involves planning, procuring, transporting, logistics, inspection, receiving, storage, and controlling material usage in construction projects. Ineffective management, poor procurement, delayed delivery, inadequate storage, and poor control systems can negatively impact project budget and completion time. The study evaluates construction material management practices at Federal Housing Corporation projects, focusing on planning, procurement, transport, logistics, handling, storage, inspection, wastage control, challenges, stakeholder involvement, and identifying best practices, aiming to provide direction for future projects. This study involved questionnaires and document reviews to gather data from contractors, clients, site counter engineers, and FHC-hired consultants involved in FHC projects. The study reveals current practices in material handling, inventory control, and material tracking, but also highlights challenges such as market fluctuations, incomplete design, local trafficking, and wastage. Stakeholders like owners, contractors, and consultants are involved in material delivery, quality planning, and schedules. Consultants focus on continuous inspections and follow-ups for material and work progress. Finally, the study suggests that effective material management techniques improve overall handling, site delivery, and prevent unexpected price variations from impacting project budget and completion time.

Keyword: Material, material management practice, construction project, FHC projects

1. Introduction

The construction industry is a vast and comprises owners, planners, supervisors, and contractors Gebruz (2017), together they are responsible for planning, executing, and evaluating construction works including physical infrastructure, road construction, water supply, and sanitation works. (Asmara , 2015).

Even if the construction sector significantly contributes to infrastructure development but also generates significant waste, impacting on project costs, profitability, and environment safety. (Mohamed, 2021) UK and Australia contribute over 50% and 20-30% respectively. (Agyekum, 2012) Material wastage significantly impacts project costs, with 30-70% of project costs being material and 30-40% being labor. (Khyomesh, 2011) And in Ethiopia, construction materials account for 57% of the total budget, emphasizing the importance of effective management. (Addise, 2005).

Material management in the construction industry is crucial for organizing and controlling activities, but many projects in developing countries face time and cost overruns, as in Ethiopia, the construction industry has many of the same problems. (Abadir, 2011) As Blackridge (2023) report, highlights failures in construction due to factors such as cost overruns, project delays, poor communication, poor planning, lack of organization, and unplanned document control and schedule issues.

According to Adams (1997), Long (2004) and others, Poor management skills among contractors, poor contract terms, lack of organizational capacity, fluctuating material costs, and unforeseen events contribute to poor project performance in developing countries, with over 65% of project budget spent on material procurement.

According to a study Abraham (2016) about 70% of construction projects do not have a responsible body for construction materials management. And Assegedech (2016) reveals that material costs account for over 50% of housing project costs in Addis Ababa, with 80% failures due to late material orders and 75% due to incorrect delivery.

The Ethiopian construction industry, particularly in Addis Ababa, often employs experience-based and traditional methods for materials management, leading to high costs and poor product quality. (Asmara , 2015) In related Semma (2021) pointed out that about 76 % of wastage that happened at federal housing corporation projects was because of material handling and storage factors. Similarly, studies Bhavshar (2016) have identified poor construction material management attributed to factors like low-quality materials, shortages, transportation issues, storage, inventory, waste utilization, and management systems. And Dakhli (2018) evaluates issues related to transportation and delivery, storage and inventory of materials, waste utilization, and management systems. Those are concerned on construction material management practices.

Even if Semma (2021) revealed about wastage minimization techniques and their causes, he did not discuss the practice of construction material management at each stage of the construction process. And other researcher pointed out that, causes of poor construction material management arise from improper practice of construction material at construction projects, and

then this research is conducted to know management practice of construction material at FHC projects.

Hence this study aims to address gaps in previous research by assessing current construction material management practices and identifying challenges at FHC projects. It focuses on construction materials, the largest cost driver in construction projects, and identifies best practices of construction material management for FHC projects.

2. Literature Review

2.1 Construction material management

Construction, defined by the UN Statistics Division as cost-effective activities involving the erection, renovation, repair, or expansion of fixed assets like buildings, land improvements, and technical structures. (Central Statistical, 2008/09) Hence the construction business is complex and fragmented; relying on appropriate personnel, tools, materials, and financial flow is required to complete projects on time and on budget. (Flanagan, 2009) Material management involves planning, assessing, tracking, purchasing, transporting, storing, and controlling materials to minimize waste and optimize profitability by decreasing material costs (Ballot, 2006) (Narimah., 2013).

Cost of material management can make up between 30 to 80% of the overall cost of building in this context, Kini (1999) points out material and equipment expenditures account for 50–60% of the total project costs. Similarly Stukhart (1995), argues materials with a value of 50 to 60% are an important part of any project. Then material management is crucial for material scheduling, ordering, managing deliveries, warehousing, purchasing, receiving, and storing. (Donyavi S, 2009)

2.2 Benefits of Construction Material Management

Material management is essential in construction, project planning, and execution to guarantee timely procurement and inventory control, hence preventing losses, shortages, and delays in the material flow process. (Pataskar, 2013)

According to Bernold (1991), enhanced material management practices diminish overall material costs, optimize material handling, minimize duplicate orders, guarantee the availability of materials in requisite quantities on-site, foster improved supplier relationships, decrease material surpluses, streamline on-site material storage, enhance project schedules, improve quality control, and facilitate superior cash flow management. In related to this Navon (2004) revealed that the main benefits of an efficient material management and control system are increased productivity and avoidance of delays; estimates of productivity gains are between 8% and 12%.

An effective management system is crucial for a construction company's success, with advanced systems potentially increasing labor productivity by 6% and saving labor costs by 4-6%. Materials management involves planning, controlling, and ensuring proper material and equipment procurement. (Mohammed, 2004), (Absalom, 2014)

2.3 Components of Construction Material Management

Researchers have developed six basic components, according to (Kanimozhi, 2014) and (Khyomesh V, 2011)

7. Material estimation, budgeting, planning, and programming. (Planning stage)
8. Purchasing and procurement. (procurement stage)
9. Transportation and logistics (Logistic stage)
10. Receiving and inspection(inventory control stage)
11. Material handling and storage (handling stage)
12. Waste management (waste control stage)

2.3.1 Material planning

A material management plan is a crucial document in construction projects, guiding teams in developing comprehensive planning and understanding the most economical construction methods to meet customer requirements. (René, 2022) Material planning is an essential procedure that establishes parameters for following tasks and profoundly influences project planning. (Stukhart, 1995) It involves establishing and maintaining records, determining target inventory quantities, and scheduling. (Kasim, 2010) Planning access and material entry routes at construction sites is crucial for effective materials management (Kasim, 2005). The BOQ is a common criterion used for identifying major construction materials based on drawings, bills of materials, and specifications. (Gulghane, 2015) A materials management plan creates a schedule for project components and calculates lead times, using four essential pieces of information: (ECPMI, 2019)

- Master schedule,
- Bill of materials,
- Cycle times and material needs at each stage and,
- Supplier lead times

2.3.2 Material Procurement

Procurement involves purchasing materials, equipment, labor, and services for a project. (Barrie, 1992) It is the initial stage in the material delivery process, involving contractor appointment and preparation of contract documents. (Mohamed, 2021) With the aiming to provide high-quality materials at the right time, place, and price. (Kaur, 2016) :

- To efficiently procure goods at a low cost,
- Ensure high-quality products,
- Ensure fast delivery,
- To distribute workload efficiently
- To optimize inventory management through scientific procedure

Materials procurement management significantly impacts project time and cost, affecting decisions during supervision, planning, and scheduling phases, as noted by (Mustapa, 2012). According to Lamer (2007) purchasing is a fundamental business function that directly impacts profitability and job profits. It involves acquiring raw materials, consumables, and equipment, which are essential for cost reduction and business management. Every business is managed or

controlled through the coordination and integration of the following six functions: (Azodoh, 2022)

- Conception, design ideas
- Funding,
- Workforces,
- Acquiring resources,
- Alteration materials into assets,
- Delivery of goods, as well as industrial relations

2.3.3 Material Transportation and Logistics

Material transportation involves the safe and cost-effective transportation of construction materials from one location to another via vehicles, ships, and aircraft. (Gulghane, 2015) The efficient movement of trucks, people, and materials has a considerable impact on the effective utilization of labor and production in building projects. (Phu, 2014) The logistics concept in construction projects enhances coordination and communication, particularly in materials flow control, ensuring efficient material management and efficient site access and routing. (Naoum, 1998).

Coordinating transportation and logistics activities with engineering, procurement, and construction schedules is crucial for the timely delivery of construction materials, as schedule delays can have significant financial impacts. (ECPMI, 2019)

Based on (ECPMI, 2019) transportation and logistics process involves:

- Identifying material origin,
- Quantifying cargo,
- Determining export port,
- Determining delivery terms,
- planning insurance,
- Evaluating transportation costs, and
- Managing logistics from the destination port to the project site.

2.3.4 Receiving and inspection material (Inventory stage)

According to Naoum (1998), the goods receiving system includes areas like external suppliers, goods receiving processing time, and materials management. The processing time starts with shipping documents being stamped and updated in the materials management system, ensuring timely delivery. An important aspect of materials receiving is the verification of materials' sources and meeting purchase order specifications; it can avoid costs and increase profitability. (Daniel, 2019)

The receiving system from internal departments involves sending purchase orders, supplier receipts, and waybills before materials arrive on site, allowing store managers to schedule material release. Handover notes and return receipts are common. According to Sundaresan (2011) the problems can be categorized into:

- Issued to consuming departments
- Issued to external suppliers for processing or transformation.

Inventory control is a crucial part of material management, ensuring timely and necessary inventory supply to prevent unnecessary investment. (Pataskar, 2013)

2.3.5 Material handling and storage

Material storage refers to the effective and methodical management of building materials and components during construction, ensuring enough space, protection, and control. (Phu, 2014) Material handling involves the cost-effective movement and storage of materials through appropriate methods and equipment, including procurement, inventory, manufacturing, and field service, requiring special attention to cost reduction. (Kasim, 2005).

Proper handling and storage of materials are crucial for maintaining their quality and preventing loss of profits due to theft, damage, waste, and low stock, as highlighted by (Haddad, 2006), (ECPMI, 2019), (Kasim, 2005). For this reason the process of loading and unloading of material should not be carried out in the rain; it is also advised that the storage area should be closed, clean, and dry with good air circulation and should be stacked on pallets for certain materials, not more than a certain safe height to prevent dampness and so on. (Keith, 2015)

To properly manage a warehouse, the following steps should be implemented (ECPMI, 2019)

- Receive materials and equipment on site,
- Conducting a total count and inspection,
- Storing and protecting materials,
- Transporting materials, equipment, tools, and consumables from the warehouse to construction workers or subcontractor personnel
- Reporting all warehouse processes

2.3.6 Material waste management (Waste control)

Waste in the construction industry refers to discrepancies between estimated and actual consumption of items, negatively impacting project delivery efficiency. (ECPMI, 2019) Based on Shen (2004) waste is the difference between delivered and accepted materials. Waste control, according to Prabu (2006), is a method to guarantee that all supplies, including raw materials, processed materials, assembly components, consumables stores, general stores, maintenance supplies, spare parts for ongoing activity, and completed goods, are available when needed.

All construction projects can expect surplus and waste material at various stages, making control of these materials crucial for successful material management. (Phu, 2014) Material waste can be minimized through proper waste management, including design, procurement, and operations. (ECPMI, 2019) A zero-waste attitude and efficient use of materials can reduce material purchases and waste production, saving on material and waste disposal costs. (Kasim, 2005).

2.4 Challenges of material management practice

The issue with materials management lies in the absence of recent and relevant information, leading to a disregard for the significance of monitoring material flows and data. (Navon, 2004) In each building phase, various factors contribute to the inadequate implementation of construction material management practices.

Table 2. 5 Challenges on construction material management practices

Author/year	Findings on challenges of construction material planning practice
(Kayiranga, 2020)	• Inconsistent resource availability leads to increased labor hours for materials management, with foremen spending up to 20% of their time searching for items and 10% tracking and expediting orders. • Forgotten material to be orders • Absence of defined material quantities
(Arijeloye, 2016),	• Works are not properly planned nor scheduled, • Money flow to the contractors destruction for clear planning, • Noncompliance of arrival material type and amount with the specifications
(Mohamed, 2021)	• Undefined scope, a lack of communication, insufficient drawings, non-standard specifications, and • Lack of knowledge of what and when the material is needed.
(René, 2022)	• Material price fluctuations.
	Findings on challenges of construction material procurement practice
(Navon R., 2005)	• Managed supplies without a list of purchases. • Inadequate awareness of material supply and inappropriate scheduling on site.
(González, 2010)	• Materials are not easily accessible. • Material expenses are higher than planned.
(Majrouhi, 2012)	• Materials have been provided within inaccurate quantities or inappropriate qualities.
(Vipin, 2019)	• procurement of materials that do not meet the stated quality
	Findings on challenges of construction material transportation and logistics practice
(Okeke, 2020),	• Lack of consideration for making material deliveries at scheduled dates and times.
(Kasim N, 2010)	• Access issues for supplying materials to the location.
(Dakhli, 2018)	• Traffic jams in urban areas, lack of space and logistic issues • Delayed delivery of materials to the site
	Findings on challenges of construction material receiving and inspection practice
(Okeke, 2020),	• delay in receiving materials on sites • Inadequate procedures for material testing, inspection, and documentation
(Kayiranga, 2020)	• Lack of calculating the amount of material required, • Insufficient material inspection based on ordered quantities. • Inadequate tracking of material supply on-site , and • There is a lack of a baseline for determining the quality of material.
	Findings on challenges of construction material storage and handling

	practice
(René, 2022)	• surplus, lack of storage space , • Lack of keeping adequate buffer stock in case of delay in receiving materials, • Lack of planning of sites to indicate the main storage area and stockpiles, • Lack of coordination for movement of plant handling materials
(Santelices, 2019)	• Poor material supervision, material exposure to harsh weather, • An abundance of material on site are
(Kasim N, 2010)	• Operational limitations due to security issues
(Phu, 2014),	• Theft, robbery and vandalism of material
	Findings on challenges of construction material wastage control practice
(Navon, 2004).	• Poor material management on construction sites
(Okeke, 2020)	• In adequate protection of materials
(Karoriya, 2018)	• lack of competent planning and management for materials

2.5 Involvement of stakeholders in construction material management practice

Stakeholders in construction projects are interconnected through formal or informal relationships, legal contracts, and direct interests, ensuring they are never isolated. (Al-Khafai, 2009).

The client initiates construction projects, funding, defining goals, and implementation. However, their requirements are often unclear and may change due to organizational structure, strategy, and environment. Most project errors are due to vague and uncertain client requirements, like incomplete designs and delayed building permits, possibility to management contracts, construction management contracts, or design management contracts for complex projects. (Al-Khafai, 2009)

Walker (2001) studies found that the client or their representative holds the most influence over design and procurement decisions, while the contractor bears most cost risk in traditional cost-reimbursable procurement approaches. In Build Own Operate Transfer (BOOT) projects, the contractor has significant influence. The dominant supplier, controlled by the contractor, is responsible for ordering materials. The order must include details about required quantity, delivery date, site receipt, and general conditions. (Al-Khafai, 2009) Reliable materials and equipment supply is crucial in construction projects, as insufficient or defective supplies can cause delays, interruptions, or even halt the project. (Al-Khafai, 2009)

2.6. Domestic construction material management practice

As (Asmara , 2015) explains, Ethiopian construction projects faces different challenges related on construction material management practice like other developing countries, with more severity. From these points of view, domestic researchers also argue with different challenges as discussed by (Assegedech, 2016) a study on Addis Ababa housing developments revealed challenges in material management, including missed delivery dates, out-of-time orders, damaged materials, and poor material quality. Owners, consultants, and contractors prioritized damage to materials, leading to tripartite wastage, material shortages, and additional costs.

Similarly, (Abdu, 2015) pointed out in Addis Ababa that 70% of respondents believe that performance indicators for construction material management are rarely used, and (Mahlet, 2016) revealed that 70% of sites lack a material management department, with 30% knowing of the existence material management department but not responsible for managing tasks. In a related survey at Bahir Dar University, it was discovered that 80% of respondents viewed the lack of understanding of construction material management systems as the primary barrier to the use of computerized systems. (TENI, 2013)

Likewise, the research held by (Semma, 2021) exposed causes of material wastage are damage during transportation of materials, improper storage of materials, improper handling of materials, poor quality of materials, and poor schedule of material procurement, which are all management issues.

There is a study on individual developers in the city of Addis Ababa and other parts of Ethiopia. However, most of the researches focus on specific targets or groups of construction sectors at minimal scope. Therefore, it is not sufficient to generalize about material management practice based on existing research.

Despite the fact that numerous investigations were carried out locally and internationally to find out construction material management practices at different projects, the following are the gaps identified. Most of the studies conducted in Ethiopia did not include the problems at each stage of construction practices of material management. This study was to fill the literature and practical gap on assessment of construction material management practice at FHC projects.

3. Research Design and Methodology

According to Alok (2011) "Research methods encompass techniques and methods used for conducting research, while methodology is the comprehensive approach to solving problems." This research considers both quantitative and qualitative approaches in order to get an in depth and detailed study concerned with construction material management practices at FHC projects. The population for this study was taken from the stakeholders involved in selected Federal Housing construction projects, which include which include 40 contractors, 25 consultants, and 35 clients (FHC), which is a total of 100 population size. The data was collected through questionnaire, literature review and site observation and then analyzed using SPSS software to achieve research objectives. The descriptive analysis was used to present the background details of the respondents through mean, frequency, percentage and RII. And to display the gather data used tables, graphs and charts. In this study, the researcher used probability sampling techniques. Which involves the population is divided into three subpopulations: client, consultant, and contractor. This allows ensuring every construction party in the projects is represented in the sample. Thus, 80 sample size, which is 30 from contractor, 30 from owner representative and 20 from consultant distributed through respondents.

4. Results and Discussion

4.1 Reliability test

The objective of reliability measurement is to test if the data in the questionnaire is reliable or not so that an accurate result can be generated. As a result, Cronbach's Coefficient Alpha is used

in this study to determine the research's reliability. As discussed by Zikmund (2010) Alpha Coefficient range, α Level of Reliability, became

0.80 to 0.95 = Very Good Reliability
0.70 to 0.80 = Good Reliability
0.60 to 0.70 = Fair Reliability

Table 4. 7 value of reliability test

Reliability Statistics

Cronbach's Alpha	N of Items
.914	117

As shown in Table 4.1 the Cronbach's alpha coefficient was calculated from a total number of 117 requested questions, and its value of Cronbach's Alpha is 0.914. This indicates, based on Zikmund (2010) the value of alpha below 0.6 is considered poor. Alpha coefficient values from 0.6 to 0.7 are considered fair. Furthermore, if the alpha coefficient is from 0.7 to 0.8, the reliability is good, and there is very good reliability for the alpha coefficient between 0.8 and 0.95. According to Table 4.1, the Cronbach's Alpha coefficient of reliability of the study has a value of 0.914, which is considered very good reliability.

4.2 Respondent background and response rate

Response rate

A total of eighty (80) questionnaires were dispersed: about 30 questionnaires for owners, 30 questionnaires for contractors, and 20 questionnaires were distributed to consultants. Out of those distributed questionnaires, 75 were received and analyzed, and the remaining 5 questionnaires were discarded since they were not completed or returned. Thus, the response rate of the questionnaires is 75 (93.75%), which is considered appropriate for study. The response rate to the questionnaires is displayed in Table 4.2 below

Table 4. 8 Summary of questionnaire distributed and responded

Category	Questionnaire distributed		Questionnaire returned	
	Number	Percentage	Number	Percentage
Owner	30	37.5%	28	35%
Contractor	30	37.5%	29	36.25%
Consultant	20	25%	18	22.5%
Total	80	100%	**75**	**93.75%**

Respondent background

As indicated in Table 4.2 owner accounts 29 respondents with 38.7% of total respondents, contractor takes 37.3% percentage with 28 respondents and consultant accounts 18 respondents with 24% of total response. Secondly, positions of respondents were divided into four categories.

Based on the collected data the main stream of the respondents are resident engineer/supervisor with 27 respondents and 36 % percentage of the total respondents. And client engineer takes 32% percentage with 24 respondents. Next is project manager with 16 respondents representing 21.3% of respondents, and lastly, other position namely like supplier,

procurement department directors, office Engineers that makes quantity surveyors has the lowest number of 8 respondents with percentage of 10.7%. Thirdly, the qualifications of the respondents was collected data, the majority of the respondents have Bachelor's degrees. Their number was 43 respondents, which accounts for 57.3% of the overall number of the respondents. This was followed by those who have master's degrees, with 29 respondents, and they account for 38.7%. The number of respondents who have other levels of education, that is, PhD degrees, was only 3 respondents, which accounts for 4%. Diploma holders were 0 respondents with 0% of total respondents. Fourthly, the questionnaire has also asked about the experience of the respondents. Based on the collected data, most respondents have experience of 11-15 years in the construction industry. Their number is 29 respondents, and their percentage is 38.7%. Followed by 6-10 years of working experience in the construction industry with a number of 19 respondents, and their percentage accounts for 25.3%. And then more than 15 years of work experience respondents account for 18 responses, with 24% of total respondents. Finally, the number of respondents who have experience of 1-5 years was 9 respondents, and their percentage was 12%.

Table 4. 3 Summary of respondent background

	Frequency	**Percent**
Company name		
Owner/Client	29	38.7
Contractor	28	37.3
Consultant	18	24
Total	**75**	**100**
Your position		
Project manager	16	21.3
Resident Engineer/Supervisor	27	36
Client Engineer	24	32
Others	8	10.7
Total	**75**	**100**
Level of education		
Master's Degree	29	38.7
Bachelor Degree	43	57.3
Others	3	4
Total	**75**	**100**
Work experience		
1-5	9	12
6-10	19	25.3
11-15	29	38.7
More than 15	18	24
Total	**75**	**100**

4.3 Current Practice of Material Management at FHC Projects

(Likert, 1932) Discussion there is different average mean index scale value as shown below:

$1.0 \leq$ Average Index $< 1.50 =$ Strongly Disagree

$1.50 \leq$ Average Index $< 2.50 =$ Disagree

2.50 ≤ Average Index < 3.50 = Neither agree nor disagree

3.50 ≤ Average Index <4.50 = Agree

4.50 ≤ Average Index < 5.00= Strongly agree

Table 4. 4 Current practice of construction material management at FHC projects

No	Current practice of CMM at FHC projects	Mean	Rank in group	Over all Rank
	7. Current practice of planning			
1.1	There is clear planning system in practice of material delivery, storage and handling system and work execution process	3.24	5	22
1.2	When material planning done it considered factors related to availability of material, supplier status and other related issues	3.37	4	18
1.3	There is proper interaction with other departments (like purchaser & logistics) to avoid shortage of material)	3.64	3	13
1.4	There is a dedicated material planning department that follow and organize the project material	3.71	2	11
1.5	Required type and quantity of material determined before the specific work started	4.07	1	3
	8. Current practice of procurement			
2.1	There is a quality check before material purchased	3.11	4	24
2.2	There are supply chain and joint venture agreements with suppliers	3.28	3	20
2.3	There is responsible department who makes check and balance that purchased material is as requested	3.83	2	8
2.4	Materials purchase based on material ordered plan	3.92	1	6
	9. Current practice of Transportation & Logistics			
3.1	Supplier direct deliver the purchased material	3.49	4	15
3.2	The requested material arrive on time on required place	3.49	4	15
3.3	There is own transportation and logistics	3.56	3	14
3.4	Purchased materials transported and distributed through required location properly	3.80	2	9
3.5	There is department that responsible for follow the purchased amount of material is fully delivered	3.96	1	5
	10. **Current practice of Received & Inspection practice**			
4.1	Count delivered amount of material and record on stock card. (Inventory control)	4.11	1	2
4.2	This department announce to planning department to be requested before the required material became empty	4.03	2	4
4.3	There is a responsible department that inspect the delivered materials are based on requested quality and type	3.76	3	10
4.4	There is control system and coordination work with material planning department	3.56	4	14
4.5	There is proper checking and balancing system	3.40	5	17
4.6	If there is any fluctuation related to material ordered and deliver	3.25	6	21

	with quality or amount, it became assess and identify the responsible department to make correction			
	11. Current practice of handling & storage			
5.1	There is store keeper responsible for material handling	4.23	1	1
5.2	Construction materials have their own storage place	4.03	2	4
5.3	There is periodically assessment done to create accountability	3.69	3	12
5.4	Placed material properly based on their physical and chemical property's	3.35	4	19
	12. Current practice of material wastage control			
6.1	There are proper management that follow the effective use of material	3.84	1	7
6.2	Give more attention for quality and usage of material in proper quantity	3.48	2	16
6.3	There is check and balance system with corresponding department	3.20	3	23
6.4	There is waste control mechanism stating from planning	2.96	4	25
6.5	They use latest technologies to minimize wastage	2.64	5	26
	Total average mean	**3.586**		

Valid N(list wise) =75

4.3.1 Discussions on Current Material Management practice at FHC projects

The first objective is to identify the current practice of construction material management at FHC projects. Among all the questions that have been asked in this section, it is obvious that the average mean of all answers is 3.586, which is located under the "Agree" category of mean, which led us to the following findings: The findings related to the current practice of construction material management at FHC projects on the planning of material management was positive from respondents where most of them agreed that the importance of determining required type and quantity of material before the specific work is started. (Perdomo, 2004) Stated that, material requirement planning should start immediately after receiving drawing and BOQ. And based on (Kasim N, 2010) a material planning is an initial process that must be performed precisely to determine what materials are needed and when they will be needed, which has a significant impact on the project schedule.

Secondly, the highest practicable activity is that the presence of a dedicated material planning department that follow and organize the project material. This finding supported by researcher (Stukhart, 1995) a material planning provides guidelines for all subsequent activities and can have a significant impact on project planning. (Stukhart, 1995). And (Gulghane, 2015) indicated important parts of the overall material management process especially the planning process which are the task of identification and determination of required materials, set up and maintain the materials records, which includes quantification, ordering and scheduling of material.

Furthermore, the finding regarding the procurement of material management at FHC projects was also positive, as most of the respondents responded to the importance of materials purchase

based on the material ordered plan and the presence of a responsible department for check and balance of the purchased material, as it ranged in agreed categories with mean values of 3.92 and 3.83, respectively. And for activities of supply chain and joint venture agreements and the presence of quality checks before material purchases, neither agree nor disagree with mean score values of 3.28 and 3.11, respectively. This finding argues with (Payne, 1996) procurement organizes the purchase of materials and planning their delivery to suppliers, and based on (ECPMI, 2019) identification and selection of suppliers and price negotiations based on different parameters can minimize costs while respecting required quality. In related to the goal of procurement in materials management is to provide high-quality materials at the right time and place, and at the agreed price (Kasim N, 2010)

Similarly, the finding related to material transportation and handling management practice is positive. Hence the presence of a department that is responsible for following the purchased amount of material that is fully delivered and materials transported and distributed through the required location properly, with mean values of 3.96 and 3.80, respectively, which lays in the agree category. As revealed by (Kasim, 2005), (Kasim N, 2010) there is evidence that the distribution of materials is one of the main issues affecting the cost and time of construction projects. Additionally, based on respondents presence of their own transportation and logistics services for construction materials to transport at FHC projects, there is a mean value of 3.56 with the agree category, which will minimize wastage and extra costs of materials. As (ECPMI, 2019) pointed out, a properly developed and executed transportation and logistics plan will significantly increase the chances of timely delivery of construction materials. Lastly, based on respondents, the task of requested material arriving on time at the required place and the supplier directly delivering the purchased material shows a mean value of 3.49, with neither agreed nor disagree. Accordingly (Gulghane, 2015) construction materials need to be transported safely to the construction site within the scheduled time and at a reasonable cost. Based on (Kasim, 2005), (Kasim N, 2010) the main problems in terms of logistics are wrong timing and wrong quality of materials arriving at the construction site.

Additionally, the finding related to material receiving and inspection practices were also positive. Most respondents agreed on the count delivered amount of material and record on the stock card. (Inventory control), announcement to the planning department to be requested before the required material became empty, presence of the responsible department that inspects the delivered materials based on requested quality and type, and work with the material planning department There is a control system, and coordination with a mean value of 4.11, 4.03, 3.76, and 3.56, respectively, lies in the agree category. As stated by (Daniel, 2019), an important aspect of materials receiving is to verify the source of the delivered goods and ensure that they meet the specifications contained in the purchase order, and as discussed by (Madhavi., 2013) if stock is low, reordering is recommended with a material requirements system; much of the detailed record keeping is automated, and project managers are aware of purchase requirements. Based on the use of automated materials requirements planning systems, master production

schedules, inventory records, and product components are incorporated; it can identify its type and quality of material delivered (Mustapa, 2012).

Similarly, activities of proper checking and balancing systems, and if there is any fluctuation related to material ordered and delivered with quality or amount, it becomes necessary to assess and identify the responsible department to make correction ranges on neither agree nor disagree with the mean value of 3.4 and 3.25, respectively, which shows not fully satisfied with the practice of those activities.

Moreover, the finding related to storage, stock, and waste control material management, as well as previous practice of material management, was also positive. Most respondents agreed on the presence of a storekeeper responsible for material handling, and materials have their own storage place; there is periodically assessment done to create accountability, Placed material properly based on their physical and chemical properties with mean score value of 4.23, 4.03, 3.69, and 3.35 respectively. This finding argue with different scholars, accordingly storage of materials at construction sites requires special care to avoid waste, loss, and damage of materials that will affect the operation of the construction project for this reason presence of store keeper is a good practice. (Mahmoud M., 2012) And (Polit, 1999) pointed out arrangements must be made to properly handle and store materials, once they are received particular attention must be given to the flow of materials. If construction materials has no continues assessment and not taken care of, materials may rot or be stolen during storage (Hemishkumar, 2015), (Naoum S, 1998). Then this periodical assessment is vital practice to create accountability.

As well, the respondents agreed the importance of the waste control of material which is the presence of proper management that follows the effective use of material, gives more attention to quality and usage of material in proper quantity, occurrence of check and balance system with the corresponding department score mean value of 3.84, 3.48 and 3.2 respectively, which all agree on the practice of those activities at FHC projects. While the practice of waste control mechanisms starting from planning and use of the latest technologies to minimize wastage was laid on neither agree nor disagree range with mean score values of 2.96 and 2.64, respectively. Which shows the practice was not fully applicable at FHC projects. This finding argues with researchers that effective material planning can reduce waste and contribute directly to increased profits and productivity. Waste reduction can be achieved by adopting a zero waste attitude (Gulghane, 2015) and (Calkins, 2009) indicated material waste as a major cost aspect of construction, where he compared the Dutch and Brazilian construction industries. Almost 30% of material purchased has been wasted, and material waste is coming from several sources such as design, procurement, storing, and implementation. Similarly (Semma, 2021) studied wastage minimization techniques at FHC projects and determined the cause of wastage was poor material management practices.

4.4 Challenges of material management practices

The second objective of this study is to identify key challenges of construction material management. To achieve this objective, the respondents were asked to rank the most challenging faced material management practice through six stages of FHC projects using a five-point Likert

scale. And the result is evaluated by a statistical formula for each factor by using the relative importance index and rank as discussed in chapter three.

According to the analysis in Table 4.5 below, the major challenges of construction material management practice at FHC projects range between high to medium levels of challenges.

The highest challenges of CMM practice are at the planning stage of market fluctuation and policy variations, which were ranked by the respondents at the first position with RII = 0.837. The second was at the procurement stage, with unexpected market fluctuation with RII = 0.803. And the third was also from the planning stage, with incomplete design and specification with RII = 0.792. From rank 4 up to 10, its RII range on H-M rank level challenges from different stages of construction projects, like the transportation and handling stage rank 4 (RII = 0.771) and rank 6 (RII = 0.747), for wastage control stage ranks at 5 with RII = 0.763 and rank 7 of RII = 0.739, additionally for planning stage rank 8 & 9 with RII = 0.736 & 0.731, respectively, and lastly from the top of 10 challenges of CMM practices was at the receiving and inspection stage rank 10 with RII = 0.723. Generally, as respondents, most challenges occur at the planning stage of FHC construction projects. And based on the result of their relative importance index of those top ten challenges of CMM practices, it was in a higher and high to medium level, which is between the intervals $0.8 \leq RII \leq 1$ & $0.6 \leq RII \leq 0.8$, which implies that great attention is needed on those factors in order to mitigate those major challenges of FHC projects.

Table 4. 5 Challenge faced on material management practices at FHC projects

No	1. Challenge on material management practices at FHC projects	RII	Rank	Rank level
1	Market fluctuation and policy variations,	0.837	1	H
2	Unexpected market fluctuation	0.803	2	H
3	Incomplete design and specification	0.792	3	H-M
4	Local trafficking situation became difficult	0.771	4	H-M
5	Less accountability for occurrence of wastage	0.763	5	H-M
6	Late delivery of material and logistics distributions	0.747	6	H-M
7	Absence of plan in each stage of construction project work for waste control	0.739	7	H-M
8	Lack of fully organized planning department for material and	0.736	8	H-M
9	Interest of client not properly defined	0.731	9	H-M
10	Use less traditional data for recorded system (limited time saving and date quality recorded)	0.723	10	H-M
11	Un availability of transportation facilities as required	0.717	11	H-M
12	Less check and balancing system	0.707	12	H-M
13	Poor planning and uncoordinated planning	0.699	13	H-M
14	Lack of proper storage for different construction materials	0.693	14	H-M

15	Occurrence of theft and loss of material	0.691	15	H-M
16	Occurrence of unexpectedly shortage of material	0.688	16	H-M
17	High cost for loading and unloading materials	0.683	17	H-M
18	Absence of communications with planner. (fragmented work)	0.68	18	H-M
19	No possibility to return surplus material to supplier	0.675	19	H-M
20	Unavailable of required quantity of material when required	0.672	20	H-M
21	Lack of standard quality of material on market	0.672	20	H-M
22	Improper placing of construction material	0.643	21	H-M
23	No assurance for quality of material from supplier	0.627	22	H-M
24	Un planned and improper usage of material	0.608	23	H-M
25	Un safe and un clean storage place	0.605	24	H-M
26	Unbalanced material delivered with respect to requested amount	0.595	25	M
27	Less awareness about wastage control practices	0.589	26	M
28	Less precaution taken for material transportation	0.584	27	M
29	Purchasing low quality material because of finance shortage	0.571	28	M
30	Less awareness of professionals about material handling	0.552	29	M

4.4.1 Discussion on major challenges of construction material management practice at FHC projects

11. **Market fluctuation and policy variation (RII=0.837):** the primary challenges of construction material management practice at FHC projects were market fluctuation and policy variation with RII of 0.837 as per the respondent at a high rank level. When the construction material management plan is done it considers policy and current market conditions. Then fluctuations of market and policy variation will cause unexpected time delay and increase project cost. This finding argues with (Phu, 2014), (Vipin, 2019) stated that material price fluctuation affects project cost and completion time.
12. **Unexpected market fluctuation (RII=0.80):** the second major challenge is unexpected market fluctuation with an RII of 0.80; the level of rank is high, and it shows that it highly affected the project work progress through unexpected increased project cost. And most respondents agree on its effect on project work progress. That is for construction work; materials are purchased based on a planned budget; however, if there is an unexpected market fluctuation, the project cost becomes affected, and the work progress becomes delayed. And this finding, also shared by (González, 2010) point out one of the challenges of construction material management is material cost becoming expenses as compared to planned value.
13. **In complete design and specification (RII= 0.79):** The third main challenge is incomplete design and specification; hence, to plan the required type and quantity of material, full

documents must be available. If there is an incomplete design and specifications, a shortage of material, and an unwanted type of material, it will be purchased, which causes project costs to be over budgeted and delays in work progress. Similarly as discussed by (Arijeloye, 2016) and (Mohamed, 2021) identified construction material management issues include noncompliance with specifications for arriving material type and amount, an undefined scope, a lack of communication, insufficient drawings, and non-standard specifications..

14. **Local trafficking situation became difficult (RII= 0.77):** Fourthly, difficulties of local trafficking became the main challenges in FHC projects with a respondent value of RII = 0.77, which is to execute the project work at good speed; the requested amount of material need to be deliver at required time and at required place. For this purpose good trafficking of transportation system has high influence. It may cause project work progress became delayed. Likewise (Kasim N, 2010) and (Dakhli, 2018) rgue on challenges of transportation are access issues for supplying materials to the location and traffic jams in urban areas, lack of space and logistic issues delayed delivery of materials to the site respectively.
15. **Less accountability for occurrence of wastage (RII= 0.76):** according to the respondents, the fifth-ranked difficulty of practice in construction material management at FHC is less accountability for occurrence of wastage with an RII of 0.76. One way to minimize project cost is minimizing wastage of construction material. Hence, construction material consumes a high percentage of project cost; great attention must be given to material usage. For this reason, the presence of accountability for wastage of material is a crucial issue. As discussed by (Navon, 2004) and (Okeke, 2020) poor material management on construction sites and inadequate protection of materials are challenges to material wastage control practices. Then if there is less accountability for the occurrence of wastage, those challenges become exaggerated and will affect project cost.
16. **Late delivery of material and logistics distribution (RII=0.75):** based on respondents challenges of late delivery of material and logistics distribution, ranked at six with an RII of 0.75. In clear understanding, late delivery of material directly affects project duration, and it may also affect project cost because of the time value of money. This challenge, also shared by other researchers like (Okeke, 2020) stated that delay in receiving materials on site is one of the challenges in construction projects and will affect project activity through delaying the work progress.
17. **Absence of plan in each stage of construction project work for waste control (RII=0.739):** as discussed in the literature review, part of waste control practice must have great attention to minimize project cost. Then one of the solutions to minimize wastage is to develop a good planning system for how to use material in each stage of construction. Then obviously the absence of material planning will affect project cost and time. As figured out by (Zeb, 2015) there are similar challenges in construction practices, like lack of planning of sites to indicate the main storage area and stockpiles and lack of coordination for movement of plant handling materials, which affect the total project cost and completion time.

18. **Lack of fully organized planning department for material (RII=0.736):** The practice of planning the material department is to plan what type, quantity, and quality of material is required, when it can be ordered and delivered, and how to use materials properly (Stukhart, 1995) and other related activities are worked out. Hence, the absence of this organized department affects all project work progress. As revealed by (Kayiranga, 2020) , (Arijeloye, 2016), forgotten material orders and the absence of defined material quantities and works that are not properly planned or scheduled became challenges in the absence of an organized planning department.
19. **Interest of client not properly defined (RII=0.731):** To plan the overall work progress, including material consumption, the client interest must be well defined. Otherwise it became difficult to set a work plan. In this related (Mohamed, 2021) argues that undefined scope and lack of communication became challenges in construction work progress
20. **Use less traditional data for recorded system (limited time saving and date quality recorded) RII=0.72:** Based on respondents from the top ten challenges of FHC projects, the last one is the use of traditional data for recorded systems (limited time saving and date quality recorded) with an RII of 0.72. For recording data correctly and within a short period of time, having modernized software is very important. However, traditional recording data may cause data differences and be less accurate. And also it affects the target of project work. As pointed out by (Okeke, 2020) one of the challenges of construction work practice is inadequate procedures for material testing, inspection, and documentation, and also (Kayiranga, 2020) stated that insufficient material inspection based on ordered quantities and inadequate tracking of material supply on-site happen because of the data recording system.

In addition, unavailability of transportation facilities, less check and balancing system, poor and uncoordinated planning, lack of proper storage for different construction materials, occurrence of theft, loss of material, and unexpectedly shortage of material, high costed for loading and unloading materials, absence of communications with planner (Fragmented work), no possibility to return surplus material to supplier, unavailable of required quantity of material when required, lack of standard quality of material on market, no assurance for quality of material from supplier, un planned and improper usage of material, un safe and un clean storage place, ranking from 11^{th} to 24^{th} at H-M ranking level. And unbalanced material delivered with respect to the requested amount, less awareness about wastage control practices, less precaution taken for material transportation, purchasing low-quality material because of finance shortage, and less awareness of professionals about material handling rank from 25^{th} to 29^{th} at a medium ranking level.

4.5 Best practice of construction material management at FHC projects

The third objective of this study is to identify best practice of construction material management at FHC projects. To achieve this objective, respondents were asked about current material management practices within group of questions for each stage of construction project. This study analyses the best practicable practice from the finding.

Based on Table 4.4 below, the highest ranking of the current practice of construction material management in Federal Housing Corporation projects is identifying the presence of a storekeeper

responsible for material handling, which indicates the importance of a responsible person for material handling with the mean score value of 4.23. Based on the average mean index, the mean score value range of 3.5 ≤ Average Index < 4.5, which is under agree category. That means most of the respondents are agree the presence of store keeper for material handling practice.

The second rank in the current practice of construction material management in FHC projects is counting the delivered amount of material and record on stock card. (Inventory control) with mean score value of 4.11. This indicates that the importance of recording material quantity to know availability of material when it is required and most of respondent agree for necessity of recording stock quantity.

The third ranking is, required type and quantity of material determined before the specific work started with an average mean score of 4.07. This shows importance of determination of required material before started the work. And the fourth rank of current practice of material management in FHC construction projects is receive and inspection department announce to planning department to be requested before the required material became empty and the presence of storage room for construction materials with equal score of mean 4.03. The fifth rank is the occurrence of department that responsible for follow the purchased amount of material is fully delivered with an average score of mean 3.96. Based on the average mean index, the mean score value ranges of 3.5 ≤ Average Index < 4.5, which is under agree category

For other remaining rankings, which are from rank 6 up to 14, as shown in Table 4.4 below, lay down under the agree category of a range of 3.5 ≤ Average Index < 4.5. Then most respondents agree the practice of materials purchase based on material ordered plan (3.92), occurrence of proper management that follow the effective use of material (3.84) and presence of responsible department who makes check and balance that purchased material as requested (3.83),purchased materials transported and distributed through required location properly(3.80), there is a responsible department that inspect the delivered materials are based on requested quality and type (3.76), There is a dedicated material planning department that follow and organize the project material (3.71), there is periodically assessment done to create accountability (3.69), there is proper interaction with other departments (like purchaser & logistics) to avoid shortage of material) (3.64), there is own transportation and logistics and control system and coordination work with material planning department (3.56).

In a related discussion based on (Likert, 1932) discussion the respondent ranks from 15 up to 26 laydown at range of 2.5 ≤ Average Index < 3.5 as shown in Table 4.4 below, which is neither agree nor disagree. That means activities are in some extent practicable but not fully satisfied as required.

4.6 Involvement of stakeholders

The research's last goal was to pinpoint the role of stakeholders at FHC projects in construction material management practice. Hence, in the construction industry, there are different stakeholders with different levels of involvement for different stages of construction projects, then considering 18 tasks in six different stages of construction projects to identify which task is best for involved stakeholders (owner, contractor, or consultant). In this respect, the

respondents were asked to rank the involvement of stakeholders using five-point' scales as shown in Table 4.6 below.

Table 4. 6 Involvement of key stakeholders at FHC construction projects

Factors considered in construction material management practice at FHC projects	Level of involvement for key stakeholders								
	Owner			Contractor			Consultant		
	RII	Rank	Rank level	RII	Rank	Rank level	RII	Rank	Rank level
Assigned responsible party for materials	0.86	1	H	0.8	4	H	0.59	14	M
Procure high quality of material based on specification	0.85	2	H	0.72	10	H-M	0.6	13	M
Deliver material on time with good protection	0.85	2	H	0.77	7	H-M	0.65	10	H-M
Arrange transportation and logistics system for materials	0.84	3	H	0.78	6	H-M	0.59	14	M
Having proper relation and communication with suppliers	0.82	4	H	0.77	7	H-M	0.63	12	H-M
Check materials are properly stored	0.82	4	H	0.82	2	H	0.85	3	H
Prepare proper storage place avoid deterioration	0.81	5	H	0.79	5	H-M	0.64	11	H-M
Make check and controlling work progress	0.75	6	H-M	0.8	4	H	0.86	2	H
Make check and balancing system for construction materials	0.73	7	H-M	0.8	4	H	0.83	5	H
Check quality of material procured	0.72	8	H-M	0.75	8	H-M	0.83	5	H
Check the procured material quantity and quality based on requested format	0.71	9	H-M	0.81	3	H	0.84	4	H
Protect materials from improper usage	0.71	9	H-M	0.78	6	H-M	0.81	7	H
Evaluate material planning is based on reality and workable	0.7	10	H-M	0.73	9	H-M	0.85	3	H
Make continues inspection and follow up for material	0.68	11	H-M	0.77	7	H--M	0.89	1	H
Prepare periodical work progress report based on usage of construction material	0.67	12	H-M	0.77	7	H-M	0.83	5	H

Prepare proper schedule and work plan progress	0.65	13	H-M	0.83	1	H	0.82	6	H
Plan the required quantity and quality of material based on specification and drowning	0.63	14	H-M	0.83	1	H	0.77	9	H-M
Prepare wastage minimization techniques	0.59	15	M	0.79	5	H-M	0.78	8	H-M

The top five highest involvement of owners in CMM practice based on respondents was at the material storage and handling stage of the assigned responsible party for material ranked at the first position with RII = 0.86. The second was at the procurement stage of procuring high-quality material based on specifications and at the transportation stage, delivering material on time with good protection with RII = 0.85. Thirdly was also from transportation and logistics, the stage of transporting material safely to the project with RII = 0.84. And then at the fourth rank, check materials are properly stored at handling and storage stages with RII = 0.82, and also at the procurement stage, having proper relations and communication with suppliers shows RII = 0.82. Lastly, according to respondents, the task of preparing a proper storage place to avoid deterioration at the storage stage ranked fifth with RII = 0.81. All those top five involvements of the owner lay on a high rank level.

Likewise, based on respondents, the top five highest involvements of contractors in CMM practice at FHC projects was identified. The first task was from the planning stage of the plan, the required quantity and quality of material based on specification and drawing, and prepare a proper schedule and work plan progress with RII = 0.83. Secondly, checking materials are properly stored from the material handling and storage stage with RII = 0.82. And at rank three, the respondent agrees on tasks of checking the procured material quantity and quality based on the requested format from the procurement stage with RII = 0.81. Then after that, at rank four, there are three different tasks: material receiving and inspection stage, material storage and handling stage, and material wastage control stage of make check and balancing system for construction materials; assign a responsible party for materials; and make check and control work progress, respectively, with RII = 0.80. Finally, the top five activities the contractor was involved in were preparing a proper storage place to avoid deterioration and preparing wastage minimization techniques from the material storage and handling stage and the material wastage control stage, respectively, ranked at five with RII = 0.79.

Similarly, the involvement of consultant also identified based on respondents, which are activities of make continues inspection and follow up for material from receiving and inspection stage ranked at first stage with RII of 0.89. Next to this, at material wastage control stage tasks of make check and controlling work progress ranked secondly with RII=0.86. Then at rank three check materials are properly stored and evaluate material planning is based on reality and workable from material storage and planning stage with RII= 0.85. Fourthly check the procured material quantity and quality based on requested format from procurement stage with RII= 0.84. And lastly from the best top five activities of consultants at FHC projects hold make check and

balancing system for construction materials from material receiving and inspection stage, check quality of material procured from procurement stage and Prepare periodical work progress report based on usage of construction material from planning stages was ranked at five with RII= 0.83.

4.6.1 Discussion on major involvement of stakeholders in CMMP at FHC projects

The main role and involvement of the owner at FHC projects was assigning a responsible party for materials; hence to protect construction material from theft and deterioration, presence of store keeper is important. This role also argue with (Al-Khafai, 2009) discussed that one of the responsibility of owner for the project work is ensure the organization's resources will be used economically and effectively, then to ensure and protect materials from theft, deterioration and improper usage responsible party is required. That is one of role of store keeper is checking materials are properly stored. In related owners have responsibility to procure high quality of material based on specification and having proper relation and communication with suppliers have advantage to purchase good quality of material and deliver material on time with good protection to the site. This means owner are responsible for procure high quality of material and deliver material to the site with specific time to achieve project completion time and good working quality. As stated by (Walker, 2001) client or their representative has the most influence in shaping the working relationship and to give procurement route decisions. Additionally procurement manager (owner) must identify the most qualified supplier and become an expert on the materials and services to be purchased. (Benton, 2010)

As it is known, a contractor is one of the key stakeholders in construction projects; in FHC projects, contractors also have different responsibilities. Among them, they plan the required quantity and quality of material based on specifications and drawings and prepare a proper schedule, and work plan progress became the first rank. That means to execute the project work progress, the first task is identifying the required type and quantity of material for project activity and preparing a schedule to know the completion time of the project. Based on (Al-Khafai, 2009) discussion materials can be ordered by the architect or the contractor. And also (Walker, 2001) points out the contractor bears most of the cost risk in a traditional cost-reimbursable procurement approach and does not make the design decisions. As a construction expert (Ghinn, 2023) revealed, "Program is king!" That being said, contractors need always to be on top of the latest project updates. Tracking changes to the program can be easier today with the help of construction software, but it can still be a big challenge if a contractor works simultaneously on multiple projects.

Then after contractors at FHC projects are involved in checking the procured material quantity and quality, it is based on the requested format. Even if the owner was responsible for purchasing good quality of material, the contractor also has the responsibility to check that the purchased material is based on required quality and quantity, because executing a building project with the best quality is given to the contractor and will be accountable by default for construction work. Likewise, contractors on FHC projects are responsible for checking that materials are properly stored to protect them from damage. This will affect project work progress by cost and time. Contractors also have the responsibility for work progress becoming smooth

and of good quality. For this reason, the contractor is responsible for preparing a proper storage place to avoid deterioration and preparing wastage minimization techniques.

Alike contractor consultants have great responsibility for different stages of construction projects at FHC. Based on finding involvement of consultants mainly focused on checking work progress of construction projects, make checks and control work progress are listed. As (Al-Khafai, 2009) revealed, ensuring project implementation within cost and time and according to quality control. Hence, consultants are responsible for achieving completion of project work in time with a budget and with good quality.

In related to findings, tasks of checking materials are properly stored and evaluating material planning is based on reality and workability; check the procured material quantity and quality based on the requested format; make a check and balancing system for construction materials; check the quality of material procured and Prepare a periodical work progress report based on the usage of construction materials are became the responsibilities of consultants. This idea is also shared by (Al-Khafai, 2009) monitor work on site with regard to quality, cost and time; attending commissioning and acceptance testing and completion of relevant work; assist in valuations and the settlement of accounts are taken by consultants.

Generalization for those three pillar stakeholders was mostly client/owner-involved at the start of projects on material procurement, transportation, and storage stages. That is the main task to start the project work and go its progress smoothly.

5. Conclusion and recommendation

5.1 Conclusion

The outcome of this study analysis can have great significance for the construction industry, especially for FHC projects. Different construction companies have different practices related to construction material management, then as the first objective of this study, assessing current practice of FHC projects related to construction material management through six construction stages (planning, procurement, transportation and logistics, receiving and inspection, storage and handling, and lastly wastage control practice) is done based on considering 29 potential factors. Then respondents were requested to rate these factors based on a five Likert scale to know the status of FHC projects and to identify best practice of FHC projects that was objective three of this study. From those factors;

- Presence of a storekeeper responsible for material handling
- Practice of counting delivered amount of material and record on stock card. (Inventory control),
- Required type and quantity of material determined before the specific work started,
- Receive and inspection department announce to planning department to be requested before the required material became empty,
- Construction materials have their own storage place and,
- Availability of responsible department to follow the purchased amount of material is fully delivered, are the top five best ranked practices at FHC projects related to construction material management.

The second objective was to identify key challenges of CMMP at FHC projects. Even if there are many challenges in practicing of construction material management, the study only considered 30 challenges. These challenges are grouped into six different construction stages, and they were ranked according to the Relative Importance Index. The most challenging are:

- Market fluctuation and planning variation in material usage,
- Unexpected market fluctuation,
- In complete design and specification,
- Local trafficking situation became difficult,
- Less accountability for occurrence of wastage,
- Late delivery of material and logistics distribution,
- Absence of plan in each stage of construction project work for waste control ,
- Lack of fully organized planning department for material,
- Interest of client not properly defined ,
- Use less traditional data for recorded system (limited time saving and date quality recorded) are top 10 challenges on construction material management practice at FHC projects.

The last objective of this study focuses on the role of key stakeholders in construction material management practices. According to stakeholder involvement, three stakeholders are considered (owner, contractor, and consultant). Those stakeholders' roles in construction material management practice were assessed through six categories (planning, procurement, transportation and logistics, receiving and inspection, storage and handling, and lastly, waste control practice). Even if the role of those stakeholders is many in this study, only 18 practices were considered through the above-listed six categories of construction project stages. From this mostly;

- The owner's role and responsibility are involved at the procurement, transportation, and logistics stages, and
- Contractor's roles are almost at all stages of construction projects, especially in the planning stage. And finally
- Consultants' role and responsibility are involved in monitoring and controlling practice.

5.2 Recommendation

According to the findings above in Federal Housing Corporation projects, the following points can be recommended by the researcher in order to minimize challenges in construction projects:

For Planning;

- Check presence of full documentation (design, specifications) before starting work,
- Develop best strategy for material planning in all construction stages.
- Create awareness about the applicability of material planning strategy and its usage.

For procurement stage;

- Consider the variation of previously constructed material costs versus the present
- Develop a spending strategy to mitigate the effects of inflation by identifying the necessity of money to be spent.
- Price your services reasonably.
- Foster a good relationship with suppliers
- Purchase materials in bulk by developing a good storage place.

For transportation and logistics stage;

- Develop a good strategic plan for material transportation, identify peak hours of local traffic time, and arrange when materials are to be ordered and transported.
- Using a proper logistic strategic plan includes coordinating the goods and activities required across the project. This is a vital practice in ensuring logistics are carried out within the relevant legislation safety standards. It can also be used to model, visualize, and optimize inventory management.

For received and inspection stage

Hence the following recommendation needs to develop a traditional data-recorded system.

- Use different software like ClickUp AI (Gantt chart view), OrangeScrum for resource allocation, and Clockify as a time tracking tool. (Evan, 2024)
- Collect data more computerized rather than on paper
- Trained worker on handling data

For handling, storage and wastage control stage

- Develop the best wastage minimization strategic plan for each construction stage (like using optimized resources, reusing scrap metal, improving quality control, and monitoring and following up on work progress frequently).
- Create awareness for workers about wastage control techniques.
- Use good work methodology for project activities.
- Assign a responsible department or person for wastage minimization practice.

Mitigation efforts are essential to minimize damages due to major problems. Earlier analysis on challenges of construction material management practice is important as it suggests the appropriate action or method to diminish its effect.

Recommendations for future studies

Further research on construction material management practice should be done in order to develop guidelines, or methods of minimizing the effects of construction material cost on project budget. Furthermore, similar research should be performed in various projects and various places. In order to provided that more reliable data, it is required to carry out studies for each specific type of construction projects, including highways, dam construction projects, utilities and etc.

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