# Implementing Lean Principle in Construction of Project Management

Mohammed Hassan Uddin [1], Dr.K.Mohammed Imthathullah khan [2]

[1]*Student of M.E (Construction Management) in Lords Institute of Engineering and Technology Hyderabad India*

[2]*Associate professor of civil engineering at Lords Institute of Engineering and Technology Hyderabad India*

***Abstract*—Lean construction is a transformative approach to project management that emphasizes value creation, waste reduction, and enhanced efficiency in construction processes. This case study examines the application of lean construction principles to a large-scale urban residential tower project. By employing tools such as Value Stream Mapping (VSM), the Last Planner System (LPS), and Building Information Modelling (BIM), the project team successfully addressed challenges related to scheduling delays, material waste, and communication gaps.**

**This case study aims to explore the implementation of Lean principles in a construction project, examining the benefits, challenges, and lessons learned. By applying Lean tools and techniques, such as value stream mapping, Last planner system, and visual management, we seek to improve the construction process, reduce waste, and enhance customer satisfaction. This research will contribute to the growing body of knowledge on Lean Construction, providing insights and practical guidance for construction professionals seeking to adopt Lean principles in their projects.**

**The implementation of lean methods led to significant improvements, including a 12% reduction in project duration, a 20% decrease in material wastage, and a 15% overall cost savings. Enhanced collaboration and safety measures resulted in a 25% reduction in workplace incidents, while the integration of digital tools improved quality and reduced rework by 30%. This study highlights the transformative potential of lean construction in achieving more efficient, sustainable, and cost-effective project outcomes, offering a practical framework for future construction.**

***Index Terms*—Lean construction, waste reduction and enhanced efficiency, employing tools, challenges, customer satisfaction, improved quality and reduced rework, sustainable, and cost-effective.**

## I. INTRODUCTION

Lean construction is a combination of operational research and practical development in design and construction with an adoption of lean manufacturing principles and practices to the end-to-end design and construction process. Lean Construction required the application of a robust programmatic framework to all repair, renovation, maintenance, and or new build activities. While each project may be unique, the application of LEAN fundamental should be applied consistently. Lean Construction is concerned with the alignment and holistic pursuit of concurrent and continuous improvements in all dimensions of the built and natural environment: design, construction, activation, maintenance, salvaging, and recycling. This approach tries to manage and improve construction processes with minimum cost and maximum value by considering customer needs.

1.1. Types of ‘Waste’ in the Construction:

- Defects: It includes incorrect installations, defects in fabrication and errors in punch lists. Not meeting the specified code is a further ‘Waste’. Also, work on in construction isn't measured
- Overproduction: This occurs once the fabric is fictional too early or stock material is within the warehouse or at the task web site. Printing a lot of blueprints or creating more copies of a report than required is associate degree production.
- Transportation: This ‘Waste’ happens once material has got to be moved round the look or from the lay-down or area to the installation purpose or when it's loaded on the truck or trailer

or when hauled to the task web site when it is dud.

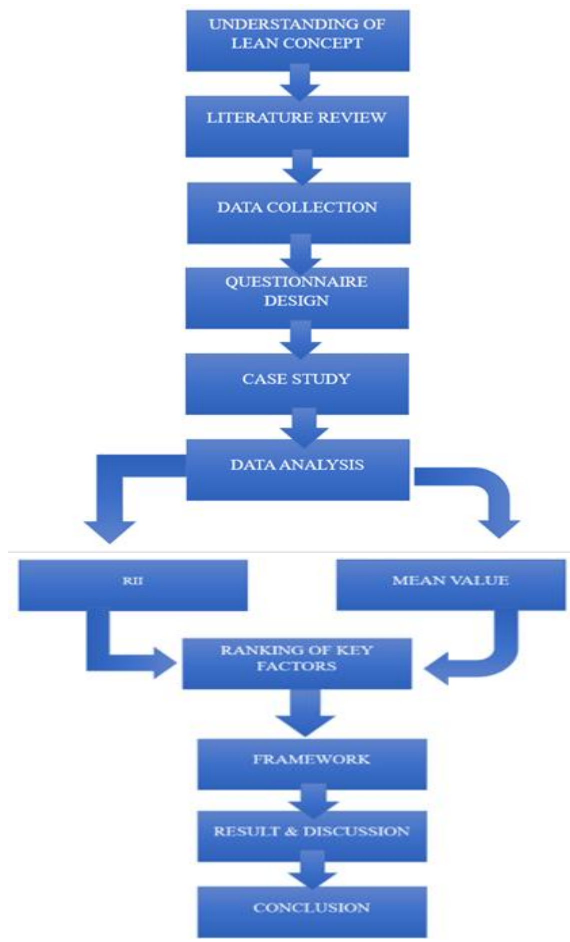
- Waiting: Construction Industry has associate degree abundance of this 'Waste'. This includes workers looking ahead to directions or materials at the task web site, unused time of onsite machinery thanks to looking ahead to material to be loaded and thus payment delays.
- Over processing: This 'Waste' includes over engineering requiring extra signatures on a requisition, multiple handling of timesheets, duplicate entries on forms and obtaining the estimates multiple times from the suppliers.
- Motion: These 'treasure hunts' happen once the fabric is hold on far from the task or when the staff seek for tools, material, or data. This 'Waste' additionally happens within the subject companies or job web site trailers once searching for files, reports, reference books, drawings, contracts or merchandiser catalogues.
- Inventory: This includes uncut materials, work-in-process (WIP), and finished fabrications. Some contractors claim that they need no inventory as a result of the job-cost all material. This 'Waste' includes spare components, unused tools, consumables, forms and copies, worker stashes, and private stockpiles.
- Not Utilizing Human Resources: Not considering someone's plan to boost a method or task.

## II-OBJECTIVE

The performed study is aimed to Re-engineering constructions project through LEAN principles. In terms to fulfil the aim of study objectives are:

a. To study LEAN methodology, its principles and application of the same in the project.
b. To identify the affecting factors for implementing LEAN technology in Infrastructure projects.
c. To design mechanism for the effective implementation of LEAN in Infrastructure projects.
d. To suggest various ways to implement effective lean construction in construction project.

## III. METHODOLOGY




3.1Questionnaire Survey

The structure of this questionnaire is consists of 32 questions and it's categorized under four criteria according to its type of waste. Totally 80 responses are taken from both, fresher's as well as experienced people from the industry. Freshers are selected because they are aware of the lean principle and experienced knows well about the kind of wastage and its reasons. People who have experience working with primary contractors and have participated in Civil residential projects are the participants in the survey. Data was gathered via an online survey. The design of questionnaire was prepared by using 5-point Likert scale. Using a five-point Likert scale with one denoting strongly disagree, second denoting disagree, third denoting Neutral, fourth denoting agree, and fifth denoting strongly agree, the respondents were asked to indicate the Limited degree of the elements.

3.2 Identifying factors affecting the lean principle in construction project

The process of developing a structured set of questions that are used to collect data from groups of participants in a research project is referred to as questionnaire design

a) Frequency of factor disturbing project cost
b) Frequency of factors disturbing project time
c) Frequency of factors disturbing project quality
d) LEAN awareness

3.3 DATA ANALYSIS

Data Analysis will be done using the relative importance index to find imperative factors and rank them accordingly, Reliability Analysis, Cronbach alpha conducted using SPSS.

3.4 RII value:

The Relative Importance Index (RII) is calculated for each indicator and ranked accordingly. It summarizes the importance of each factor as follows:

$$(\mathbf{RII}) = \frac{\sum W}{A * N}$$

W = The weight assigned by each respondent on a Likert scale ranging from 1 to 5, where:

1 - Strongly Disagree 2 - Disagree 3- Neutral
4-Agree 5- Strongly Agree

A = The highest possible weight (in this case, 5)

N = The total number of respondents in the sample

| Factors No. | QUESTIONS | RII |
|---|---|---|
| F1 | Change of orders throughout Unqualified hands Low productivity of labours | 0.812 |
| F2 | Repetition of labour because of errors | 0.698 |
| F3 | Inadequate website management and supervising | 0.875 |
| F4 | Communication and coordination issue | 0.907 |
| F5 | Ineffective designing and planning | 0.895 |
| F6 | Mistakes in documents | 0.812 |
| F7 | Inadequate details in drawings | 0.779 |
| F8 | Insufficient information assortment and survey before style | 0.674 |
| F9 | Delay in material delivery | 0.894 |
| F10 | Changes in material kind and specification throughout construction | 0.851 |
| F11 | Execution Low productivity and potency of kit | 0.618 |
| F12 | Unqualified hands | 0.676 |
| F13 | Low productivity of labours | 0.803 |
| F14 | Material Availability and Procurement: | 0.791 |
| F15 | Labor issues | 0.883 |
| F16 | Design and Documentation | 0.912 |
| F17 | Project Scope and Complexity | 0.872 |
| F18 | Financial factors | 0.832 |
| F19 | External factors | 0.721 |
| F20 | Unacceptable construction methods | 0.753 |
| F21 | Unfortunate skill of labours | 0.681 |
| F22 | Mistake in documents | 0.784 |
| F23 | Insufficient drawing details | 0.831 |
| F24 | Low productivity | 0.692 |
| F25 | Insufficient Training and Education | 0.875 |
| F26 | Leadership and Management Support | 0.823 |
| F27 | Lack of Employee Engagement | 0.790 |
| F28 | Organizational culture | 0.765 |
| F29 | How frequently are Lean Construction principles applied in your projects? | 0.684 |
| F30 | How effective have Lean Construction practices been in improving project outcomes (cost, time, quality)? | 0.873 |
| F31 | Clear job contents, work time, material requirements, among other information are prepared before releasing a work task to a crew | 0.735 |
| F32 | Has your company implemented Lean Construction methods? | 0.893 |

Table No. 1 represent RII values of all the factors

3.5 Mean Value:

The mean score is calculated for each factor by summing all responses and dividing by the number of respondents. It provides a direct measure of central tendency and is useful for comparing average perceptions.

Formula: Mean=∑X \ N

Where: • ∑X= Sum of all Values • N = Number of Values

| Group | Key Factors | Mean / RII |
|---|---|---|
| A. Project Cost Disturbance | Communication gaps, Planning errors, Material delays, Labour quality | Mean: 0.805 |
| B. Project Time Disturbance | Labour issues, Design and documentation gaps, Procurement issues | Mean: 0.835 |
| C. Project Quality Disturbance | Drawing issues, Low productivity, Mistakes in documents | Mean: 0.748 |
| D. Lean Awareness | Training gaps, Management support, Cultural issues, Adoption of lean methods | Mean: 0.805 |

Table No. 2 represent mean value of all the factors

Reliability Analysis

Reliability analysis is a statistical technique used to assess the consistency and internal reliability of a measurement scale or instrument. It helps researchers determine the extent to which the items or questions in a survey or test measure the same construct or attribute consistently.

| Reliability Statistics | |
|---|---|
| Cronbach's Alpha | No. of Items |
| 0.805 | 32 |

Table No. 3 represent reliability Statistics.

| Cronbach's alpha | Internal consistency |
|---|---|
| a>0.9 | Excellent |
| 0.9 > a>0.8 | Good |
| 0.8> a >0.7 | Acceptable |
| 0.7> a>0.6 | Questionable |
| 0.6> a>0.5 | Poor |
| 0.5 > a | Unacceptable |

Table No. 4 Represent Cronbach's alpha

SPSS

SPSS (Statistical Package for the Social Sciences) is one of the most widely used statistical software packages in the world. Originally developed by IBM, SPSS is designed for data management, statistical analysis, and reporting. It has become an essential tool in various fields such as social sciences, health research, market research, education, and government, where data analysis is crucial for decision-making. SPSS offers a user-friendly interface combined with powerful analytical tools, making it accessible to both beginners and advanced users. Its versatility in handling large datasets, performing complex statistical tests, and generating detailed reports makes it a preferred choice for researchers and analysts. SPSS supports a wide range of statistical procedures, from basic descriptive statistics to complex multivariate analyses, which helps users extract meaningful insights from their data.

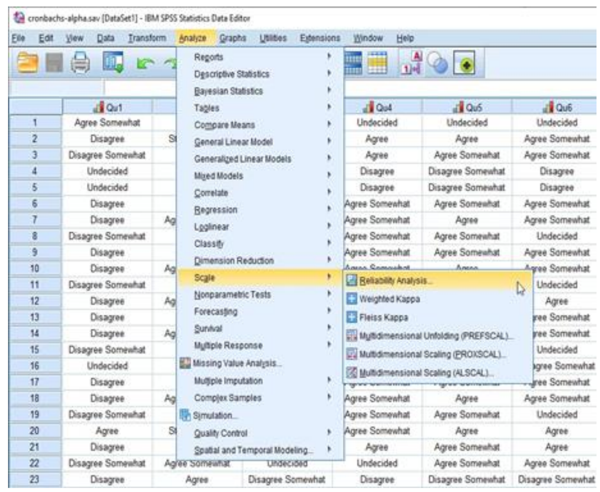
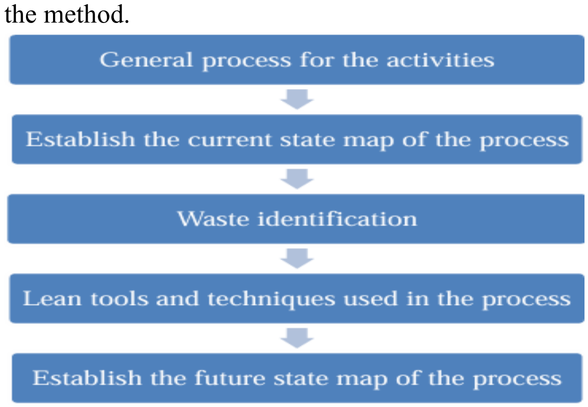


Fig.SPSS Interfaces

LEAN construction framework

LEAN construction framework

This chapter introduces a projected framework for the implementation of lean principles to inflate the Indian construction project performance. This framework was enforced to a Case Study to examine the possible enhancements that lean can do. the most purpose of the case study is to indicate a true current process for the prepared combine concrete works at a construction web site in Asian nation and to analyse the method.



## IV. RESULTS

The obtained data from all the places were analyzed by using Statistical Methods and each waste parameter were given grading depending upon their impact, in this study, an ordinal measurement scale 1 to 5 was used to determine the effect level. Respondents were asked to rank the factors affecting quality performance.

| Factors No. | QUESTIONS | **RII** | **RANK** |
|---|---|---|---|
| F1 | Change of orders throughout Unqualified hands Low productivity of labours | 0.812 | 16 |
| F2 | Repetition of labour because of errors | 0.698 | 26 |
| F3 | Inadequate website management and supervising | 0.875 | 7 |
| F4 | Communication and coordination issue | 0.907 | 2 |
| F5 | Ineffective designing and planning | 0.895 | 3 |
| F6 | Mistakes in documents | 0.812 | 15 |
| F7 | Inadequate details in drawings | 0.779 | 21 |
| F8 | Insufficient information assortment and survey before style | 0.674 | 31 |
| F9 | Delay in material delivery | 0.894 | 4 |
| F10 | Changes in material kind and specification throughout construction | 0.851 | 11 |
| F11 | Execution Low productivity and potency of kit | 0.618 | 32 |
| F12 | Unqualified hands | 0.676 | 30 |
| F13 | Low productivity of labours | 0.803 | 17 |
| F14 | Material Availability and Procurement: | 0.791 | 18 |
| F15 | Labor issues | 0.883 | 6 |
| F16 | Design and Documentation | 0.912 | 1 |
| F17 | Project Scope and Complexity | 0.872 | 10 |
| F18 | Financial factors | 0.832 | 12 |
| F19 | External factors | 0.721 | 25 |
| F20 | Unacceptable construction methods | 0.753 | 23 |
| F21 | Unfortunate skill of labours | 0.681 | 29 |
| F22 | Mistake in documents | 0.784 | 20 |
| F23 | Insufficient drawing details | 0.831 | 13 |
| F24 | Low productivity | 0.692 | 27 |
| F25 | Insufficient Training and Education | 0.875 | 8 |
| F26 | Leadership and Management Support | 0.823 | 14 |
| F27 | Lack of Employee Engagement | 0.790 | 19 |
| F28 | Organizational culture | 0.765 | 22 |
| F29 | How frequently are Lean Construction principles applied in your projects? | 0.684 | 28 |
| F30 | How effective have Lean Construction practices been in improving project outcomes (cost, time, quality)? | 0.873 | 9 |
| F31 | Clear job contents, work time, material requirements, among other information are prepared before releasing a work task to a crew | 0.735 | 24 |
| F32 | Has your company implemented Lean Construction methods? | 0.893 | 5 |

Table No. 5 RII value and Ranking

Material Waste Percentages and Causes

| S.No | Material | Material Waste (%) | Material Waste Causes |
|---|---|---|---|
| 1 | Cement | 10%- 12% | Poor supervisory system, Improper handling Bad storage Frequent transportation Lack of on-site material management |
| 2 | Concrete | 10%- | Poorly |

| | | | |
|---|---|---|---|
| | | 15% | constructed formwork<br>Poor supervisory system<br>Improper handling<br>Lack of management team & labor awareness<br>Lack of quality management system |
| 3 | Ready mix plaster | 5%-8% | Poor technology<br>Poor construction techniques |
| 4 | Sand | 10%-15% | Oversized building components<br>Bad storage |
| 5 | Bricks | 5%-10% | Improper handling<br>Poor supervisory system |
| 6 | Blocks | 8%-12% | Unsuitable cutting<br>Lack of skilled workers & subcontractors<br>Damage during transportation |
| 7 | Steel | 4%-8% | Cutting and bending waste<br>Unsuitable cutting<br>Lack of proper supervision team<br>Poor construction techniques |
| 8 | Tiles, Granite | 5%-6% | Unsuitable cutting<br>Lack of skilled workers & subcontractors<br>Manufacturing defects<br>Forced cutting<br>Selection of low-quality materials |
| 9 | Wood | 5%-7% | Cutting waste<br>Decay woods |
| 10 | Gypsum | 30%-40% | Poor technology |
| 11 | Paint | 5%-8% | Improper handling<br>Lack of labor awareness<br>Rework due to workers' errors<br>Selection of low-quality materials |
| 12 | Electrical wires | 2%-4% | Cutting waste |
| 13 | Plumbing fittings | 7%-8% | Cutting waste<br>Poor handling<br>Unsuitable cutting |
| 14 | Packaging | 30%-40% | Packaging waste of tiles<br>Plumbing fittings<br>Electrical fittings, etc. |

Table No. 6 Material Waste Percentages and Causes

Key Observations:

- High Waste Materials: Gypsum and packaging have the highest waste percentages (30%-40%).
- Common Causes: Poor supervision, improper handling, unsuitable cutting, and lack of skilled workers are recurring causes across different materials.
- Material Specific Issues: Some materials have specific issues, such as decay for wood, or manufacturing defects for tiles and granite.

.

## V. CONCLUSION

This study has demonstrated the practical value and transformative potential of Lean Construction principles in improving the performance of infrastructure projects in India. By applying Lean methodologies such as Value Stream Mapping (VSM), the Last Planner System (LPS), and Building Information Modelling (BIM), along with tools like the 5S Methodology and Six Sigma, the research has highlighted their impact in minimizing waste, improving scheduling, and enhancing communication.

The analysis of two case studies revealed significant improvements across key performance metrics. Implementation of Lean practices resulted in a 12% reduction in project duration, 20% decrease in material wastage, 15% cost savings, and a 25% reduction in workplace incidents. Furthermore, quality was improved, with a 30% decrease in rework. These findings validate the role of Lean tools in achieving sustainable, cost-effective, and timely project delivery.

Despite these benefits, the study also identified several barriers to Lean adoption, including lack of awareness, insufficient training, organizational resistance, and poor communication. The data collected via surveys and analyzed using the Relative Importance Index (RII) and Mean Value methods emphasized that ineffective planning, communication gaps, and unqualified labor are among the most critical issues impacting project outcomes.

The proposed Lean Construction Framework offers a structured approach for implementing Lean practices effectively. For broader adoption in India, it is imperative to invest in workforce training, promote industry awareness, and foster a culture of continuous improvement. This research serves as a guide for construction professionals aiming to embrace Lean methodologies to enhance project performance and align with global best practices.

In conclusion, Lean Construction is not just a set of tools, but a cultural shift that promises enhanced efficiency, value delivery, and long-term sustainability in the Indian construction sector.

## REFERENCES

[1] Dave Brown and Julia Tell (2025), "Lean Construction: Principles, Implementation & Benefits" https://www.procore.com/library/lean-construction

[2] Abdelazim Ibrahim, Tarek Zayed (2025), "Bridging barriers to lean construction adoption in megaprojects" https://link.springer.com/article/10.1007/s10668-025-06424-9#Sec8

[3] Mrinmoyee Bhattacharya, (2025),"Reinventing Lean: An Optimized and Adaptive Approach to ConstructionEfficiency"https://www.irjet.net/archives/V12/i5/IRJET-V12I5132.pdf

[4] Yetty Dwi Lestari (2024), "Implementation of Lean Construction to Reduce Waste with the Value Stream Analysis Tools (VALSAT) Method" https://ejournal.unair.ac.id/SABR/article/view/62011https://www.getpowerplay.in/resources/blogs/lean-construction/

[5] Vinayak Pavate, Sayali Thorushe, Siddhi Dharmadhikari, Gayatri Dalavi (2024), "A Review - Factors Affecting on Time, Cost and Quality of Construction" https://www.ijraset.com/research-paper/a-review-factors-affecting-on-time-cost-and-quality-of-construction

[6] Rajparsad j, Pagadala Saimohan Reddy (2022), "Implementation of Lean Techniques in ConstructionProjects"https://www.researchgate.net/publication/357949327 Implementation of Lean_ Techniques_ in_ Construction_ Projects

[7] Sina Moradi and Piia Sormunen (2023), "Implementing Lean Construction: A Literature Study of Barriers, Enablers, and Implications" https://doi.org/10.3390/buildings13020556

[8] Nikhitha Adepu, Apurva Pamidimukkala, K Loganathan (2023), "Analysing the factors affecting construction project schedules" https://www.sciencedirect.com/science/article/pii/S2666721523000212

[9] Shakil Ahmed and Iffat Haq (2020), "Implementation of lean construction in the construction industry in Bangladesh: awareness, benefits and challenges", https://www.researchgate.net/publication/340358885_Implementation_of_lean_construction_in_the_construction_industry_in_Bangladesh_awareness_benefits_and_challenges

[10] O. Babalola and O. Ibem (2019), "Implementation of lean practices in the construction industry",

https://www.sciencedirect.com/science/article/abs/pii/S0360132318306760

[11] Mohammad Darabseh (2019), "Lean Applications in Construction"https://www.researchgate.net/publication/337643725_Lean_Applications_in_Construction