Implementation of refined material management system in construction industry by lean techniques using SPSS Tool

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Abstract— *Efficient material management is a cornerstone of successful construction project execution, directly impacting timelines, cost efficiency, and resource utilization. However, traditional material management practices often suffer from poor planning, inadequate tracking, and lack of real-time control, leading to delays, wastage, and budget overruns. This study presents the design and implementation of a Refined Material Management System (RMMS) aimed at overcoming these limitations in the construction industry. The proposed system emphasizes digital integration, real-time monitoring, optimized procurement strategies, and inventory automation to streamline the entire material lifecycle—from requisition to deployment on-site.*

A structured methodology involving system modeling, stakeholder input, and field implementation was adopted. The effectiveness of RMMS was evaluated through a case study conducted on an active construction site, comparing key performance indicators before and after system deployment. Results indicate a significant reduction in material wastage, improved delivery timelines, enhanced inventory accuracy, and better coordination among project teams. The refined system not only supports sustainable construction practices but also enhances decision-making and productivity.

This report contributes to the growing body of knowledge in construction project management by offering a practical and scalable framework that integrates modern technologies into conventional construction workflows. The findings advocate for industry-wide adoption of smart material management solutions to drive efficiency and sustainability in future infrastructure development.

Keywords: Material Management, Project Optimization, Digital Tracking, Cost Efficiency, Real-Time Monitoring, Resource Management.

INTRODUCTION

The construction industry is a multifaceted domain characterized by tight schedules, complex workflows, and resource-intensive operations. Among the various components that contribute to the success of a construction project, material management holds a central and strategic role. It is estimated that construction materials account for approximately 50–70% of the total project cost, highlighting the critical importance of efficient procurement, handling, and utilization.

However, in practice, many projects face persistent challenges such as inaccurate material forecasting, poor coordination between site and procurement teams, delays in delivery, theft or damage of materials, and excessive wastage—ultimately affecting the project's cost, timeline, and quality.

Traditional approaches to material management, which often rely on manual tracking, siloed communication, and reactive decision-making, are increasingly proving inadequate in today's fast-paced construction environments.

With the rising demand for infrastructure, the growing scale of projects, and the need for sustainable practices, there is a pressing demand for the adoption of refined, technology-integrated material management systems. These systems aim to introduce real-time visibility, data-driven decision-making, automation in inventory control, and seamless coordination across all project stakeholders.

Material management is a vital component of the construction industry, directly influencing project cost, duration, and quality.

Inefficient material handling often leads to delays, wastage, cost overruns, and reduced productivity on construction sites. In traditional construction practices, material management systems are often fragmented, lack real-time tracking, and are poorly integrated with planning and execution processes. As construction projects become more complex and time-sensitive, the need for a systematic, technology-driven approach to material planning, tracking, and control becomes crucial. This project focuses on the design and implementation of a refined material management system that integrates advanced planning tools, real-time tracking, and effective control strategies.

By leveraging digital solutions and incorporating Lean Construction principles, the refined system aims to enhance material flow, reduce wastage, and improve overall project performance. The system will be deployed on an active construction site to assess its effectiveness and analyzed using statistical tools such as SPSS to draw insights and provide recommendations for industry-wide adoption.

This study focuses on the design, development, and field implementation of a Refined Material Management System (RMMS) tailored specifically for construction projects. The system integrates digital tools such as barcoding, material tracking software, predictive analysis, and workflow optimization techniques to enhance efficiency, minimize delays, and reduce material wastage. By bridging the gap between material planning and on-site execution, the proposed RMMS strives to improve productivity, ensure cost control, and support sustainable construction practices.

This report outlines the current industry practices, identifies the challenges faced in conventional systems, and demonstrates the practical application of the refined system through a case study approach. The findings are expected to contribute meaningful insights for engineers, project managers, and decision-makers in adopting smarter, more adaptive material management methodologies to meet the evolving demands of the construction sector.

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This project focuses on the design and implementation of a refined material management system that integrates advanced planning tools, real-time tracking mechanisms, and effective control strategies to streamline the flow of materials. To ensure that the system's implementation is both efficient and measurable, statistical analysis using the SPSS tool (Statistical Package for the Social Sciences) will be conducted.

This analysis will evaluate various project performance metrics such as material delivery time, material wastage, inventory accuracy, cost efficiency, and labor productivity before and after system implementation. The use of SPSS allows for data-driven decision-making, uncovering patterns and correlations that may not be evident through manual observation alone.

Furthermore, by incorporating Lean Construction principles, the proposed system aims to minimize waste, enhance productivity, and ensure just-in-time material availability. The ultimate goal is to improve overall project performance and provide a scalable model for material management practices that can be recommended across the construction industry.

Goal of Work

This study aims to create and execute a Refined Material Management System (RMMS) to improve the efficiency, accuracy, and reliability of material handling in the construction industry.

Objectives

- Analyze shortcomings and limitations of current material management in construction.
- Design and develop a refined material management system integrating planning, tracking, and control.
- Implement the system on an active construction site and assess its effectiveness.
- Evaluate the system's impact on project performance metrics using SPSS tool.
- Provide industry-wide recommendations for material management practice improvement using Lean Technology.

Problem Statement

Material management is crucial for construction projects, but current practices are fragmented and inadequately integrated. This leads to issues like material shortages, excess inventory, delayed deliveries, wastage, and miscommunication. A refined material management system is needed to integrate planning, tracking, and control mechanisms, demonstrating measurable improvements in project performance. Implementing Lean Technology principles can minimize waste, optimize resource use, and streamline material flow.

Research Methodology

In this investigation, with reference to the different sources, it is concluded that the building quality will be strengthened as follows for medium-to large-scale construction sites with lean technology or lean technological principles. Evaluation of non-value-added operating variables for different forms of work/product and waste in terms of material, time and effort generated in construction activities is mainly due to its wide area of fieldwork through the observation of project site visits.

The preparation of a matrix for the detection of waste is intended for the study of waste in the various tasks engaged in the exercise. Production and analysis of all details related to specific incidents and aspects.

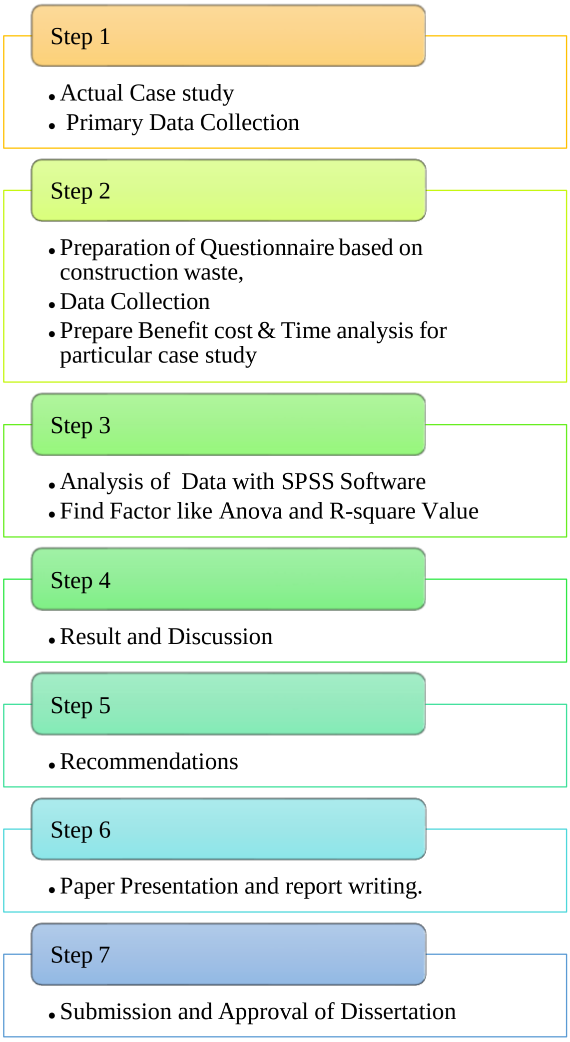

Figure1.3: Methodology Flow Chart

Adjust lean production and lean technology activities to reduce non-value-added activity or pollution and optimize the productivity of the construction industry. Testing and reassessing the true effects and findings of construction operations and processes for the construction industry.

The cost of building is the cost of value-added. Failed to rework the (due to design errors detected during design) Value-free added information and workflow appropriate partnership flow for heavy machinery and main conditions are established. Minimize physical and process emissions.

In this investigation with reference to various papers, it is concluded that for any medium to large scale construction site applying construction waste technique will increase the productivity and reduces wastage of the construction in following manner.

1) To find out the various sources of waste generation in terms of material, and time required for recycling and reuse of construction waste and efforts generated in construction activities.
2) For further study in construction wastes take a case study that includes all construction activities. For that particular case study cost-time management will be done.
3) The material wastage generate on site will be measured and maximum amount of material will reuse and recycle to minimize waste. To find cost required to recycle and reuse using cost benefit analysis.
4) To find the factor of construction wastes prepare a questionaries related to wastages to know current scenario about construction waste management.
5) Collect all data regarding the particular survey and the respond of survey will analyze using SPSS software to find the frequency of question responses.
6) For finding factor of construction waste use Relative importance index in which rank shows which factor is more concern to wastages generate on site.

- Rework (due to design errors detected during design)
- Non-value-adding activities in information and work flows

- Waste identification,
- Source separation and collection;
- Waste logistics;
- Waste processing;
- Quality management;
- Policy and framework conditions

To verify and re-evaluated the status of existing productivity and performances on construction activities and processes for construction industries. The cost of design is made up of costs of value-adding activities and waste. The waste in the design process is formed by.

Research Framework

Analysis of SPSS Software

Analysis of the questionnaires survey was done using IBM SPSS Software. SPSS Statistics is a software package used for statistical analysis. The software name originally stood for Statistical Package for the Social Sciences (SPSS), reflecting the original market. It is a Windows based program that can be used to perform data entry and analysis and to create tables and graphs. It is capable of handling large amounts of data and can perform all of the analyses covered in the text and much more.

It is a widely used program for statistical analysis in social science. It is also used by market researchers, health researchers, survey companies, government, education researchers, marketing organizations, data miners, and others. All the responses obtained from the questionnaires are entered in to the software. First, the variables or the questions are entered in the data view, then, the responses are entered into the software from the various data entered into the software, frequency can be found which is used to determine the importance factor.

SPSS data View

The Questionary Survey responses were reported in excel file. After opening data, SPSS displays them in a spread sheet-like fashion as shown in below figure. The excel file was export in data View and check the values and other information in spread sheet

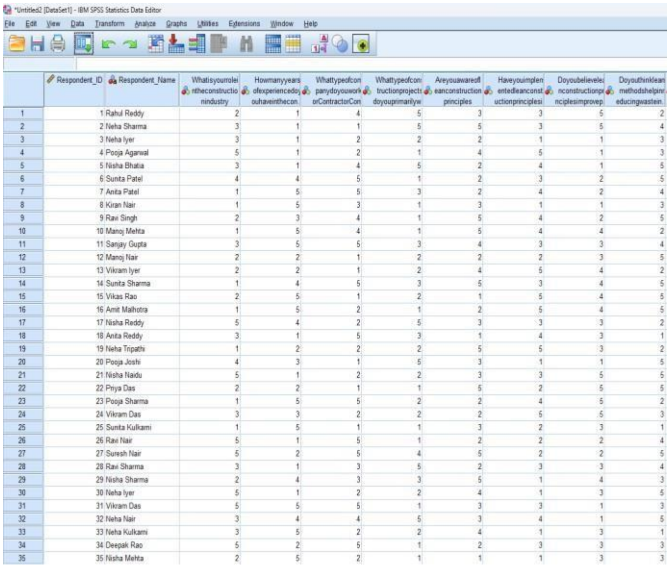

Figure1.4: SPSS Data view

SPSS Variable View

An SPSS data file always has a second sheet called variable view. It shows the metadata associated with the data. Metadata is information about the meaning of variables and data values. In Variable View, different columns are displayed. Each line corresponds to a variable

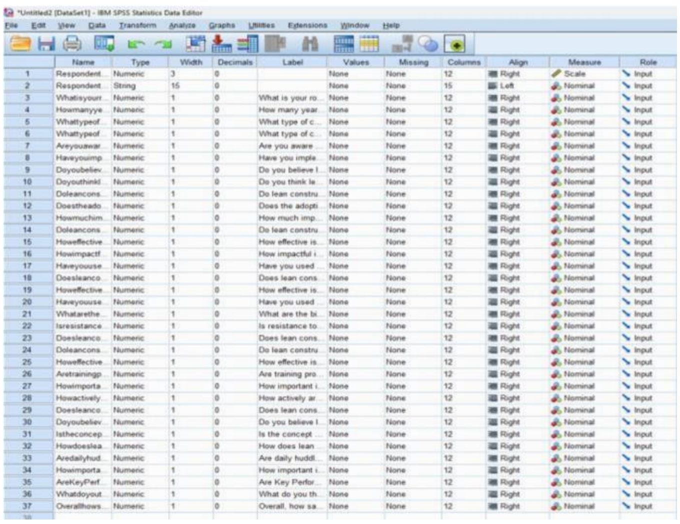

Figure1.5: SPSS Variable View

A variable is simply a quantity of something, which varies and can be measured, such as height, weight, number of children, educational level, gender and so forth. Name of the variable it is your own choice, but make it understandable and do not use numbers or symbols as the first letter since SPSS will not accept it. Moreover, you cannot use spaces in the name. The name of variable was used such as EMI, Construction material etc. The variable view spread sheet is shown in the below figure.

SPSS Data analysis

SPSS can open all sorts of data and display them -and their metadata- in two sheets in its Data Editor window. In our data contain a variable holding respondents on related question, we can compute the frequency by navigating to Descriptive Statistics as shown in below figure. For better understanding and detailed study pie charts and Bar chart option is also selected.

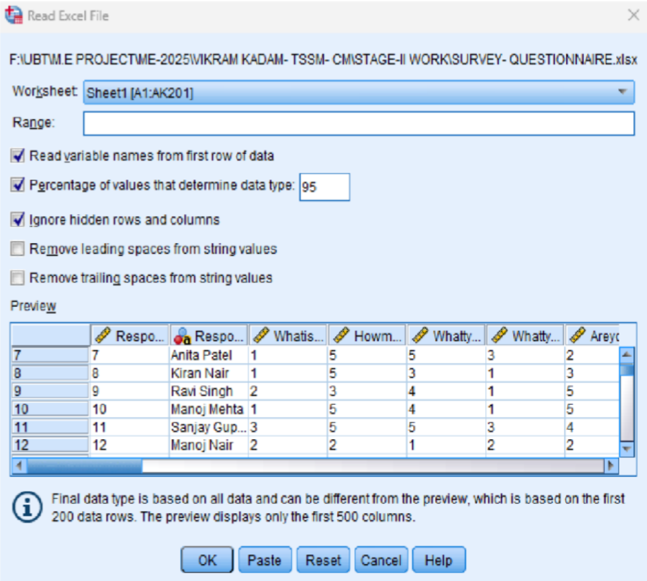

Figure1.6: SPSS Data analysis

SPSS Output Window

After clicking Ok, a new window opens up, SPSS output viewer window. It holds a nice table with all statistics on all variables we chose. The screenshot below shows what it looks like. As we see, the Output Viewer window has a different layout and structure than the Data Editor window we saw earlier. Creating output in SPSS does not change our data in any way; unlike Excel, SPSS uses different windows for data and research outcomes based on those data.

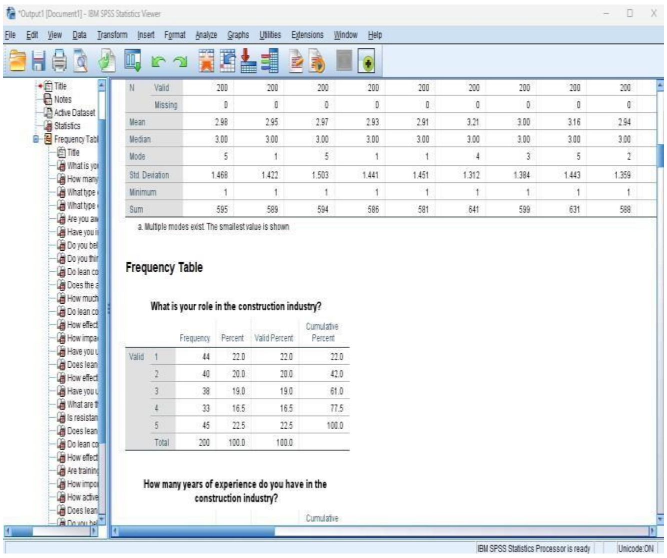

Figure1.7: Output File

Frequency Table

With India in mind, it introduces the idea of building. However, companies implementing lean construction tools and strategies from a corporate point of view are unlikely to maintain their use or achieve maximum advantages from the implementation of construction because their operation is not accompanied by sufficient strategic planning.

CONCLUSION

The refined material management system developed and implemented in this study addresses the key inefficiencies present in traditional construction practices. By integrating real-time tracking, planning, and control features, the system significantly improves material availability, reduces wastage, and enhances overall site productivity. The application of Lean Construction principles further contributed to minimizing non-value-adding activities, resulting in cost and time savings. The statistical analysis performed using SPSS provided clear, evidence-based insights into the system's impact on various performance metrics, including inventory accuracy, material delivery timelines, and cost control. These findings confirm that adopting a structured and data-driven material management approach can lead to more efficient and successful construction project execution.

Future Scope

- Integration with IoT and RFID Technology: Future enhancements can include integration with IoT sensors and RFID tags for automatic tracking of materials in real time, reducing human error and increasing efficiency.
- Mobile and Cloud-Based Platforms: Developing a cloud-enabled, mobile-accessible version of the system will allow for better coordination among site engineers, warehouse teams, and project managers.
- Predictive Analytics: By integrating advanced machine learning algorithms, the system can be enhanced to predict material shortages or delays before they occur, further optimizing planning and procurement.
- Scalability for Larger Projects: The system can be scaled and customized for mega infrastructure or multi-site construction projects with higher complexity and material volume.
- Environmental Impact Monitoring: Future versions of the system could also evaluate the carbon footprint or sustainability of material usage to align with green construction practices.
- Integration with ERP and BIM: Linking the refined system with Enterprise Resource Planning (ERP) and Building Information Modeling (BIM) tools can ensure seamless information flow across departments.

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