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# Inventory management of material for small and medium scale projects (Residential and Commercial)

Mansi Gambhire<sup>1</sup>, Amruta Vyas<sup>2</sup>

<sup>1</sup>Construction Management <sup>1,2</sup>Dr. D Y Patil College of Architecture

#### Abstract

Effective inventory management is a crucial aspect for the success and sustainability of Small and Medium Projects. These firms often face challenges such as limited resources, fluctuating market demands, and inefficient supply chain practices, which can lead to issues such as stockouts, overstocking, and high operational costs. This study aims to explore the inventory management practices in Small and Medium Projects, focusing on the materials management process, and identifying common challenges these firms face in maintaining optimal inventory levels.

Material Management is a very critical part of the construction industry. The purpose of efficient material management is that goods used for construction should be available in the right quantity and quality and more importantly at the right time. The research examines various inventory control techniques such as Just-In-Time (JIT), Economic Order Quantity (EOQ), and ABC analysis, Material requirements planning (MRP), First in First out (FIFO), Last In First Out (LIFO) assessing their effectiveness within the context of limited financial and human resources.

The findings will highlight practical solutions and strategies to enhance inventory control, reduce costs, and improve operational efficiency. By focusing on Small and Medium Projects across different industries, this research seeks to provide actionable insights and recommendations for Small and Medium Enterprises to optimize their inventory management practices, improve cash flow, reduce stock imbalances, and ultimately increase their competitive advantage in the market.

The software application recommendations are drafted based on the research and findings of this dissertation. Furthermore, guidelines and an online test application are a result from this dissertation to test the hypothesis in a real-world scenario. With an emphasis on affordability and user-friendliness, this solution is required to small and medium-scale projects. As a result, the app enhances overall project efficiency, reduces material wastage, and optimizes cost control, making it an essential tool for improving construction site operations.



#### 1. Introduction

Inventory management plays a vital role in the successful execution of construction projects, particularly in small and medium-scale residential and commercial developments. Effective inventory control ensures that materials are available when needed, in the right quantity and quality, while minimizing waste, cost overruns, and delays. Inventory includes raw materials, work-in-progress and finished goods. Inventories in the sense of tangible goods, which are held for sale, in process of production and available readily for consumption.

Inventory management includes forecasting, planning, procurement, tracking, and optimization. Demand forecasting predicts customer purchases. It helps businesses determine inventory. Inventory planning determines how much to buy or manufacture based on demand, lead time, safety stock, and order cycle. Procurement supplies inventories to fulfill demand. It involves picking a seller, ordering, and receiving. Inventory tracking involves managing inventory levels. Inventory optimization maximizes efficiency and profit.

In the construction industry, especially among small and medium scale projects, material mismanagement often leads to challenges such as overstocking, stock outs, loss of materials, and inefficient use of storage space. These issues can significantly affect the profitability and timeline of a project.

This project focuses on analysing and improving the inventory management practices used in small and medium-scale construction projects. It explores techniques for tracking, ordering, storing, and utilizing construction materials efficiently. The study also identifies existing gaps in the current inventory systems and aims to propose a structured, digital solution that incorporates forecasting tools, material tracking, and inventory optimization strategies make for small and medium scale projects.

By use of modern inventory practices and technologies, this project find to enhance overall project performance, reduce material-related risks, and contribute to sustainable construction practices. The proposed approach will be applicable to both residential and commercial projects, ensuring scalability and adaptability to diverse construction scenarios.

#### **1.1 BACKGROUND TO THE STUDY**

Inventory management is a fundamental activity for all businesses, including small and medium-sized Projects. Effective inventory management ensures that businesses can fulfill customer demands, minimize costs, and maintain smooth operations. However, small and medium-sized projects with limited resources often cannot afford advanced inventory management software and, instead, rely on manual and oral methods for managing their inventory. Proper inventory management ensures that firms can meet customer demand without overstocking or under stocking, which directly impacts profitability, cash flow, and operational efficiency. Inventory management involves overseeing the supply of raw materials, finished goods, and other essential items required for business activities.

Manual and oral inventory management methods are still common among Small and Medium scale projects, primarily due to limited resources or budget constraints. While these methods present challenges, such as human error, time-consuming processes, and lack of real-time data, businesses can make improvements by standardizing record-keeping, creating clear communication protocols, and



implementing practical inventory management strategies.

In small and medium firms, the approach to inventory management can differ significantly from larger organizations due to limited resources, personnel, and technology. These challenges can make inventory management a complex and dynamic task.

Inventory management in small and medium-sized firms is vital for maintaining operational efficiency, minimizing costs, and ensuring customer satisfaction. Despite facing resource constraints, Small and medium scale projects can overcome challenges through the adoption of appropriate techniques, automation tools, and best practices. By improving their inventory management systems, Small and medium scale projects can enhance their competitiveness, profitability, and growth potential.

Overall, an understanding of inventory management principles, coupled with technology and sound strategies, is crucial for the success of small and medium enterprises in today's competitive marketplace.

#### 1.2 AIM

Aims to make material management simpler, more transparent, and more efficient, ultimately leading to smoother project execution and improved profitability for small and medium firms in the construction industry.

To be user-friendly, ensuring that Site engineer, store manager and owners, regardless of their technical expertise, can easily track and manage inventory. One of its key features is accurate quantity tracking, which helps users determine the exact amount of materials needed for a specific construction area. This ensures that projects are executed smoothly without delays caused by material shortages or overstocking.

#### **1.3 OBJECTIVES**

This research project aims to enhance the inventory management of materials for small and medium-sized firms in construction projects by integrating tools and creating an easy-to-execute system. The specific objectives are:

1) To Assess Inventory Management Practices in small and medium scale projects.

2) Conduct a comprehensive review of existing literature on materials management processes in construction projects.

3) Develop recommendations to improve material management practices based on findings from case studies.

4) To carry reserve stock to avoid stock out

5) To provide reasonable level of client service.

6) To streamline the entire process of material management, from procurement to usage, in a way that improves accuracy, reduces costs, and enhances overall efficiency for firms with limited resources and technical expertise, increases operational efficiency, and contributes to the successful execution of construction projects.

IJSAT25024623

# International Journal on Science and Technology (IJSAT) E-ISSN: 2229-7677 Website: www.ijsat.org Email: editor@ijsat.org

Inventory management of materials for small and medium-sized Projects



Figure 1 : Scope of the Project

#### 1.4 LIMITATION OF THE STUDY

These limitations can arise from various factors such as resource constraints, methodology, external factors, and organizational challenges. Below are the key limitations of the study on inventory management in Small and Medium scale projects:

1. **Limited Access to Data:** Small and Medium Scale Projects may not maintain comprehensive or up-to-date inventory records, particularly if they are using manual systems. This lack of data accuracy or availability can hinder the analysis of inventory management practices.

2. **Resource Constraint**: Small and Medium scale Projects often face financial and human resource limitations that prevent them from implementing advanced inventory management systems. This may lead to reliance on manual processes or basic tools like spreadsheets.

3. **Subjectivity of Data Collection:** In small and medium firms, inventory management may be less formal, often dependent on individual employees' experience or judgment. This subjectivity can influence data accuracy and decision-making.

4. **Dependence on Manual or Semi-Automated Systems:** Many Small and Medium scale Projects still rely on manual methods (e.g., paper records, spreadsheets) or basic software tools to track inventory. These systems may not offer real-time data or advanced features needed for accurate inventory management.

5. **Lack of Standardized Practices:** Unlike larger organizations, Small and Medium scale Projects may not have formalized or standardized inventory management procedures. Each business might have its own approach, which can vary significantly from one firm to another.

6. **Limited Timeframe for Observation:** Inventory management practices in small and medium scale projects may vary seasonally or change over time. Studies conducted over a short period may not capture the full impact of inventory strategies or fluctuations in demand.

7. **External Environmental Factors:** Small and medium scale projects are often affected by external factors such as supply chain disruptions, economic changes, and fluctuating demand, which can impact inventory management practices.



8. **Sample Size and Scope:** Depending on the size of the study, the sample of Small and medium scale projects may not be large enough to offer comprehensive insights into inventory management across a wide variety of industries or geographic regions.

9. **Technological Barriers:** Many small and medium scale projects may lack access to modern inventory management software or advanced technology, which could limit the study's ability to explore the full range of tools and systems that could improve inventory management.

10. **Changes in Business Conditions:** The dynamic nature of business, especially for Small and medium scale projects, means that inventory management strategies may change rapidly based on market conditions, competition, or internal business shifts.

#### 2. LITERATURE REVIEW

#### 2.1 Overview of construction Inventory Management of Material

Inventory management in construction is a critical aspect of ensuring that construction projects run smoothly, on time, and within budget. Construction inventory management refers to the processes, systems, and strategies used to track, store, and control materials, equipment, and supplies required for a construction project. Effective inventory management helps construction companies avoid delays, minimize costs, reduce waste, and maintain a steady supply of materials throughout the project lifecycle.

In the construction industry, inventory management can be more complex than in other industries due to the diverse range of materials used, unpredictable project timelines, and variable worksite conditions. Properly managing materials on a construction site requires careful planning, monitoring, and coordination between various stakeholders, including suppliers, contractors, and project managers.

Efficient inventory management is critical for project success, particularly in small and medium-scale construction projects. Studies highlight that material costs account for 50–60% of total project expenses Poor inventory control leads to delays, cost overruns, and material wastage. Techniques like **Just-In-Time** (**JIT**), **Economic Order Quantity (EOQ), and ABC Analysis** have been used to optimize material procurement and storage.

Inventory management is an essential element of operations for small and medium scale projects, ensuring that materials and products are available to meet customer demand without incurring unnecessary costs. Small and medium scale projects, however, face unique challenges due to limited resources, fluctuating demand, and the complexity of supply chain management. This literature review explores key concepts, methods, and findings from existing research on inventory management in small and medium scale projects, providing insights into effective practices, challenges, and strategies for improvement.

#### Key Coponents of Construction Inventory Management

#### 1. Material Planning and Procurement



• **Material Forecasting**: Estimating the quantity and type of materials required for the construction project, based on blueprints, designs, and project timelines.

• **Supplier Coordination**: Ensuring timely procurement from reliable suppliers to avoid stock outs or delays. This involves managing supplier relationships, negotiating prices, and setting up delivery schedules.

• **Budgeting**: Keeping track of material costs to ensure the project stays within budget, while also considering the quality and availability of materials.

#### 2. **Storage and Handling**

• **Warehouse Management**: Storing materials in a way that reduces damage, prevents theft, and ensures easy access when needed. This involves effective storage strategies, such as shelving or stacking materials by type or project phase.

• **On-Site Storage**: Materials stored on the construction site must be protected from the elements and secured to avoid theft. Proper organization of materials on-site also ensures quick access when required.

• **Material Handling**: Ensuring that materials are properly moved on and off the site and that workers have the right tools and equipment to handle them efficiently.

#### 3. **Inventory Tracking and Control**

a. Manual and Digital Tracking: Materials can be tracked using traditional paper logs or, more commonly, using digital systems such as spreadsheets or inventory management software. Some companies use barcodes, Radio Frequency Identification tags, or QR codes for easy scanning and tracking.
b. Inventory Audits: Regular physical inventory audits are essential to confirm the accuracy of inventory records, ensuring there are no discrepancies between the actual stock and recorded data.

c. **Real-Time Tracking**: Some construction companies implement cloud-based inventory management systems that allow for real-time updates, helping project managers monitor material use and manage reorders instantly.

#### 4. Material Usage and Waste Control

a. **Efficient Material Use**: By accurately forecasting material needs and tracking inventory levels, construction firms can minimize excess and underuse of materials, ensuring that only what is needed is ordered.

b. **Waste Reduction**: Proper inventory management helps reduce material wastage by ensuring that materials are ordered in the correct quantities and used efficiently. Waste management programs can also help recycle or repurpose leftover materials.

#### 5. **Inventory Replenishment**

a. **Reorder Triggers**: Establishing reorder points ensures that materials are replenished at the right time before running out. The right reorder levels depend on the pace of construction and the lead time for material procurement.

b. **Just-in-Time (JIT) Inventory**: Many construction companies adopt JIT inventory practices to minimize holding costs and reduce the need for large amounts of on-site storage. JIT ensures that materials arrive only when needed, helping keep costs down.



#### 6. Supplier and Vendor Management

a. **Reliable Suppliers**: Effective inventory management requires reliable suppliers who deliver materials on time and within specifications. Strong relationships with suppliers are crucial for the timely procurement of materials.

b. **Vendor Performance Monitoring**: Regularly evaluating suppliers based on factors like delivery reliability, quality, and cost can help ensure materials are consistently available when needed.

# 2.2 INVENTORY MANAGEMENT OF MATERIAL FOR SMALL AND MEDIUM SCALE PROJECT

#### 2.2.1 Purpose of Material Management

- Economize purchasing
- Cost Control and Budget Management
- Fulfill demand during replenishment periods.
- Maintain reserve stock to prevent stockouts.
- Stabilize consumption fluctuations.
- Provide satisfactory client services.
- Minimizing Wastage and Reducing Material Loss
- Enhancing Decision-Making

#### 2.2.2 Importance of Inventory Management in Construction

- **Cost Reduction**: Prevents over-purchasing and material wastage.
- **Time Efficiency**: Reduces project delays caused by stockouts or supply chain issues.
- **Resource Optimization**: Ensures the right materials are available at the right time and place.
- **Improved Project Planning**: Enhances workflow and project scheduling.
- **Sustainability**: Reduces environmental impact by minimizing excess materials and waste.

#### 2.2.3 Challenges in Material Management

• Material Shortages & Overstocking: Poor forecasting leads to delays or excess materials.

• **Storage Constraints**: Limited space on construction sites makes inventory management complex.

• **Manual Tracking & Errors**: Many small and medium scale projects still use traditional methods, leading to inefficiencies.

- Theft & Material Loss: Unsecured materials often result in financial losses.
- **Supply Chain Disruptions**: Delays in material procurement affect project timelines.

#### 2.2.4 Best Practices for Small and Medium Scale Projects

- Implement **real-time tracking** and **digital inventory systems**.
- Use **inventory forecasting models** to prevent shortages.
- Train staff on **material handling & waste reduction strategies**.
- Establish standard procurement & stock management policies.



#### • Collaborate with suppliers for **timely deliveries & bulk discounts**.

#### 2.2.5 Benefits of Inventory Management

An effective material management system can bring many benefits for a company in construction industry. From the study of Construction Industry Institute (CII) we can conclude that labor productivity could be improved more than 6% and can produce 4-6% additional savings from the total cost. Proper management of materials ensures that the project runs smoothly, stays within budget, and meets deadlines. Below are the key benefits of inventory management of materials for small and medium-scale projects:

- 1. Cost Reduction
- 2. Prevention of Stock outs
- 3. Enhanced Project Timeliness
- 4. Improved Cash Flow Management
- 5. Reduction of Material Waste
- 6. Efficient Resource Allocation
- 7. Better Supplier Relationships
- 8. Increased Accountability and Transparency
- 9. Accurate Forecasting and Planning
- 10. Flexibility to Adapt to Project Changes
- 11. Improved Quality and Quantity Control
- 12. Sustainability and Environmental Benefits

#### 2.3 BOOK REVIWS

#### 2.3.1 BOOK 01 : MATERIAL MANAGEMENT AN INTEREATED APPROACH

#### Authors: P. Gopalkrishnan

#### Administrative Staff of College of India, Hyderabad

#### M. Sundaresan Graduate School of Business Columbia, New York

#### Year of Publication: 2018

This book focusses on the significance the total integrated option of material management within the Indian context. It provides an overall understanding about:

- Operational details of stores.
- Purchase and Inventory control.

• New Developments in Site Storage which include sack and bulk stores. This is a very economic and efficient method of dry storage.

• Speed of material movement also plays an important role and minimizing bottlenecks should be planned well in advance.

#### 2.3.1.1 Problems and developments in store management:



(Gopalkrishnan & Sundaresan, 2018) Many decisions in store management selection of racks . bins, handling equipment, safety practices, codification, training personnel and accounting call for considerable skill and an ability to coordinate with other departments as well as outside agencies.

In many organizations, this scrap yard also comes under the control of the store manager. This is an entirely new responsibility calling for the ability to maximize returns on the disposal of this scrap.

#### 2.3.1.2 Roles of the chief stores officer:

Besides coming into contact with the production, purchase maintenance, inspection add finance departments within his organization he has to come into contact with outsiders like suppliers, transport carriers and bankers. Qualified engineers should be posted as chief store officer reporting to the material manager.

#### 2.3.2 BOOK 02 : PURCHASING AND INVENTORY MANAGEMENT

#### Authors K.S Menon

#### Sarika Kulkarni

#### Year of Publication: 2011

• (Menon & Kulkarni, 2011) This book has very good examples and understanding of India scenario of case study. For example, buying a car also comes with a spare wheel.

• In case of Taj Mahal workers were laid off when inventories ran out. They were re hired once the materials arrived. Major cost involved in inventories is the money involved in keeping the goods in stock and storage of inventory.

• In India inventory carrying cost varies from 28 to 23 percent these include:

• warehousing, shrinkage evaporation, spoilage of goods, rentals, on site electricity and material handling.

• E- Purchasing is a web-based requisition system with online catalogues and electronic approvals' -sourcing can create tremendous value for both the buyer and the supplier. The immediate advantage of having an apt E-Sourcing is reduction in the total cost associated with Business-to-Business B2B transactions.



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#### 2.4 RESEARCH PAPER REVIEW

# 2.4.1 IMPROVING MATERIALS MANAGEMENT PRACTICES ON FAST-TRACK CONSTRUCTION PROJECTS

AUTHOR: - Narimah Kasim, Chimay J. Anumba, Andrew Dainty

**ISSUE DATE: -** October 2005

**VOLUME: -** Volume 05

**PAGE NO.: -** 793 – 802

PUBLISHED IN: - 215 Annual ARCOM Conference

#### **REVIEW 01: -**

Narimah Kasim, Chimay J. Anumba, Andrew Dainty, "Improving Materials Management Practices On Fast-Track Construction Projects", 21s Annual ARCOMConference, Volume 02, Pages 793 - 802, October 2005

• A brief review of the methods used for materials management on expedited construction projects has been provided in this study.

• Managing all materials is crucial from the planning stages through the building phases.

• Poor handling of construction materials has an impact on the timeliness, cost (budget), quality, and productivity of a project.

• In order to prevent a loss of profit for construction companies, the wastage of materials should also be limited during building.



• In order to increase the effectiveness of the manufacturing process in fast-track building projects, new approaches to materials management must be developed.

• The potential of IT applications serves as a foundation for creating a framework that will allow the development of a better materials management system for such projects.

# 2.4.2 ANALYSING MATERIAL MANAGEMENT TECHNIQUES ON THE CONSTRUCTION PROJECT

AUTHOR: - Ashwini R. Patil, Smita V. Pataskar

**ISSUE DATE: -** October 2013

**VOLUME:** - Volume 03

**PAGE NO: -** 96 – 100

**PUBLISHED IN: -** International Research Journal of Engineering and Technology

#### **REVIEW 02: -**

Ashwini R. Patil, Smita V. Pataskar, "Analysing Material management techniques on the construction project", International Research Journal of Engineering and Technology, Volume 03, Pages 96-100

This study demonstrates that cost of construction materials is a significant part of every construction project. The entire cost of the materials may make up half of the overall cost. so it is crucial for the contractor to understand that timely material availability could be a factor in the projects success.

This paper tells us about two different types of analysis 5 curve analysis and EOQ analysis through this, we cane to know that the unavailability of Rcc design drawings causes major problems for the contractor.

According to the pie charts analysis in the paper, administrative factors account for su70 of the reasons for contractor rework and S% of the reasons are attributable to material shortages.

# 2.4.3 CRITICAL ANALYSIS OF MATERIAL MANAGEMENT TECHNIQUES IN CONSTRUCTION PROJECT

AUTHOR: - B. Madhavarao , SS. Asadi and K. Mahindra

**ISSUE DATE: -** 4 April 2018

**VOLUME: -** Volume 09

**PAGE NO: -** 1-11

PUBLISHED IN: - International Journal of Civil Engineering and Technology (IJCIET)



#### **REVIEW 03: -**

In construction sector, material management plays major role for effective completion of the project. The cost of project increases when the planning, material identification system is poor. Shortage and deficiency in storage of material will cause losses in labor productivity. To maintain the effective management, to achieve the timely supply of materials and equipment and to reduce the cost of projects, a well-planned material management program is required. This improves planning, higher labor productivity, proper schedules and lower project costs. This paper explains about the techniques for material management of four important construction materials. By implementing these techniques, we have found an optimized way to reduce the cost of the project. Using S-curve technique, the variation in planned cost and actual cost is assessed. Quantity of materials procured for the project should be determined by the using A-B-C analysis.

The main aim of material management to reduce the cost of project by using different techniques, Material management is defined as "the process to provide right material at right place at right time in best quantity so as to minimize the cost of project". the goal of material management is to ensure that construction material are available at right quality of material and quantity of material are appropriately selected, purchased, delivered and handle on site in a timely manner and at reasonable cost.

# 2.4.4 MATERIAL MANAGEMENT IN CONSTRUCTION PROJECT USING INVENTORY MANAGEMENT SYSTEM

AUTHOR: - Ashika M and Monisha V

**ISSUE DATE: -** 05 May 2020

VOLUME: - Volume 06

**PAGE NO: -** 1-9

PUBLISHED IN: - International Journal for Modern Trends in Science and Technology

#### **REVIEW 04: -**

In construction industries 70-80% of amount will be used to purchasing material. Sometimes, material fluctuation may give profit or loss to contractor or client. Economic order quantity analysis for cement, which is 506 bags repetition of requesting days which has succeeded the problems of stock out successfully over the actual site stock record. In this project we have proper scheme of material management in the construction industry for building process also conducting survey of industries and to collected all the data also information about the controlling the wastage of material. And analysed all the required data and minimized cost of material by using inventory management system.

It is defined materials management function which take off, vendor evaluation and selection, purchasing, expenditure, shipping, material receiving, where housing and inventory, and material distribution. In this project we have prepare scheme of material management in the construction industry for building project also conducting survey of industry and determine the various format for construction material



management. In conclusion the wastage of material, control cost of material and time should be analysed by using inventory management system.

# 2.4.5 FACTOR AFFECTING MATERIAL MANAGEMENT IN CONSTRUCTION INDUSTRY

AUTHOR: - V.P.Vipin, S.Rahima Shabeen

ISSUE DATE: - 03 September 2019

**VOLUME: -** Volume 08

**PAGE NO.: -** 01-05

**PUBLISHED IN: -** International Journal of Civil Engineering and Technology (IJCIET)

#### **REVIEW 06: -**

#### Material cost is almost 50-60% of most construction

Material cost is almost 50-60% of most constructionprojects. A better material management contributes to lesser cost for a project and also, sustainable use of available resources in the long run. This project aims to identify the major factors affecting material management in a construction project. The various factors at different stages of material management are identified and put in a form of a questionnaire. The responses to the questionnaire were obtained from the stakeholders such as architect, storekeepers, material managers, quantity surveyors, site engineers, project managers, and project engineers. The relative importance of each factor is arrived at based on the ranked response obtained from questionnaire survey. Among the factors identified, the factor 'unclear definition of roles and responsibilities' is ranked as the major factor that affects material management.

#### 2.4.6 MATERIALS MANAGEMENT FOR CONSTRUCTION SITES-A REVIEW

AUTHOR: - Aditya Pande, Syed Sbihuddin

**VOLUME: -** Volume 01

**PAGE NO: -** 1-7

PUBLISHED IN: - International Engineering Journal For Research & Development

#### **REVIEW 06: -**

# Aditya Pande, Syed Sbihuddin , "Material Management for Construction Site -A Review", International Engineering Journal for Research & Development, Volume 01.

The successful completion of projects now heavily depends on effective materials management. Organizations are now aware of the many advantages that good material management practices can bring. This shift away from a purely tactical role has given it strategic value. We also looked at several material management research models as well as how modern information technology is applied to them today.

#### 2.4.7 A STUDY REPORT ON MATERIAL MANAGEMENT IN CONSTRUCTION INDUSTRY



AUTHOR: - R.Ramya1, K.E.Viswanathan

**VOLUME: -** Volume 07

**PAGE NO: -** 1990-1994

**PUBLISHED IN: -** International Journal of Intellectual Advancements and Research in Engineering Computations.

#### **REVIEW 07: -**

A Brief review of Material management is a major problem in a construction project for many years. In construction field construction materials consumes 50 to 60 % of overall cost of a project. Nowadays, successful material management of construction has to be based on the innovative techniques. This paper work helps to explore material management techniques used in present days and identify the factors that affects material management. This project also involves applying ABC analysis for a residential building. The material management literatures and some material management techniques are studied. A questionnaire survey is used to identify the current practices in material management. The main recommendation of this research is using material management techniques to determine the required quantities of materials for reducing the time and errors.

#### 2.5 INVENTORY MANAGEMENT OF MATERIAL FOR SMALL & MEDIUM SCALE PROJECTS USING SOFTWARE TECHNOLOGY

1. **Improved Accuracy and Reduced Human Error :** software systems minimize the risk of human error associated with manual inventory tracking, such as incorrect data entry, lost items, or miscalculations.

2. **Real-Time Inventory Tracking :** Software provides real-time updates on inventory levels, stock movements, and order statuses, helping businesses stay on top of inventory fluctuations.

3. **Inventory Forecasting and Demand Planning:** Inventory management software can analyze historical data to predict future demand for products or materials.

4. **Efficient Order Management:** Software automates the order management process, from creating purchase orders to managing supplier deliveries, ensuring smooth procurement workflows.

5. **Inventory Valuation and Financial Reporting:** Inventory management software helps firms track the financial value of their stock, making it easier to calculate the cost of goods sold (COGS) and track inventory-related expenses.

6. **Improved Supplier Relationship Management:** Inventory management software often includes tools for managing supplier information, such as contact details, pricing, and lead times, allowing businesses to communicate more effectively with suppliers.

7. **Multi-location and Multi-channel Management:** Many software solutions support multilocation and multi-channel inventory management, allowing businesses to track inventory across different warehouses, stores, or sales platforms.

8. **Better Stock Optimization:** Inventory software helps businesses optimize stock levels, identifying slow-moving or obsolete stock that may need to be discounted.



9. **Enhanced Security and Reduced Theft:** Inventory management software helps track the movement and location of items in real time.

10. **Scalability for Growth:** Inventory management software can scale with the growth of a business, supporting increasing inventory levels, more locations, and more complex workflows.

#### 3. METHODOLOGY

#### **3.1 GENERAL INTRODUCTION**

#### Significance of the Methodology

For Small and Medium scale projects, efficient inventory management can directly affect profitability, customer satisfaction, and operational efficiency. By adopting modern methodologies ,which may include inventory management software, best practices for stock control, and predictive tools for demand planning ,small and medium firms can:

• Reduce the time spent on manual stocktaking and order management.

• Enhance operational visibility, helping management make informed, data-driven decisions.

• Improve cash flow by optimizing inventory levels and reducing the amount of capital tied up in unsold or obsolete stock.

• Strengthen relationships with suppliers and customers through accurate delivery schedules and better stock availability.

The methodology also emphasizes a collaborative approach, involving key stakeholders such as business owners, managers, procurement teams, warehouse staff, and suppliers, all of whom play crucial roles in the overall inventory management process.

#### **3.2 TARGET AUDIENCE GROUPS:**

1. **Business Owners/Managers**: Business owners and managers are typically the decision-makers responsible for overseeing the inventory management process.

2. **Inventory/Procurement Managers**: These individuals are responsible for overseeing the inventory and material procurement processes on a day-to-day basis.

3. **Warehouse Staff/Inventory Clerks**: Warehouse staff or inventory clerks manage the physical handling, storage, and tracking of materials.

4. Suppliers/Vendors: Suppliers and vendors provide materials or goods to the business.

5. **Sales and Marketing Teams**: Sales teams rely on inventory data to ensure that products are available for customer orders, while marketing teams plan promotions based on stock availability.

#### **3.3 METHODOLOGY CHART**

INVENTORY MANAGEMENT OF MATERIAL FOR SMALL AND MEDIUM SCALE PROJECTS

15



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#### 4. DATA COLLECTION

#### 4.1 ROLE IN MATERIAL MANAGEMENT

• Role of Material Management in Inventory Management for Small and Medium-Scale



#### Projects

#### 1. Planning and Forecasting

**Role**: Determines what materials are needed, when, and in what quantity.

> **Importance**: Prevents overstocking and understocking, which can either tie up capital or cause project delays.

#### 2. Procurement and Sourcing

- **Role**: Selects suppliers, negotiates prices, and purchases materials.
- > **Importance**: Ensures timely availability of quality materials at competitive prices.

#### 3. Storage and Handling

- **Role**: Manages proper storage conditions and material handling on-site.
- > **Importance**: Reduces material wastage, theft, and damage.

#### 4. Inventory Control

- **Role**: Keeps track of material inflow and outflow.
- > **Importance**: Maintains optimal inventory levels and supports accurate budgeting.

#### 5. Cost Management

- **Role**: Monitors material costs in relation to project budgets.
- > **Importance**: Helps avoid budget overruns and supports financial planning.

#### 6. Waste Reduction

- **Role**: Identifies and eliminates sources of material wastage.
- > **Importance**: Enhances sustainability and improves profitability.

#### 7. Vendor and Supply Chain Coordination

- **Role**: Coordinates with suppliers to ensure timely delivery and correct specifications.
- > **Importance**: Reduces delays and miscommunication.

#### 8. Documentation and Reporting

- **Role**: Maintains records of material usage, stock levels, and purchase histories.
- > **Importance**: Enables auditability, transparency, and future project planning.



#### 9. Technology Integration

- **Role**: Uses inventory software or digital tools to automate and streamline operations.
- **Importance**: Improves accuracy, saves time, and enhances decision-making.

#### • Important for Small and Medium-Scale Projects

- > Limited Budgets: Proper material management helps avoid unnecessary spending.
- **Smaller Teams**: Efficient systems reduce the burden on site supervisors and engineers.
- > **Tighter Schedules**: Timely material availability avoids construction delays.
- > **Space Constraints**: Optimal inventory ensures minimal clutter and efficient site management.

# • DETAILED EXPLANATION OF THE ROLE OF THE OWNER, SITE ENGINEER AND STORE MANAGER

#### **1. SITE ENGINEER:**

The **Site engineer** plays a crucial role in ensuring that the construction project follows the correct technical specifications and standards. They oversee the material requirements based on the project phases and ensure that materials used meet the design and structural requirements. Their role within the app involves:

• **Material Planning:** The Site engineer reviews the project schedule and determines the materials required for specific construction phases. For example, they may specify the need for **concrete blocks** in the initial phase for wall construction.

• **Approving Material Requests:** Based on the project's needs, the Site Engineer communicates the material requirements to the **Store Manager** through the app, providing detailed specifications on the quantity and type of materials needed.

• **Monitoring Material Arrival:** The Site Engineer receives notifications when materials are delivered to the site. They can check photos and quantities uploaded by the **Store Manager** to verify that the materials meet the required standards for quality and quantity.

• Making Informed Decisions: Using data such as remaining stock and material condition alerts, the Site engineer can decide if additional material is needed for the upcoming phases. They can advise the Store Manager to procure more material if necessary.

• **Ensuring Compliance:** The Site Engineer ensures that materials used meet the structural and safety standards set for the project. They can access real-time data and inspect the material quality through photos, helping maintain project integrity

#### 2. OWNER:

The **Owner** is the stakeholder who funds the project and has the overall responsibility for ensuring that the construction is completed on time, within budget, and meets quality standards. Their role in the app is more about oversight and decision-making:



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• **Project Oversight:** The Owner can monitor real-time updates provided by the **Site Engineer** and **Store Manager** regarding materials, project progress, and inventory levels.

• **Tracking Costs & Budgeting:** The Owner can see the **costs** associated with materials and monitor how much material is being used or wasted, which helps keep the project within the budget. This data is accessible through the app's reporting features.

• **Real-Time Communication:** The Owner is notified when materials reach the site and can view documentation like **challans** and **material photos**, ensuring transparency and reducing the chance of miscommunication or disputes.

• **Approving & Decision-Making:** Based on the data provided by the app (such as material wastage, remaining stock, etc.), the Owner can make informed decisions regarding budget adjustments, project timelines, and future procurement needs.

• Access to Project Updates: The Owner can view project status, including material usage, costs, and any potential delays or issues, ensuring they are always in the loop and can make informed decisions to keep the project running smoothly.

#### **3. STORE MANAGER:**

The **Store Manager** is responsible for managing the material inventory on-site and ensuring that the right materials are available when needed. They play a central role in the day-to-day management of materials and inventory flow. Their role within the app includes:

• Material Procurement & Inventory Management: The Store Manager receives material requests from the Site Engineer based on the project phases. They order and manage the stock from the warehouse, ensuring that the materials required for the project are available on-site in a timely manner.

• Material Arrival & Delivery Notification: When materials are delivered to the site, the Store Manager uses the app to send real-time notifications to the Owner and Site Engineer confirming the material arrival and quality. They upload material photos to ensure transparency and validate that the right materials were delivered.

• Material Tracking & Stock Monitoring: The Store Manager continuously monitors material usage on-site and tracks remaining stock levels. The app allows them to send stock-out alerts to notify the Site Engineer when inventory levels are low, ensuring that materials are restocked before running out.

• Challan & Documentation Management: The Store Manager uploads challans (invoices/receipts) from the warehouse into the app, providing proof of material deliveries. This documentation is used for future reference, audits, and tracking material costs.

• **Material Usage Reporting:** The **Store Manager** logs how much material has been used for specific project tasks and how much is left. This helps in assessing material efficiency, calculating waste, and planning for future material orders.

• Security & Accuracy: All material data entered by the Store Manager in the app is securely logged and serves as a reliable record of material transactions, safeguarding both the Owner and Site Engineer from potential discrepancies.

#### 4.2. BUILDING MATERIAL AND THEIR CLASSIFICATION



# > LIST OF IMPORTANT BUILDING MATERIAL CONSIDERED FOR THE RESERCH STUDY :

- Steel Bars
- Cement Bags
- Sand
- Aggregate
- Red Clay Bricks
- AAC -Autoclaved Aerated Cement Blocks
- Floor Tiles
- Electrical Wires
- Paint

Building materials have an important role to play in this modern age of technology. Building materials are essential because they provide the foundation for constructing structures that offer shelter, stability, and safety. They determine the structural integrity, durability, and aesthetic appeal of a building, influencing its longevity and overall quality.

The the above list is for materials which have been used at builder sites extensively. They contribute to a major part of the financial budget allocated towards materials add site

These prices are average based on the type of material selected. These prices fluctuate based on fuel pricing and demand. If we are to cut down on wastages in the above-mentioned materials it would significantly lower the material cost and increase the overall project profits.

The right materials can also enhance a building's energy efficiency, leading to significant savings and reduced environmental impact. In the case of designs, materials influence spaces' visual and tactile qualities, affecting how people experience and interact with their environments.

Therefore, the thoughtful selection of building materials is crucial in achieving desired outcomes in construction, functionality, and sustainability.

#### 4.2.1. STEEL BARS

Steel bars, also known as reinforcing bars or rebars, are a crucial building material widely used in the construction industry. These bars, typically made of carbon steel, are commonly used to reinforce concrete structures such as buildings, bridges, highways, and other infrastructure projects.

One of the main reasons steel bars are preferred as a building material is their exceptional strength and durability. Steel has a high tensile strength, which means it can withstand heavy loads and resist bending and breaking, making it ideal for reinforcing concrete structures. Steel bars are designed to

provide added structural integrity and prevent cracking or collapsing of concrete under various loads, including dead loads (self-weight of the structure) and live loads (loads imposed by usage or environmental factors). Another advantage of steel bars is their versatility.



They come in various sizes, shapes, and grades, allowing for customization based on specific construction requirements. Steel bars can be easily bent, cut, and shaped, which makes them adaptable to complex structural designs and configurations. Moreover, steel bars can be used in both vertical and horizontal orientations, providing reinforcement in multiple directions and enhancing overall structural stability. steel bars come in different diameters like 8mm, 10mm, 12mm, 16mm, 20mm, 25mm, 32mm, 36mm.



#### Figure 3: Steel bars

#### **4.2.2. CEMENT**

Cement is a fundamental building material that has been used for centuries in construction. It is a fine powder made by grinding clinker, which is a mixture of limestone, clay, and other minerals, in a kiln. Cement acts as a binder when mixed with aggregates (such as sand and gravel) and water, and it undergoes a process called hydration, where it hardens and binds the aggregates together to form concrete.

Concrete, which is made by mixing cement, aggregates, and water, is renowned for its versatility, durability, and strength. It is widely used in construction for a wide range of applications. including buildings, bridges, highways, dams, and many other infrastructures. Concrete structures can withstand heavy loads, resist fire, and endure harsh environmental conditions, making them an essential building material in modern construction practices.

One of the main advantages of cement as a building material is its adaptability. It can be easily mixed with different types of aggregates to create concrete with specific properties, such as strength, workability, and durability, to suit different construction needs. This versatility allows for a wide range of design possibilities, from simple to complex structures, making cement a preferred choice in various construction projects.

4.2.5.2. Details of Cement Bags :

Table 1 : Details of cement bags



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Cement Bag Size	Weight (kg)	Average Price (₹)	Common Use	Transport Volume (Truckload)	Monthly Volume
50 kg	50	₹370–₹420	General construction (RCC, plastering, masonry)	400 bags per 10- wheeler truck	18–22 lakh bags/month
25 kg	25	₹190–₹220	Small repairs, tiling, DIY	800 bags per truck	1–2 lakh bags/month
Bulk Cement	NA (Loose)	₹7,500– ₹8,500/ton	Ready-mix plants, large projects	15–20 tons per bulk tanker	10,000–15,000 tons/month

#### 4.2.3. SAND

Sand is primarily composed of finely granulated silica and, depending on its location, can include various rock, coral, shell or lava fragments. It is lightweight and easily transported by wind and water. Its composition directly affects its color, resulting in black, white, pink and green coloring. Sand is an engineering material in concrete work. It is usually termed as fine aggregate. Sand is a form of silica (quartz) and may be of argillaceous Siliceous or calcareous according to its composition

- A form of silica of small grains.
- Formed by the decomposition of sandstone due to various weathering effects.
- Mostly obtained from pits, shores, river beds and sea beds.

Source of sand : 1.Pit Sand , 2.River Sand , 3. Sea Sand

#### 1. Pit Sand

- Obtained by forming pits into the soil
- Sharp, angular, porous and free from harmful salts.
- Clay and other impurities should be washed and screened before using it.
- Fine pit sand when rubbed between finger should not leave any strain on it.
- Used for mortars.

#### 2. River Sand

- Found at river beds and banks.
- Almost white in color.
- Fine, rounded and polished due to rubbing action of water currents.
- Having less frictional strength because of roundness.



- Grains are smaller than pit sand hence more suitable for plastering work.
- Normally available in pure condition and can be used in all kinds of CE works.
- 3. Sea Sand
- Obtained from sea shores.
- Fine, rounded and polished due to rubbing action of water.
- Light brown in color.
- Worst of the three types of sand because of containing lots of salts.

#### 4.2.3. CRUSHED SAND

M Sand and Crush Sand are almost identical to each other except the finer particle size percentage and the shape of the particle. M Sand do have more cubical or round shape and has less amount of fines passing through 150 micron, this helps in making it usable for doing plastering and waterproofing.

#### 4.2.3.1. Difference between M-Sand and Crushed sand:

**1. Production Process:** Crushed sand is produced by crushing hard rocks, such as granite, basalt, limestone, or quartzite, into fine particles. On the other hand, M-sand is manufactured by crushing specific types of rocks, typically granite or basalt, and then grading them to obtain the desired particle size.

**2.** Availability: Crushed sand can be readily available in local quarries, while M-sand may need to be manufactured and supplied by specific producers, which can affect its availability in certain regions.

**3. Particle Shape:** Crushed sand typically has angular and rough-edged particles due to the crushing process, while M-sand has more rounded and smoother particles due to the shaping process during manufacturing. The particle shape of M-sand is more similar to natural river sand.

#### 4.2.3.2. Benefits of Using Crushed Sand:

1.Consistent Quality , 2. Higher Strength and Durability ,3. Cost-Effective and EnvironmentallyFriendly , 4. Improved Workability , 5. Reduces Imperfections ,6. Sustainable Alternative





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Figure 4: Crushed sand as a building material



Figure 5: Aggregate

#### 4.2.4 AGGREGATE

Aggregates are inert granular materials, like sand, gravel, or crushed stone, that are essential components in building materials, particularly concrete. They provide strength and bulk to the final structure when mixed with cement and water. Aggregates can be natural, recycled, or manufactured. Aggregates are raw materials that are produced from natural sources and extracted from pits and quarries, including gravel, crushed stone, and sand. When used with a binding medium, like water, cement, and asphalt, they are used to form compound materials, such as Concrete. The price of construction aggregates in Pune varies based on type and size.10mm and 20mm crushed stone aggregates can cost around ₹2600/tonne.

#### 4.2.4.1. Uses of Aggregates:

- **Concrete:** Aggregates are the primary component of concrete, along with cement and water.
- Mortar: Aggregates are also used in mortar, a binding material for brick and stone construction.
- **Asphalt:** Aggregates are a key component of asphalt, used for road paving.
- **Sub-bases:** Aggregates are used as a foundation for roads and other structures.

#### **4.2.4.2. Importance of Aggregates:**

• **Strength and Durability:** Aggregates provide the necessary strength and durability to building materials like concrete.

- **Stability:** Aggregates help to stabilize structures and prevent them from collapsing.
- **Cost-effectiveness:** Aggregates are generally a relatively inexpensive and readily available.





Figure 6: Types of Aggregate

#### 4.2.5 BURNT CLAY BRICKS

Brick is obtained by moulding good clay into a block, which is dried and then burnt. A rectangular block of clay mixed with sand and fired in a kiln or baked by the sun, used in building construction. This is the oldest building block to replace stone. Manufacture of brick started with hand moulding, sun drying and burning in clamps. The size of the bricks are of 90 mm  $\times$  90 mm  $\times$  90 mm and 190 mm  $\times$  90 mm  $\times$  40 mm. With mortar joints, the size of these bricks are taken as 200 mm  $\times$  100 mm  $\times$  100 mm and 200 mm  $\times$  100 mm  $\times$  50 mm.

#### 4.2.5.1. Tests on Bricks

1. **Crushing Strength** -The brick specimen are immersed in water for 24 hours. The frog of the brick is filled flush with 1:3 cement mortar and the specimen is stored in damp jute bag for 24 hours and then immersed in clean water for 24 hours. The specimen is placed in compression testing machine with 6 mm plywood on top and bottom of it to get uniform load on the specimen.

2. **Absorption Test -**Brick specimen are weighed dry. Then they are immersed in water for a period of 24 hours. The specimen are taken out and wiped with cloth. The weight of each specimen in wet condition is determined. The difference in weight indicate the water absorbed. Then the percentage absorption is the ratio of water absorbed to dry weight multiplied by 100.

3. **Shape and Size-**Bricks should be of standard size and edges should be truely rectangular with sharp edges. 20 bricks are selected at random and they are stacked along the length, along the width and then along the height. For the standard bricks of size 190 mm  $\times$  90 mm  $\times$  90 mm. IS code permits the following limits: Lengthwise: 3680 to 3920 mm Widthwise: 1740 to 1860 mm Heightwise: 1740 to 1860 mm.

4. **Efflorescence -** The presence of alkalies in brick is not desirable because they form patches of gray powder by absorbing moisture.



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Figure 7: Burnt Clay Bricks

#### 4.2.6 AAC - AUTOCLAVED AERATED CEMENT BLOCKS



Figure 8: AAC Blocks

Autoclaved aerated concrete (AAC) is made with fine aggregates, cement, and an expansion agent that causes the fresh mixture to rise like bread dough. AAC block is made of Portland cement, fine aggregates (fly ash or sand), water and an expansion agent. The autoclaving process results in the production of air voids in the material, making it less dense, easy to cut/ mould and better insulating. Autoclave is a strong, pressurized, steam-heated vessel. Using AAC Blocks reduces the load on the foundation and other structural components in a structure due to its lower self-weight. About 55% reduction in weight of walls can be obtained when compared to that of walls made with clay bricks.

#### 4.2.6.1. Benefits of using Autoclaved Aerated Concrete Blocks

1. Environment friendly, 2. Durability ,3. High Thermal insulation ,4. Fire resistant ,5. Sound Insulation, 6. Easy workability



#### 4.2.6.2. Details of Autoclaved Aerated Concrete Blocks

Block Type	Standard Size (mm)	Approx. Price (₹ per block)	Approx. Price (₹ per m³)	Typical Transport Volume
Standard AAC Block	600 x 200 x 100	₹45 – ₹55	₹3,000 – ₹3,500	500–600 blocks per truckload (15–18 m <sup>3</sup> )
Standard AAC Block	600 x 200 x 150	₹65 – ₹75	₹3,000 – ₹3,500	400–500 blocks per truckload (15–18 m <sup>3</sup> )
Standard AAC Block	600 x 200 x 200	₹85 – ₹95	₹3,000 – ₹3,500	350–450 blocks per truckload (15–18 m <sup>3</sup> )
Jumbo AAC Block	625 x 240 x 200	₹100 – ₹120	₹3,200 – ₹3,800	300–400 blocks per truckload (15–18 m <sup>3</sup> )
Thin AAC Block	600 x 200 x 75	₹35 – ₹45	₹3,000 – ₹3,500	700–800 blocks per truckload (15–18 m <sup>3</sup> )
Partition AAC Block	600 x 200 x 50	₹25 – ₹35	₹3,000 - ₹3,500	900–1,000 blocks per truckload (15–18 m <sup>3</sup> )

Table 3 : Details of Autoclaved Aerated Concrete blocks

#### 4.2.7. FLOOR TILES

Floor covering is a term to generally describe any finish material applied over a floor structure to provide a walking surface. Flooring is the general term for a permanent covering of a floor, or for the work of installing such a floor covering. Both terms are used interchangeably but floor covering refers more to loose-laid materials.Materials almost always classified as floor covering include carpet, area rugs, and resilient flooring such as linoleum or vinyl flooring. Materials commonly called flooring include wood flooring, laminated wood, ceramic tile, stone, terrazzo, and various seamless chemical floor coatings.

#### 4.2.7.1. Types Of Tiles

1. Clay Floor Tiles , 2. Clay Wall Tiles , 3. Clay Roofing Tiles , 4. Clay Drain Tiles 5. Glazed Earthen Ware

#### 4.2.7.2. Details of Tiles

 Table 3 : Details of tiles

Tilo Typo	Common Sizes	Approx. Price	Notos	
The Type	( <b>mm</b> )	Range (₹/sq.ft)	Notes	
Commin Tilog	300x300,	<b>₹</b> 20 <b>₹</b> 150	Affordable and versatile; suitable for walls	
Ceranne Thes	400x400, 600x600	$x_{30} - x_{130}$	and low-traffic floors.	
Vitrified Tiles	600x600,	<b>₹</b> 25 <b>₹</b> 200	Durable and low-porosity; ideal for high-	
vitiliteu Tiles	600x1200	$\chi_{23} = \chi_{300}$	traffic areas.	
Porcelain Tiles	600x600, 800x800	₹50 – ₹250	Dense and water-resistant; suitable for both indoor and outdoor use.	



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Mosaic Tiles	25x25, 50x50	₹60 – ₹400	Decorative; often used for accents and artistic designs.
Marble Tiles	600x600, 800x800	₹200 – ₹500	Luxurious appearance; requires maintenance.
Granite Tiles	600x600, 800x800	₹100 – ₹400	Extremely durable; ideal for kitchens and high-traffic areas.
Cement Tiles	200x200	₹50 – ₹150	Rustic charm; suitable for vintage or industrial aesthetics.
Terracotta Tiles	300x300	₹40 – ₹200	Earthy tones; commonly used in outdoor spaces.
Quartz Tiles	600x600	₹200 – ₹600	Non-porous and stain-resistant; ideal for countertops and walls.

#### **4.2.8. PAINTS**

Paints are liquid compositions of pigments and binders which when applied to the surface in thin coats dry to form a solid film to impart the surface a decorative finish, apart from giving protection to the base material (i.e., concrete, masonry and plaster surfaces) from weathering, corrosion and other chemical and biological attacks. Paints preserve timber structures against warping and decay. Most of the metals corrode if not painted at suitable interval. Painting on surfaces impart decoration, sanitation and improved illumination.

Paints & Painting Calcareous surfaces, like lime and cement plastered surfaces, are highly alkaline in the initial stages, they retain large quantities of water during construction and it takes long time for the greater part of the water to evaporate even when the atmospheric conditions are favourable.

#### 4.2.8.1. Types of a Paint

- 1. Oil Paint
- 2. Enamel paint
- 3. Lacquers Emulsion paint
- 4. Synthetic paint
- 5. Aluminium paint
- 6. Cement paint

#### 4.2.8.2. Details of Paints

Table 4: Details of Paints



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Paint Type	Interior/E xterior Use	Approx. Price (per litre)	Common Applications	Key Features
Emulsion	Interior &	₹150 _ ₹450	Walls and ceilings in	Water-based, quick-drying, low
Paint	Exterior	(150 - (450	homes and offices	VOC, washable
Oil Paint	Interior	₹309 – ₹1500	Doors, windows, metal grills, wooden surfaces	Oil-based, glossy, durable, longer drying time
Enamel	Interior &	₹ <u>8</u> 7 ₹5668	Metals, wood, kitchen &	Hard, glossy finish, stain-
Paint	Exterior	x82 - x3008	bathroom walls	resistant, washable
Cement	Exterior	Exterior ₹80 – ₹200	External walls, rough	Weather-resistant, breathable,
Paint	LATEIIOI		surfaces	suitable for exteriors

#### 4.2.9. ELECTRICAL WIRES

Electrical wiring is generally refers to insulated conductor used to carry current and associated device. Domestic electric appliances like lights, fans, washing machines, water pumps etc. are connected to the supply through insulated wires which are controlled by switches. The wiring diagram gives the connections of different appliances to the supply within a house or building.



Figure 9: Electrical wires

#### 4.2.9.1. Reducing wastage of wires on construction sites:

- 1. Accurate material estimation
- 2. Proper storage and handling
- 3. Efficient cutting and trimming
- 4. Proper routing and installation
- 5.Recycling and reusing
- 6.Good Inventory management
- 7. Worker training and awareness



8. Collaboration and coordination among stakeholders

#### 4.2.9.1. Details of Electrical wires

#### Table 5: Details of electrical wires

	Size (sq.			
Wire Type	mm)	Strands	Common Use	Price/100m (₹)
FR (Flame				
Retardant)	1	14/0.3 mm	Light points, fans	₹1,100–₹1,250
FR	1.5	22/0.3 mm	Light circuit wiring	₹1,350–₹1,500
			Power sockets, AC	
FR/FRLS	2.5	36/0.3 mm	wiring	₹1,900–₹2,200
FRLS (Low			Geysers, heavy power	
Smoke)	4	56/0.3 mm	loads	₹2,900–₹3,300
Armoured			Outdoor, underground	
Cable (3-core)	4.0 / 6.0	Solid/Stranded	supply	₹50–₹80 per meter
Multi-core	1.5 x 3			
Flexible	Core	Flexible stranded	Appliances, sub-circuits	₹25–₹40 per meter

#### 4.3 STUDY OF CURRENT SENARIO OF MATERIAL MANAGEMENT OF SITE

Table 6: Study of current scenario of material management of site

Parameter	Small-Scale Project	Medium-Scale Project	Large-Scale Project
Project Cost	Up to ₹50 Lakhs	₹50 Lakhs – ₹5 Crores	Above ₹5 Crores
Project Type	Individual homes, small shops	Apartments, schools, office buildings	Malls, factories, highways, hospitals
Plot Area	Below 5,000 sq.ft.	5,000 – 50,000 sq.ft.	Above 50,000 sq.ft.



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Team Size	5–15 workers	15–50 workers	50+ workers, multiple subcontractors
Project Duration	1–8 months	8–18 months	18+ months
Material Variety	Limited (cement, sand, bricks, steel)	Moderate (multiple finishes, fittings)	Wide range (structural, MEP, specialized materials)
Storage Area	Limited or on-site temporary storage	On-site with partial warehousing	Dedicated warehouses and off-site storage
Management Style	Informal, site engineer or owner-driven	Semi-formal with a site manager	Formal with full material management team

Parameter	Small-Scale Project	Medium-Scale Project	Large-Scale Project
Technology Used	Manual tracking, paper- based	Excel, basic software	ERP systems, material tracking software, BIM
Procurement Method	Local vendors, cash purchases	Bulk orders, some tendering	Tendering, rate contracts, centralized procurement
Material Registration	Manual logbooks or notebooks	Excel sheets maintained by site/store in-charge	Customized software with barcode/RFID integration
Communication Method	Orally (on-site discussions or phone calls)	Mostly oral, with some WhatsApp or Excel sharing	Formal through notifications, emails, project management apps



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Role of Material Management	Basic ensure availability of core materials	Moderate planning, tracking, reducing waste	Critical cost control, inventory optimization, timely delivery
Person Responsible	Site engineer or contractor (multi- tasking)	Store in-charge or site manager	Dedicated store manager + purchase officer + material team
Challenges	Stock outs, wastage due to poor planning	Coordination issues, tracking gaps	Complex logistics, theft risk, high-volume procurement

#### 4.4. INVENTORY MANAGEMENT OF MATERIAL

Inventory Management Flow (Manufacturing → Construction Site)





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#### 4.4.1 Key components of construction inventory management

Component	Description
Tracking	Utilizing technologies like Radio Frequency identification barcode scanners to properly monitor all construction mate and equipment, ensuring accurate records and preventing lo theft.

Table 7: Key components of Construction Inventory management

Tracking	Utilizing technologies like Radio Frequency identification and barcode scanners to properly monitor all construction materials and equipment, ensuring accurate records and preventing loss or theft.
Ordering	Making informed purchasing decisions by ordering necessary materials at the right time and in the right quantities, avoiding overstocking or under stocking.
Storing	Implementing proper storage practices to prevent damage or degradation of materials, considering factors like temperature control, moisture levels, and secure organization.
Usage Monitoring	Observing and analyzing material usage patterns to gain insights for effective demand forecasting and resource optimization.
Waste Management	Planning to minimize waste generation, reusing or recycling materials when possible, and ensuring proper disposal of unavoidable waste to enhance sustainability.



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Effective inventory management of materials in construction involves systematically tracking and controlling the flow of materials from procurement to usage on-site. Proper ordering and procurement practices are essential to maintain the right balance between supply and demand, preventing delays due to shortages or wastage from overstocking. Once materials arrive at the site, they must be stored correctly to protect against damage, deterioration, or loss, with attention to factors such as weather conditions and security. Monitoring material usage regularly allows project managers to forecast future needs accurately, ensuring smooth project progress and reducing unexpected costs.



#### 4.5. STAGES OF INVENTORY MANAGEMENT





#### 1. Material Planning

This is the foundation of inventory management. It involves:

- **Estimating material requirements** based on the project schedule or production plan.
- Preparing a **Bill of Quantities (BOQ)** or **Bill of Materials (BOM)**.
- Considering lead times, buffer stock, and supplier capacities.
- Helps prevent **overstocking**, **understocking**, and project delays.

#### **Example:**

For a 2-storey residential building, the project engineer estimates 1000 bags of cement, 5 tons of steel, and 5000 bricks based on the BOQ and project schedule.

#### 2. Procurement

Once planning is done, the next step is to purchase the required materials:

- Identify and evaluate suppliers based on cost, reliability, and delivery.
- Issue purchase orders (POs) with defined specs and quantities.
- Ensure timely procurement aligned with project timelines and budget.
- Important for maintaining smooth workflow and cost control.

#### **Example:**

A purchase order is raised to **Cement** for 1000 bags of cement at ₹350 per bag, with a delivery timeline of 5 days.

#### **3. Receiving & Inspection**

When materials arrive:

- Inspect the quantity and quality of delivered goods.
- Match them with the purchase order and delivery challan.
- Record any discrepancies, damages, or missing items.
- Accept only materials that meet quality standards.

#### **Example:**

Out of 1000 cement bags received, 10 are torn and 5 are underweight. These are **rejected or returned** to the supplier. The remaining 985 are accepted and logged into the stock register.

#### 4. Storage & Handling

After inspection:

- Store materials safely and in an organized manner.
- Classify and label materials for easy identification.
- Follow handling practices to avoid spoilage, breakage, or theft.



• Proper storage ensures space optimization and safety compliance.

#### **Example:**

Cement bags are stacked on wooden pallets in a covered, dry area to avoid moisture damage. Steel is stored on racks with proper tagging.

#### 5. Issue & Usage

Materials are issued to teams as per requirements:

- Maintain a Material Requisition Form (MRF) or digital record.
- Track who is using what materials and where.
- Helps monitor actual consumption vs. planned usage.
- Aims to reduce material wastage and unauthorized use.

#### **Example:**

50 bags of cement are issued to the site for slab casting. An **issue slip** is filled out, recording the date, quantity, and purpose.

#### 6. Monitoring & Controlling

This stage ensures active control of inventory:

- Track stock levels, consumption rates, and usage patterns.
- Apply techniques like ABC analysis, FSN, or JIT.
- Set minimum stock levels, reorder points, and lead time buffers.
- Key for preventing stockouts and surpluses.

#### Example:

Inventory software shows that cement usage is higher than estimated. The site engineer checks for possible **wastage or pilferage**.

#### 7. Reordering & Replenishment

When stock levels fall below a predefined point:

- Automatically or manually trigger reorders.
- Use methods like Economic Order Quantity (EOQ) or Just-in-Time (JIT) for efficiency.
- Maintain safety stock for critical or frequently used items.
- Ensures uninterrupted project operations.

#### Example:

When cement stock drops to 100 bags (reorder point), an automatic alert is generated, and a new order for 500 bags is placed.



#### 8. Documentation & Reporting

Throughout the process, documentation is essential:

- Maintain records for all transactions: POs, GRNs, stock registers, MRFs, etc.
- Regular reporting for stock status, consumption, and discrepancies.
- Facilitates data-driven decision-making and project tracking.

#### **Example:**

Monthly inventory reports are generated showing opening stock, received, issued, and closing stock of materials. This is submitted to the project manager for review.

#### 9. Audit & Review

Periodic review is vital for accountability and improvement:

- Conduct physical stock verification or cycle counts.
- Reconcile with inventory records to find mismatches or losses.
- Analyze performance, cost efficiency, and material wastage.
- Implement corrective actions and update procedures as needed.

#### **Example:**

An internal audit reveals that 20 bags of cement are missing from the stock. A corrective action is initiated, and security protocols are strengthened.

#### 4.6 INVENTORY MANAGEMENT TECHNIQUES

#### 1. ABC Analysis

An inventory management technique known as ABC Analysis includes classifying inventory items according to their worth and level of significance to the company. The Pareto principle, which claims that roughly 80% of outcomes result from 20% of causes, is the foundation for that approach. It implies that a small fraction of inventory products account for a significant portion of the expenditures associated with managing inventory.

The ABC Analysis classifies inventory goods into three categories, A, B, and C, according to their worth and degree of significance to the company. The most valuable and significant things, or A items, often make up a tiny portion of the inventory items but are responsible for a significant portion of the inventory expenditures. B items make up a higher portion of the inventory items and expenditures and are of medium value and importance. C items aren't very valuable or important, and there are a lot of them, but it only cost a small portion of the inventory prices.



#### 2. Vendor Managed Inventory (VMI)

Vendor Managed Inventory (VMI) refers to a method of inventory control in which the supplier manages the consumer's inventory levels. It is a system that allows suppliers to monitor stock levels at their customers' locations and then ship replacement goods as needed. It helps organizations reduce the expenses involved with keeping an inventory, decrease the likelihood of stock outs, and increase the efficiency of their supply chains.

VMI is able to function because it creates a robust connection between the client and the supplier. It is the provider's responsibility to keep track of the quantity of stock owned at the customer's location and restock it as required. It implies that firms have a smaller selection of products since they rely on their suppliers to keep track of their inventory levels. VMI is able to aid businesses in increasing the effectiveness of their supply chains by reducing the lead times, improving the accuracy of orders, and lowering the risk of either running out of stock or having an excess inventory.

#### 3. Material Requirements Planning (MRP)

The method is utilized to effectively handle materials and components, guaranteeing their availability for production purposes. It computes the necessary materials and components for every product by considering the production schedule and the bill of materials. Subsequently, it generates a materials plan that outlines the quantity and timing of each material that must be ordered or manufactured. It is characterized by several essential components, including the utilization of a master production schedule (MPS) to specify the required quantity of each product, a bill of materials (BOM) to enumerate the constituents and raw materials necessary for the production of each product, and inventory data to furnish details on the overall inventory levels of each component and raw material.

#### 4. Economic Order Quantity (EOQ)

It is a way of supervising inventory that specifies the best number of items to buy to keep costs low while still having enough to meet customer needs. It looks at things like order costs, carrying costs, and demand rates to figure out the best amount to buy. It determines the optimal order number to keep stock costs low while ensuring enough stock to meet customer demand. It looks at things like order costs, carrying costs, and demand rates to figure out the best amount to buy. Businesses cut inventory holding costs while ensuring it has enough to meet consumer demand by estimating the ideal purchase quantity. Its calculation is influenced by several crucial factors, namely the yearly product demand, the unit cost, and the cost incurred per order. The formula computes the most favorable inventory quantity to be ordered, considering the relevant factors, including the holding cost per unit. The holding cost denotes the expenses incurred in storing the list.

#### 5. Just-in-time (JIT) Inventory Management

It is a strategic methodology that endeavors to reduce inventory levels by generating and transporting products precisely when needed to fulfill customer demand. The Just-In-Time (JIT) methodology has found the concept of manufacturing the appropriate quantity of goods exactly when and where they are required to minimize waste, curtail lead times, and enhance the overall effectiveness of the supply chain.



#### 6. FIFO & LIFO (First In, First Out & Last In, First Out)

The **First In, First Out (FIFO)** method is a widely used inventory management technique where the materials that are received first are also the ones used or issued first. This approach ensures that older stock is utilized before the newer stock, helping prevent issues such as deterioration, spoilage, or expiry especially important in construction materials like cement, paint, or chemicals, which may degrade over time.

For example, if cement bags are delivered on two different dates say April 1st and April 10<sup>th</sup> FIFO dictates that the April 1st batch is used first on site. This method not only reduces waste but also keeps inventory fresh and rotating properly. In terms of accounting, during periods of inflation, FIFO reflects older, lower-cost materials in the cost of goods sold, resulting in a higher net profit.

#### LIFO (Last In, First Out)

On the other hand, the **Last In, First Out (LIFO)** method works in the opposite way materials that are most recently received are used or issued first. This means that older inventory remains in storage while the newer stock is consumed. LIFO is less practical for industries like construction where materials have a shelf life or are prone to damage over time. Using LIFO in such cases can lead to wastage or obsolescence, especially if older materials are left unused for long periods.

For example, if bricks are delivered in multiple batches, LIFO would have the latest batch used first, regardless of whether earlier batches are still in stock. While LIFO can be beneficial from a tax or accounting perspective especially in inflationary environments, as it increases cost of goods sold and reduces taxable income it is not commonly adopted in practical site-level material management due to the risk of material aging and inefficiencies in stock rotation.

#### 4.7 SITE SURVEYS CASE STUDIES

A comprehensive study was conducted to gather data on material management practices at various construction sites. Multiple constructions were selected as part of study, allowing for a diverse range of data to be collected. The research team meticulously observed and documented the material management processes and practices employed at each sites, including procurement, storage, tracking and utilization of construction materials. The data collected from these different construction sites provided valuable insights into the current state of material management in the construction industry and served as a foundation for further analysis and recommendations for improvement.

The surveys were collected from small to mid-scale projects in primarily in congested tones of city. On site visits ensured authenticity of data and collection of photographic evidence required fir the understanding of the gap faced by the onsite project management teams.

CASE STUDY: 01 NAME OF SITE: Abhinav TYPE OF PROJECT: Residential CONFIGURATION: G+3 ADDRESS: Camp, Pune ESTIMATED COMPLETION: March 2025



#### **OBSERVATIONS:**

- **Poorly stacked materials** at site.
- Sand run off on road due to improper storage.
- Cement and ground surface is touching so comes in contact with water occasionally.
- Compromise in quality of material will result in compromise in quality of construction.
- The strutting on the lower floors for a slab doesn't allow the material to be stacked within the building line.
- Need off separate shed / room for material Inventory store.
- Material Management were done through Orally and What's app.



Figure 12: Case study 01 Site views



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Figure 13: Material Entry registration

CASE STUDY: 02 NAME OF SITE : Sai Essen Group PLOT AREA : 7847.60 Sqm TYPE OF PROJECT : Comm. & Resi. CONFIGURATION: B+G+2P+14 ADDRESS: Chikhali



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Figure 14: Case study 02 Site views

#### **OBSERVATIONS :**

- Material is place at assembly point, which easily accessible to everyone.
- **Material is not placed at basement** because the material keep and pull having extra charges and energy.
- **Double-check the Excel shee**t to confirm that all materials listed are correctly logged, and compare it with the actual material placement on-site.
- I see at site some **miscommunication** happened related lift and column.



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Figure 15: Material Entry registration

CASE STUDY: 03

NAME OF SITE : 24 Elite PLOT AREA : 899 Sqm TYPE OF PROJECT : Residential CONFIGURATION: G+06 ADDRESS: Moshi



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Figure 16: Case study 03 Site views

#### **OBSERVATIONS :**

- Material is place at assembly point, which easily accessible to everyone.
- Sand run off on road due to improper storage.
- Bricks are placed at ground floor. It order according to schedule.
- At ground parking floor storage point is assign.
- For Material register they did manually registration for record.



#### 4.7 INTERVIEWS WITH EXPERTS

#### **EXPERT: SITE ENGINEER**

**Q1:** What is your approach to material planning on medium-scale projects? A. "In my experience, material planning starts with a close review of the BOQ and work schedule. I break the project into phases foundation, structure, finishing and estimate material needs for each stage. This allows us to avoid overstocking and keep cash flow optimized."

#### Q2: How do you manage wastage and theft on-site?

A: "Strict gate pass systems and daily material issue slips are important. We also use CCTV and regular stock audits.

For example, in one project we noticed a discrepancy in steel usage, and it turned out some was being miscounted during bar bending."

Q3: What challenges do you face in procurement for small and medium projects? A:"Suppliers often prioritize larger clients. So, timely procurement becomes a challenge. We rely on long-term vendor relationships and sometimes pay a premium for on-time delivery. Also, fluctuating prices, especially for steel and cement, can mess with budgeting."

#### Q4: Which inventory technique do you use most often?

A: "ABC and Minimum-Maximum methods are our go-to.

For example, we always track high-value items like electrical fittings under tight control, while general items like sand are tracked in bulk."

#### Q5: How can technology improve inventory management in small projects?

A: "Even basic Excel templates can help, but now some small and medium scale projects use mobilebased inventory apps or cloud platforms. These tools offer real-time tracking, alerts for reordering, and reduce manual errors. I advise every site, even small ones, to digitize their inventory logs."

#### Q6: What's one common mistake small builders make in material management?

A: "They tend to ignore proper storage. Materials like cement or paint get spoiled just because they're left in the open. Proper stacking, moisture protection, and labelling can save lakhs in losses."

#### 4.8 DIFFERENTIATING LARGE-SCALE AND SMALL-SCALE INVENTORY MANAGEMENT SOFTWARE

Criteria	Large-Scale Projects	Small-Scale Projects	
Project Size & Budget	High budget, multi-phase, complex projects	Limited budget, simpler and smaller in scope	
Software Type	Enterprise-level ERP systems	Lightweight tools, Manual entries	



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Cost of Software	Expensive, subscription-based or custom- built	Affordable or free versions, open- source tools	
Users/Access Levels	Multiple users with defined roles (procurement, site, finance, etc.)	Few users, often handled by site engineer or contractor	
Features	Advanced: automated procurement, multi-site tracking, forecasting	Basic: stock in/out, manual entry, reorder alerts	
Integration	Integrates with HR, finance, billing, and project scheduling systems	Standalone or limited integration options	
Data Handling	Handles large datasets across multiple locations	Handles small, localized data	
Training Requirement	Requires professional training and support	Minimal training, user-friendly interfaces	
Reporting & Analytics	Real-time dashboards, predictive analytics	Basic reports, manual summaries	
Cloud & Mobile Access	Full cloud support with mobile and remote access	Often limited to local or What's app	
Customization	Highly customizable per project needs	Limited customization, mostly off-the- shelf features	
Examples	SAP ERP, Autodesk BIM 360	MS Excel, Manual entries, What's app	

 Table 8: Differentiating large-scale and small-scale inventory management software



#### 5.00 DATA ANALYSIS 5.1 INTERVIEW ANALYSIS

The data collected through structured questionnaires targeted at project stakeholders provided valuable insights into current inventory management practices in small and medium-scale construction projects. The participants included site engineers, contractors (owners), store managers, and clients involved in four different small-scale residential projects. Each respondent provided their perspective on various stages of inventory control, procurement, usage, and reporting.

The analysis revealed that **material planning** in most small projects is carried out manually by the site engineer in coordination with the contractor, often relying on past experience rather than using software tools.

In terms of **procurement**, the responses highlighted a reliance on weekly ordering practices based on immediate needs rather than a forecasted material plan.

**Receiving and inspection** processes were fairly basic across the studied projects. While some store managers used a checklist to verify quantity, only a few checked material quality thoroughly.

**Storage and handling** were major challenges, especially in congested urban sites. Most small-scale projects lacked dedicated storage space. Materials were stored in temporary sheds or open areas, covered.

When analysing the **issuance and usage** of materials, it was evident that formal documentation was rare. Most sites used a simple register or verbal communication to issue materials.

The study also examined the use of **inventory management techniques**. Techniques like FIFO (First In, First Out) were not actively followed, although a few site engineers claimed they practiced it informally.

In terms of **audits and stock reviews**, there was a general lack of regular practices. Two projects reported monthly audits by the contractor, but the process lacked documentation.

Finally, the questionnaire showed that stakeholders acknowledged the importance of proper inventory management in reducing costs and avoiding delays. However, the gap between awareness and implementation was clear. While clients expected efficient use of resources, contractors often struggled with time constraints and a lack of digital tools or trained personnel.



#### **5.2 APPENDIX**

# Inventory Management of Material For Small & Medium scale projects (Residential & Commercial)

\* Indicates required question

- 1. Site /Project Name \*
- 2. Address \*
- 3. Plot Area \*
- 4. No. of Floors \*

#### 5. Designation \*

Check all that apply.

Site Supervisor
Store Manager
Rcc Consultant
Contractor
Sub Contractor
Architect
Security Person



#### 6. How is material requirement planning done ?\*

Check all that apply.

- Manually using BOQ and engineer input
- Spreadsheet or software-based estimation
- Experience-based estimation by contractor

Vendor suggested quantities

#### 7. What method is used for procurement of materials ?\*

Check all that apply.

- Bulk purchasing at the beginning
- Weekly on-demand purchases
- Just-in-time delivery by supplier
- Phase-wise procurement with cost negotiation

#### 8. Audits or reviews conducted? \*

Check all that apply.

- Monthly internal review
- Only at project completion
- Third-party audit
- No formal audit

#### 9. How is material received and inspected ?\*

Check all that apply.

- Physical inspection by site supervisor
- Formal checklist with quality parameters
- Verbal confirmation from supplier
- Only quantity checked, not quality



#### 10. How is reordering of materials decided? \*

Check all that apply.

- Based on visual depletion
- After site staff request
- When minimum stock level is reached
- Weekly planning and reordering

#### 11. Which inventory technique is used? \*

Check all that apply.

- FIFO (First In, First Out)
- LIFO (Last In, First Out)
- ABC Analysis
- No formal method

#### 12. How frequently is inventory monitored ?\*

Check all that apply.

- Daily
- Weekly
- Monthly
- No regular monitoring

#### 13. What type of material storage is used on site? \*

Check all that apply.

Enclosed shed or container storage

Open yard with cover

- Vendor-managed storage and supply
- No structured storage, open placement



#### 14. How are materials issued to workers? \*

Check all that apply.

Manual register entry and signature

Digital logbook (Excel/app)

Verbal handover without record

Barcode or tag-based issue

#### 15. How are material shortages handled ? \*

Check all that apply.

Immediately informed to site engineer

Wait for routine order

Use alternative materials

Escalate to owner for urgent order

# 16. Do you think efficient inventory management of material affects overall project cost ?

Check all that apply.

Strongly agree

Agree

Disagree

Strongly disagree

#### 17. What is the primary purpose of material handling on a construction site ?\*

#### Check all that apply.

- To increase project cost
- To delay project completion
- To ensure materials are delivered to the right place at the right time
- to decrease worker productivity



#### 18. What is the most common inventory challenge? \*

Check all that apply.

- Overstocking or unused materials
- Theft or material loss
- Delay in reordering
- Improper estimation
- 19. If software is provided for inventory management of materials for small and medium-scale projects, how much would it help your project?

Check all that apply.

Extremely helpful Moderately helpful Slightly helpful

Not helpful

20. How do you rate the inventory management at your site \*

1 2 3 4 5 ☆☆☆☆☆ \*



#### **5.5.1 RESPONSES**

# Inventory Management of Material For Small & Medium scale projects (Residential & Commercial)

17 responses



Email



Copy



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Plot Area	
17 responses	
408.809 sq.m	
2400 SQM	
3000 sqft	
476 sqmt	- 1
516.8 sq m	
232.00 sqm	
8450	
8450sqft	_
1650.00 sq.m.	
	•



15 responses

Сору



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10

5

15



What method is used for procurement of materials ?



Audits or reviews conducted?

Copy

17 responses



#### How is material received and inspected ?

Copy

17 responses











How frequently is inventory monitored ?

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17 responses

17 responses









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If software is provided for inventory management of materials for Copy





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#### 6. FINDINGS AND PROPOSALS

#### 6.1 COMPARATIVE SOFTWARE OF SMALL, MEDIUM AND LARGE SCALE PROJECTS

Small-scale software tools are low-cost and simple but lack automation. Medium-scale tools offer a balance of control and usability with basic analytics. Large-scale systems are advanced, integrated, and suitable for complex operations.

Software Feature	Small-Scale Projects	Medium-Scale Projects	Large-Scale Projects
Material Estimation	Manual entry in Excel or notebooks	Software-based BOQ import, automated calculation	Integrated with BIM, BOQ auto-sync
Real-Time Stock Monitoring	Not available or manually updated	Partial (via cloud-based tools or mobile apps)	Fully automated with real-time dashboard & sensors
Procurement Management	Manual orders via calls or WhatsApp	Software tracks supplier lists, quotes, and orders	Integrated procurement module with vendor comparison
Reorder Level Alerts	Not available	Custom alerts based on minimum stock	Predictive reordering using AI

#### Table 10: Comparative software of small, medium and large scale projects



Software Feature	Small-Scale Projects	Medium-Scale Projects	Large-Scale Projects
Material Issue & Usage Logs	Manual registers maintained	App-based logging with date and user info	RFID/barcode scanning with centralized logs
Multi-site Inventory Handling	Not required (usually 1 site only)	Supports 2–3 active sites	Multi-location tracking with consolidated reporting
Inventory Reporting & Analytics	Simple manual reports (weekly/monthly)	Auto-generated usage, wastage, and reorder reports	Dynamic dashboards, live KPIs, data visualization
Audit & Review Features	Limited or manual cross-checks	Weekly/monthly digital audits	Role-based access, automatic audit trails
User Access Controls	Minimal (one or two users only)	User roles like admin, storekeeper, manager	Multi-level access with hierarchy and approval flow
Cloud and Mobile Access	Optional (e.g., Google Sheets)	Mobile apps and cloud- based storage	Always cloud-based with mobile, desktop integration
Integration with Finance & Billing	Not available	Links to Tally, QuickBooks	Full ERP integration with financial modules
Support & Training Needs	Self-learn or minimal training	Basic vendor support	Dedicated onboarding, 24/7 support, and system integrators



#### 6.2 SOFTWARE PROPOSAL: INVENTORY MANAGEMENT OF MATERIAL

# Proposal for Mobile Application Inventory Management of Material for Small and Medium-Scale Projects (Residential & Commercial Buildings)

#### **1. INTRODUCTION**

Effective inventory management is a key component in the success of construction projects, especially for small and medium-scale residential and commercial buildings. These projects often involve tight budgets, timelines, and multiple stakeholders, making it crucial to ensure materials are available when needed and efficiently tracked. Traditionally, managing materials is done manually, leading to errors, delays, and inefficiencies. The proposed mobile application aims to digitalize the entire material management process, providing a streamlined, user-friendly platform to track and manage materials, from warehouse to project site.

#### **2. OBJECTIVES**

The primary goals of the mobile application are:

• **Digital Material Entry:** Replace the outdated manual processes by enabling digital entry of material details such as the date, person responsible, company name, received quantity, and used quantity.

• **Tracking from Warehouse to Site:** Provide real-time tracking of materials from storage to the actual project site, ensuring full visibility of the material movement.

• **Material Photos and Quantities:** Allow users to upload and view images of materials, along with the corresponding quantities for each specific project area.

• **Stock-Out :** The app will show us that how much material is have on site.

• **Challan Upload & Verification:** Enable users to upload challans, serving as digital records for material receipts and verifications for accountability and audit purposes.



#### **3. FEATURES OF THE APPLICATION**





#### 1. **Digital Material Entry:**

• Users (e.g., store managers, contractors, or project managers) can enter material details such as the receipt date, the name of the person receiving the materials, the company supplying the materials, and the quantities received or used.

• This will help track material flow and consumption efficiently, providing accurate data onsite.

#### 2. Material Display with Photos:

• Photos of materials can be uploaded into the app alongside their corresponding quantities. This helps users visually identify materials, reducing confusion on-site about the availability or correct type of material.

• For specific project areas, materials can be tagged and easily tracked based on their location, ensuring that the right materials are delivered to the right place.

#### 3. Material used , remaining & wastage :

• Users can monitor material consumption, remaining stock, and wastage in real time, helping to reduce losses and improve budget and order accuracy.

#### 4. Challan Upload:

• Users can upload challans, which are digital receipts or invoices that confirm the delivery of materials.

• These challans can be attached to specific material entries, ensuring that there is a record of each delivery for auditing purposes. The upload process can include digital signatures or QR codes for verification.

#### 5. **Real-time Data Sharing:**

• The app will allow for real-time data sharing between the project site, warehouse, and other stakeholders (e.g., consultants, architects).

• This facilitates quick decision-making and ensures all parties are up-to-date on inventory status, helping to reduce delays caused by miscommunication.

#### 6. Monitoring & Controlling :

• Site engineer calculate the precise material requirements based on the project design and structural needs, ensuring no over-ordering. The store manager tracks material inventory, monitors usage on-site, and enforces proper handling and storage to minimize waste, ensuring that materials are used efficiently and stored in optimal conditions.

• Waste is controlled by accurate material estimation, efficient storage, and proper handling procedures.

#### 7. **Proof of Document & Data :**

• The software stores long-term records of material prices, quantities, and usage data, ensuring reliable historical proof for audits and future planning.



#### 8. User Roles & Permissions:

• Different stakeholders (e.g., project managers, store managers, Site engineer) will have different access levels within the app.

• Store managers may have the ability to manage inventory, while site engineers may have access only to material specifications or usage data. This ensures that each user has the appropriate level of control and information.

#### **4. EXPECTED OUTCOMES**

By adopting this mobile application software for material management, the following benefits are expected:

1. **Improved Accuracy**: Digital tracking reduces human errors in material entries, quantities, and stock levels.

2. **Reduced Wastage & Loss**: Real-time monitoring prevents over-ordering and minimizes material wastage.

3. **Better Resource Planning**: Access to real-time data allows project managers to plan material procurement based on current needs, not estimates.

4. **Enhanced Communication**: Facilitates better coordination between warehouse teams, site managers, and other stakeholders, ensuring timely material availability.

5. **Faster Decision-Making**: Immediate access to inventory data allows quicker resolution of issues, ensuring smooth project execution.

6. **Streamlined Documentation**: Digital handling of challans and documents reduces paperwork, simplifying audits and future references.

7. **Identification of Current Inventory Practices**: Helps to understand the existing inventory management practices on site.

8. **Recognition of Key Challenges**: Identifies the main obstacles faced in inventory management for better problem-solving.

9. **Customer Satisfaction & Order Fulfilment**: Ensures timely and accurate material supply, improving customer satisfaction and order fulfilment.

10. **Best Practices & Strategies**: Suggests strategies for optimizing inventory management based on the identified gaps and challenges.

11. **Cost Implications & Savings**: Analyses cost-saving opportunities by reducing material wastage, excess ordering, and inefficient processes.

12. **Impact on Supply Chain Efficiency**: Improves overall supply chain efficiency by integrating inventory management with project planning.

13. **Recommendations for Improvements**: Provides suggestions for both technology and process enhancements to optimize inventory management.



#### 7. CONCLUSION AND RECOMMENDATIONS

#### 7.1 CONCLUSION

Effective inventory management plays a critical role in ensuring the smooth execution of small and medium-scale construction projects. It not only controls material costs but also improves project timelines, reduces waste, and enhances overall site productivity. Based on the findings from live case studies and stakeholder feedback, it is evident that the lack of a structured inventory system leads to delays, material shortages, and budget overruns in many projects.

This mobile application provides a complete solution for **inventory management** in small and mediumscale construction projects. By integrating the workflow of **store managers**, **Site Engineer**, and **owners**, the app enhances communication, reduces the risk of material wastage, improves cost control, and ensures security and transparency.

1. **Real-time updates** on material arrival, usage, and stock levels.

2. **Strong proof** of material transactions, deliveries, and wastage.

3. **Improved decision-making** for future material procurement and construction phases.

4. **Efficient management** of costs, resources, and communication.

5. **Cost Control** Accurate material tracking prevents over-purchasing and theft, helping contractors stay within budget.

6. **Reduced Material Wastage** Timely tracking and issuance ensure materials are used efficiently, minimizing damage, spoilage, or expiration.

7. **Improved Project Timelines** By maintaining optimal stock levels, the risk of delays due to material shortages is reduced.

8. **Better Procurement Planning** Historical data and material usage trends help plan purchases in advance, avoiding last-minute ordering.

9. **Enhanced Accountability** Clear records of material receipts, usage, and stock help assign responsibility and reduce internal errors.

10. **Simplified Audits and Reporting** Organized inventory data makes it easier to conduct audits and generate reports for clients and internal review.

#### 7.2 RECOMMENDATIONS

#### 1. Use the Mobile App on Construction Sites

The mobile app should be used in small and medium projects to help manage materials easily and avoid using paper or Excel sheets.

#### 2. **Give Training to Users**

Provide simple training or video guides to help storekeepers, engineers, and owners learn how to use the app without confusion.



#### 3. Connect All Team Members in One App

The app should allow storekeepers, Site engineer, and owners to work together and share real-time updates, so everyone stays informed.

#### 4. Allow Use Without Internet (Offline Mode)

The app should work even if there is no internet on the site. Once connected to the internet, the data should automatically get saved online.

#### 5. Add Excel Sheet of Calculation of Quantity

The app should show simple Excel sheet like how much material is requires and the cost of materials helping with better planning.

#### 6. Send Alerts and Notifications

The app should give alerts when material stock is low or when too much material is being wasted, so quick action can be taken.

#### 7. Update the App Regularly

keep improving the app based on user feedback. Add useful features like barcode scanning or delivery tracking in the future.

#### 8. Keep Data Safe and Backed Up

All data should be stored safely online with backup options so that nothing is lost even if the phone or app has problems.

#### 8. FUTURE SCOPE STUDY

#### 1. Implementation of Digital Inventory Tracking Systems

• Adoption of cloud-based or mobile inventory management systems to monitor stock levels in realtime.

- Use of barcode technology to minimize errors and enhance efficiency in material tracking.
- Integration of inventory software with project management tools for better coordination.

#### 2. Artificial Intelligence (AI) & Data Analytics

• Use of AI-powered forecasting models to predict material demand based on historical data and project schedules.

- Data-driven decision-making to optimize procurement and reduce material wastage.
- Machine learning algorithms to analyze supplier performance and suggest improvements.

#### 3. Automation & Robotics in Inventory Management

• Use of automated storage and retrieval systems (AS/RS) for efficient material handling.

• Implementation of robotic solutions for material sorting and transportation within warehouses and construction sites.

#### 4. Sustainable & Green Inventory Management

• Prioritizing the procurement of eco-friendly and sustainable materials.



• Recycling and reusing excess materials to reduce waste and cost.

• Implementing a circular supply chain approach for long-term environmental and economic benefits.

#### 5. IoT (Internet of Things) for Smart Inventory Monitoring

- Deployment of IoT sensors on materials to track location, usage, and environmental conditions.
- Real-time alerts for stock shortages, excessive usage, or material deterioration.
- Integration with predictive maintenance systems for better asset management.

#### 6. Improved Supplier Collaboration & Just-in-Time (JIT) Delivery

• Strengthening partnerships with suppliers to ensure timely material delivery and reduce excess inventory.

- Implementing a Just-in-Time (JIT) inventory strategy to minimize on-site storage needs.
- Utilizing blockchain for transparent and efficient supply chain management.

#### 7. Training & Skill Development for Workforce

- Conducting regular training sessions on best practices in inventory management.
- Encouraging the use of digital tools among site managers and procurement teams.
- Upskilling workers to efficiently handle modern inventory technologies.

#### 8. Regulatory Compliance & Standardization

• Ensuring compliance with industry standards and local regulations for material storage and handling.

- Developing standardized inventory management procedures across all projects.
- Establishing guidelines for safety stock levels to prevent shortages.

#### **10. Risk Management & Contingency Planning**

- Developing contingency plans for supply chain disruptions.
- Diversifying suppliers to reduce dependency on a single source.
- Conducting periodic risk assessments to mitigate potential inventory-related challenges.

In essence, the **Site Engineer** is the technical overseer, the **Owner** is the financial and overall project manager, and the **Store Manager** is the operational executor ensuring that materials are available, tracked, and documented efficiently. The app connects all these roles, ensuring seamless communication, real-time updates, and accountability throughout the construction process.



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