



# ANALYSIS OF LEAN CONSTRUCTION METHODOLOGIES IN THE INDIAN CONSTRUCTION

Manish Kumar Sharma<sup>1\*</sup>, Monu kumar<sup>2</sup>, Saurabh Kumar<sup>3</sup>

## Abstract:

Lean construction is a highly effective managerial approach aimed at improving productivity within the construction industry. Extensive research has been conducted in recent years, with ongoing efforts to apply lean principles derived from the manufacturing sector to construction practises. The introduction of lean construction as a noble management tool aims to enhance efficiency and minimise waste. However, the implementation of lean concepts in the Indian construction industry faces numerous challenges. Limited attention and a lack of familiarity with lean management principles among stakeholders such as builders, contractors, engineering firms, and project management entities hinder the widespread adoption of these principles in a construction project. This study focuses on identifying the primary obstacles to implementing lean techniques in the Indian construction industry through a comprehensive questionnaire survey and on-site practical implementations to develop a process map for ongoing projects. Survey results indicate that certain lean techniques require greater emphasis to optimise processes. The framework analysis reveals that Non-value-added (NVA) and Essential Non-value-added (ENVA) activities exert the most significant impact on project duration. Consequently, the proposed implementation of lean techniques successfully improves the efficiency of NVA and ENVA activities, resulting in substantial reductions in their durations

**Keywords:** Lean Construction, NVA, ENVA

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<sup>1\*,3</sup>Department of Civil Engineering, IIMT University, Meerut, Uttar Pradesh, India

**\*Corresponding Author:** Manish Kumar Sharma

\*Department of Civil Engineering, IIMT University, Meerut, Uttar Pradesh, India

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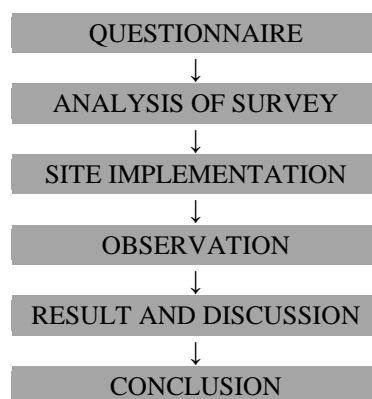
## 1. Introduction

Lean construction can be defined as a systematic approach to designing production systems with the aim of minimising waste materials, time, and efforts while maximising value. Despite the unorganised nature of the construction industry in India, it holds comparable value to other businesses. Embracing lean principles represents a promising investment for future projects, offering benefits and a confirmed return on investment. The Indian construction sector has witnessed an influx of new entrants, including corporate and management firms, contributing to recent infrastructure development. Increased competition among companies is driven by the significant demand and profit potential within the industry as a whole. However, a major challenge faced by the Indian construction industry is the availability of skilled labour. Unskilled labour and poor workmanship sometimes lead to concerns regarding project quality. To address this issue and ensure high-quality construction, firms need to leverage the latest innovative technologies. One such technique is lean management, which helps tackle labour-related problems and improve construction quality. Implementing lean techniques within the construction industry enhances profitability and project quality within a reasonable timeframe. The primary principle of lean management is to achieve more value by utilising scarce resources. Lean manufacturing tools can be adapted for construction projects and effectively implemented. Successful implementation of these tools heavily relies on the commitment of top management. Henry Mwanaki identifies the provision of inputs precisely when needed as the most significant barrier, while keeping required items in the right place is considered the easiest barrier to overcome. Mohd Arif Marhani et al. emphasise the importance of stakeholders' knowledge in implementing Lean construction principles effectively. However, stakeholders often lack understanding of basic lean construction technologies, preventing them from fully leveraging their potential benefits. Implementing lean construction practises maximises value and improves sustainability in the construction industry. Resource constraints pose significant challenges, which can be addressed through effective project planning and the application of lean manufacturing concepts. Organisational culture presents a major obstacle to implementing change. Overcoming resistance requires open discussions, conversations, and immediate actions to encourage employees to participate in the change process, thereby empowering them and reducing resistance. The

main barriers to implementing lean principles in the Indian construction industry include a lack of awareness regarding the need for adopting lean construction tools, supply chain uncertainty, a tendency to rely on traditional management tools, cultural and attitudinal issues, a lack of commitment from the top management, and non-participating management styles. Ashwin Amarshi Maru's analysis highlights the benefits of using lean methods in construction.

## 2. Methodology:

To accomplish the objectives of this study, a research methodology was employed, following the steps illustrated in Fig. 1. The formulation of the questionnaire involved a comprehensive review of relevant literature, ensuring a deep understanding of lean construction techniques along with their associated benefits and challenges. The questions were designed in a binary format (yes or no) to facilitate quick and efficient responses. Additionally, certain barriers were identified through a thorough examination of the literature, and respondents were requested to rate their probability of occurrence on a scale of 1 to 5. The questionnaire was distributed via email to a target sample of 50 civil engineering professionals, including contractors, site engineers, government employees, and project managers. Participants were requested to provide their perspectives by answering the questionnaire. Subsequently, the collected responses were analysed, focusing on the likelihood of barriers occurring, and the most probable barriers were identified and documented in the results section. The compilation of questionnaire responses enabled a clear understanding of the barriers that are most likely to be encountered.



**Figure 1.** Proposed Methodology

Consultants and contractors responded promptly to the survey, demonstrating their engagement with the topic. However, government employees, despite their involvement in large-scale community and social projects, neglected to

provide responses. The majority of consultants acknowledged the benefits of lean principles and expressed their belief that it would be a valuable initiative to minimise waste and improve efficiency in the Indian construction industry. The survey findings highlight several significant barriers to implementing lean practises. These barriers include:

1. Lack of awareness and understanding of lean principles.
2. Cultural and attitudinal challenges among stakeholders.
3. Commercial pressures affecting the adoption of lean practices.
4. Insufficient training opportunities related to lean construction.
5. Lengthy implementation time required for lean initiatives.
6. Inadequate commitment from top management.
7. Education issues impacting the integration of lean principles.

Addressing these barriers is crucial for successful lean implementation in the Indian construction industry.

### 3. Result & Discussion:

To implement lean techniques, a residential construction site was chosen as the site of observation for this study. The selected site is a residential building project situated on Kurshi Road in Lucknow, Uttar Pradesh. The building is a seven-story structure (G+6) with residential units. Table 1 provides key details about the project. The research primarily focused on the reinforced concrete (RCC) and concrete processes involved in constructing the building. After analysing the process map for all project activities, lean tools were applied, and their impact on the duration of the process was observed. The construction processes were thoroughly examined, and various

construction wastes were classified. Based on the actual data, suitable lean techniques were implemented to drive improvements, following these steps:

1. Enhancing the efficiency of value-added activities by implementing alternative methods.
2. Improving the work methods of essential non-value-added activities using lean techniques.
3. Eliminating non-value-added activities through effective planning and utilizing just-in-time techniques.
4. Selecting appropriate lean tools to achieve the aforementioned steps:

The efficiency of the implemented lean tools was calculated using literature data. The literature indicated that similar countries achieved a 25% to 31% reduction in project durations through the application of lean techniques. Therefore, a 25% improvement in each activity was considered a benchmark in this research.

**Table 1:** Project Details of Proposed site

Items	Description
Project Type	Building
Project Value	5 Cr
Contact Type	Premeasured/Design-Bid-Build
Scope of work	Concrete Works/Steel Structure
Project Duration	15 months

Table 2 presents the time saved for non-value-added (NVA), essential non-value-added (ENVA), and value-added (VA) activities after implementing lean techniques. The results reveal a significant reduction in duration (measured in days) following the application of lean tools. Specifically, NVA activities were reduced by 100%, while ENVA and VA activities experienced reductions of 25% and 20%, respectively, as indicated in Table 2.

**Table 2:** Time saved per cycle after imposing the proposed framework

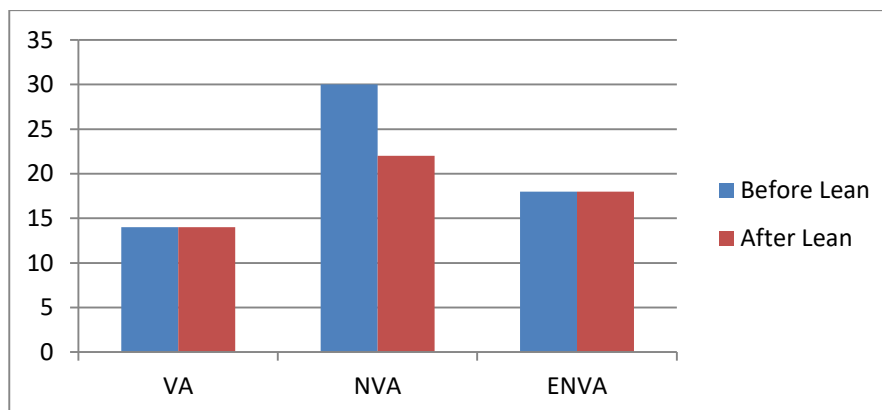
Types of Activity	Action	Preparation Process		Material Delivery/On-site transportation		Execution Process	
		Time Saved (Days)		Time Saved (Days)		Time Saved (Days)	
NVA	Eliminated/Reduced	37	100%	7	35%	17	25%
ENVA	Reduced/Improved	50	25%	1	22%	22.5	25%
VA	Reduced/Improved	10	20%	4	26%	21.5	25%
<b>Total</b>		<b>97 Days</b>		<b>12 Days</b>		<b>61 Days</b>	

Table 3 displays the decrease in the number of activities resulting from the implementation of the proposed framework. The number of non-value-added (NVA) activities can be reduced by 27%, while the number of essential non-value-added

(ENVA) and value-added (VA) activities cannot be reduced. In total, there is an overall reduction of 13% in the number of activities, as illustrated in Table 3. The quantitative analysis of the activity reduction is depicted in Figure 2.

**Table 3:** Number of activities after applying the proposed Framework

Activity Type	No. of activities Before Lean	Future Map (ongoing projects)	
		No. of activities After Lean	Reduction %
NVA	30	22	27%
ENVA	18	18	0%
VA	14	14	0%
<b>Total</b>	<b>62</b>	<b>54</b>	<b>13%</b>

**Figure 2:** Number of activities of Future map before & after Lean

#### 4. Conclusion:

Based on the study findings, it can be deduced that over 80% of the respondents confirmed that certain factors contribute to project delays in India. These factors include insufficient communication by the contractor, changes made to the issue order by the owner, discrepancies in document delivery, and commercial pressures. Additionally, 455 of the respondents were unaware of the lean concept, while 55% had limited awareness of it.

The outcomes of the site implementation revealed the impact of different activity types on the overall duration of the project. The factors influencing the adoption of lean tools significantly affected the percentage of improvement in process durations. It can be inferred that there were substantial reductions in durations measured in days following the implementation of lean tools, resulting in approximately a 25% reduction in project duration and a 13% reduction in process activities.

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