Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 10, October - 2025

The Importance of Implementing Lean Construction in Construction Projects in Indonesia

Nurlaelah
Civil Engineering Department, Faculty of Engineering,
UMJ, Jl. Cempaka Putih Tengah XXVII, Jakarta 10510,
Indonesia.

***Abstract*-This paper explores the implementation of Lean Construction in the Indonesian construction industry, focusing on its impact on improving project efficiency, reducing waste, and optimizing resource utilization. Lean Construction, a methodology derived from Lean Manufacturing, emphasizes value creation by eliminating non-value-added activities and fostering collaboration among all stakeholders. This study employs a qualitative research approach by exploring various literature related to the implementation of lean construction, both in Indonesia and in other countries. The findings suggest that adopting Lean Construction in Indonesia could address critical challenges in the sector, such as delays, budget overruns, and inefficient resource management, contributing to the industry's competitiveness and growth. Finally, the paper discusses the potential benefits of integrating Lean Construction with other innovative technologies, such as Building Information Modeling (BIM), to further streamline construction processes and achieve higher levels of project success.**

***Keywords*- lean construction; construction efficiency; waste reduction; Indonesia**

I. INTRODUCTION

With a population reaching 284.44 million based on BPS data in 2025, Indonesia is one of the most populous countries in Asia and is currently actively undertaking various construction projects, including the development of buildings, infrastructure, and other sectors. This contributes significantly to economic growth by creating jobs and stimulating related sectors such as manufacturing and transportation. On the other hand, construction activities often have negative environmental impacts, such as air pollution, material waste, and ecosystem degradation.

A construction project is a series of interrelated activities aimed at building infrastructure or physical structures. Since each project has unique characteristics and cannot be executed in exactly the same way, a variety of skills are required throughout the process. This uniqueness is one of the main distinguishing features of construction projects (Wangsadiputra, 2020). In addition, construction projects possess several characteristics, including having clear objectives, a defined budget, established quality standards, and a scheduled start and finish time. Implementation methods also vary, making the outcome of each project different. Furthermore, the intensity of activities within a project is dynamic and often undergoes changes during the execution process.

In its implementation, construction projects are often faced with various issues, including the generation of different types of waste during the construction process. Waste refers to activities that do not add value for the client or project owner and is one of the factors contributing to low productivity. Waste can be defined as inefficiencies caused by the use of resources such as equipment, materials, labor, or funds beyond the optimal requirements in the construction process. This waste is not only in the form of visible physical materials such as piled-up wood and steel, but also includes inefficient, non-value-adding activities, such as delays in material delivery from suppliers, work that does not meet specifications, and improper material organization

There are several potential impacts resulting from construction waste. According to Sulistio and Waty (2021), material waste can cause financial losses for construction executors. For instance, in a high-rise building project, the losses caused by ready-mix concrete waste reached 9.06% of the project's profit. The main contributing factors include material loss due to theft, design changes, and unclear or complex drawings. In addition to increasing direct costs, material waste also affects the contractor's profitability. The wastage of resources such as materials, time, and labor that do not add value reduces the profit margin of the project. As an example, the construction project of the Kubu Raya District General Hospital (RSUD) in 2019–2020 experienced significant material waste due to errors in estimating the required materials during the initial planning phase. This issue was worsened by extreme weather conditions at the project site, which led to damage to materials such as cement and bricks. These materials were not stored according to standard procedures, making them vulnerable to damage from rain and high humidity. As a result, more than 10% of the total required materials were damaged. To continue the work, the project had to repurchase the damaged materials, leading to a cost overrun of approximately IDR 600 million. Additionally, the work was delayed by one month due to the extra time needed for the procurement of new materials.

Meanwhile, waste related to non-value-added activities (NVA) includes: (1) waiting for materials or equipment, which can lead to schedule delays and reduced work efficiency; (2) inefficient material transportation or unnecessary worker movements, which waste time and labor, ultimately increasing overall project costs; (3) defective work due to errors or rework, which directly impacts the quality of the construction output and can reduce client trust; (4) excessive storage of

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 10, October - 2025

materials that are not immediately used, which risks damage or loss, resulting in material waste and hindering project progress; and (5) inefficiencies in work processes and underutilization of workforce capabilities, which decrease productivity and may prolong project duration. In the construction project of the Kuwil Kawangkoan Dam in North Sulawesi, which was carried out from 2016 to 2023, a problem arose due to the initial design of the drainage system not aligning with the geotechnical conditions in the field. This mismatch led to part of the completed work needing to be dismantled and redone. As a result of this rework, the project incurred significant cost overruns, amounting to approximately IDR 4 billion. In addition, the rework caused a project delay of five months. This situation also triggered tension between the contractor and the project owner, particularly regarding responsibility for the design error and the additional costs incurred.

Given the numerous negative impacts that arise in construction projects due to the aforementioned types of waste, strategies have been developed to minimize them—one of which is the implementation of the lean construction concept. According to Tamallo and Nursin (2020), Lean Construction is a principle applied in construction work aimed at minimizing waste in the form of materials and time, with the goal of increasing value. Meanwhile, the Lean Construction Institute Indonesia (2019) emphasizes that Lean Construction is not merely about cost reduction, but rather an effort to eliminate non-value-added activities in order to enhance project efficiency and quality. Previously, Lauri Koskela (2002) described Lean Construction as a production system approach designed to reduce waste in materials, time, and labor to deliver maximum value to the customer. Based on the description above, the objective of this research is to analyze the importance of implementing the Lean Construction concept as an effective managerial approach to minimize waste in construction projects in Indonesia, in order to improve efficiency, productivity, and the overall success of project execution.

II. MATERIAL AND METHODS

To achieve the research objectives, several research stages have been established as illustrated in the following figure.

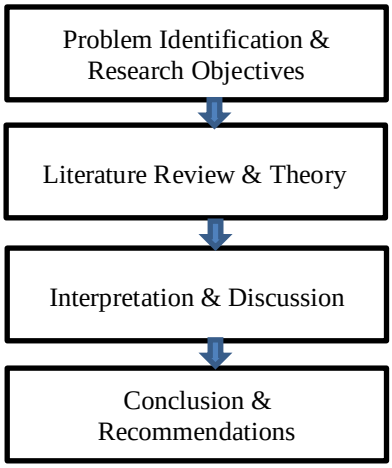

Figure 1. Research Stages

The research process begins with problem identification and the formulation of research objectives, aiming to understand the context of construction waste and define the focus of the study. This is followed by a literature review and theoretical framework, which explores the principles of Lean Construction, the nature of waste in construction projects, and best practices both globally and locally. The next stage is interpretation and discussion, where the collected data is analyzed to uncover the meaning behind Lean implementation, its impact on reducing waste, and the supporting or inhibiting factors. Finally, the study concludes with conclusions and recommendations**,** providing practical implications and suggestions for effectively implementing Lean Construction in the Indonesian construction industry.

Furthermore, this study employs a qualitative approach, which is a type of research that focuses on understanding the meaning, experiences, and subjective perspectives of individuals or groups regarding a phenomenon. This approach is commonly used to explore complex, contextual issues that cannot be measured quantitatively. The method used in this research is grounded theory, which involves an examination of theories related to construction waste, theories on lean construction, and their connection to the application of lean construction principles.

III. RESULTS AND DISCUSSIONS

A. Reducing Construction Waste is Essential to Improving Project Efficiency

The reduction of construction waste is a crucial aspect of project execution, as it directly impacts the efficiency, cost, and environmental footprint of the project. Poorly managed construction waste can lead to material wastage, increased operational costs, project delays, and environmental pollution. By minimizing waste, projects can optimize resource utilization, reduce the need for re-procurement of materials, and accelerate completion time due to more organized and efficient workflows. Moreover, waste reduction reflects the implementation of sustainable development principles, which are increasingly demanded in the modern construction industry. Through careful planning, the use of technologies such as Building Information Modeling (BIM), and proper training of workers in waste management, projects can run more smoothly, cost-effectively, and in an environmentally friendly manner.

According to Sagan and Mach (2025), Improper waste management can lead to various problems, such as air, water, and soil pollution, as well as health issues for nearby residents. Therefore, the implementation of an effective waste management system is essential. In addition to minimizing negative impacts on the environment and public health, proper waste management can also enhance overall project efficiency by reducing operational costs, accelerating project completion time, and improving the construction company's public image. Furthermore, The reduction of Non-Value Added (NVA) waste in construction projects is crucial for improving overall efficiency and productivity. NVA waste includes activities that do not add value to the customer, such as waiting time, unnecessary material movement, rework, and excess inventory. If left unaddressed, these activities can lead to resource waste, project delays, and increased costs. By identifying and reducing NVA waste, project teams can streamline workflows, optimize the use of labor and materials, and enhance the quality of construction outcomes. Moreover Dara, et al (2024) said minimizing NVA waste also

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 10, October - 2025

contributes to creating a more organized and safer work environment. The analysis results show a strong positive relationship between the implementation of Lean tools and the reduction of NVA activities, with a β value of 0.654. This finding can be leveraged to enhance construction project productivity by focusing on minimizing NVA activities through the use of Lean tools. By applying these tools effectively, projects can optimize their processes, reduce waste, and achieve more efficient and cost-effective outcomes. Nurlaelah (2023) emphasizes that identifying and reducing Non-Value Added (NVA) activities is a crucial step in enhancing the efficiency and smooth operation of construction project development. NVA activities, which include any actions that do not directly contribute value to the final product, are often the main causes of wasted time, labor, and resources. By systematically identifying these activities using approaches such as Value Stream Mapping, project stakeholders can comprehensively map the workflow and highlight unproductive segments of the process. Once identified, NVA activities can be minimized or eliminated through the implementation of Lean Construction principles, such as work standardization, improved team coordination, and the adoption of supportive technologies. The result is a more efficient construction process, characterized by shorter completion times, lower costs, and improved final product quality. The author stresses that implementing this strategy offers not only short-term benefits but also serves as a long-term investment in fostering a more productive and sustainable work culture within the construction industry.

B. Lean Construction Helps Eliminate Non-Value-Adding Activities, Commonly Referred to As Waste

Dara et al. (2024) explain that the construction industry is a sector that integrates both production and service systems, which serves as the foundation for adapting lean production theories to the construction context (Salem et al.,2006; Bygballe et al., 2023). The literature review on Lean philosophy in this industry covers several key topics, including barriers to implementation, critical success factors, accident reduction efforts, sustainability aspects, and the overall benefits of lean in construction (Gupta et al, 2013; Enshassi et al, 2019; Ahmed et al, 2021). Several studies have revealed that non-value-added activities consume approximately 95% of working time, leaving only 5% for value-added tasks. As a result, the lean approach places a strong emphasis on minimizing non-value-added activities. Six lean construction tools—final planner, enhanced visualization, huddle meetings, first-run studies, the 5S approach, and fail-safe systems for quality—are incorporated into an evaluation tool developed by Salem et al (2006). This evaluation contributes to cost reduction, improved communication between subcontractors and managers, faster project completion, and accident prevention. However, the long-term benefits of lean implementation still require further investigation. Lean has significant potential to reduce the frequency of accidents in the construction sector.

Setiawan (2024) stated that the implementation of lean construction is comprehensively applied across various stages of construction projects, from the planning phase to the execution phase, with a primary focus on its impact on the efficient use of materials, labor, and project time. Through data analysis and relevant case studies, the findings indicate that applying lean construction principles can significantly optimize resource utilization, reduce operational costs, and accelerate project completion without compromising quality. These results affirm that lean construction is not merely an efficiency technique but also a strategic approach with substantial potential to enhance overall project performance. Therefore, integrating lean construction into project management practices can contribute meaningfully to improving operational efficiency and supporting the achievement of sustainability goals in the construction industry.

Lean construction aims to reduce non-value-adding activities—often labeled as waste—by enhancing workflow efficiency, delivering greater value to the client, and minimizing the use of resources. This methodology adapts Lean principles, initially designed for the manufacturing sector, to the context of construction with the goal of identifying and eliminating processes that do not directly contribute to the final output. Examples of waste in construction include overproduction, idle time, unnecessary movement of materials, surplus inventory, errors requiring rework, and inefficient use of labor. Through tools like Value Stream Mapping, the Last Planner System, and continuous improvement strategies, Lean construction supports project teams in optimizing processes, preventing delays, reducing costs, and achieving higher-quality results. Ultimately, it encourages a work culture centered on collaboration, responsibility, and long-term sustainability throughout the duration of the project.

In earlier studies, Koskela (1992) identified 11 core principles of Lean Construction (LC), which include: (1) reducing non-value-added activities, (2) increasing output value by systematically addressing customer needs, (3) minimizing variability, (4) shortening cycle times, (5) simplifying processes by decreasing steps, components, and connections, (6) enhancing flexibility in output, (7) improving process transparency, (8) focusing control on the entire process, (9) embedding continuous improvement, (10) balancing flow and conversion improvements, and (11) using benchmarking to drive progress.

Womack and Jones [30] streamlined these into five key lean principles: mapping the value stream, ensuring continuous value-creating flow, establishing customer pull at the right time, and pursuing continuous improvement with the goal of perfection. These five principles are directly relevant to managing overall flow processes and their interrelated activities within the construction sector (Lim, 2008; Marhani et al, 2013). The authors conclude that applying these principles leads to minimal use of labor, resources, and materials while still fulfilling project requirements. Lim (2008) emphasizes that efficient resource utilization allows organizations to reduce costs, cut waste, and meet project deadlines. Lean Construction is thus considered an ongoing effort to optimize processes in construction by boosting customer value and minimizing resource waste. To support this, Lim (2008) identifies key elements such as Total Quality Management (TQM), Just-in-Time (JIT), Total Productive Maintenance (TPM), employee involvement, continuous improvement, standardization, Concurrent Engineering (CE), value analysis, and visual management. In addition, Alinaitwe [33] further condensed and presented essential LC concepts including JIT, TQM, Business Process Re-engineering (BPR), CE, Value-Based Management (VBM), teamwork, and the Last Planner System (LPS) (Marhani et al, 2013).

According to Banna (2023), An increasing number of construction companies are adopting the Lean methodology, which focuses on delivering maximum value to the customer while reducing waste to a minimum. This approach is appealing due to its simplicity and relevance in an industry where cost control, deadlines, and safety are crucial. However, since Lean project delivery differs significantly from conventional construction practices, its effective implementation can be challenging. It is important to recognize that Lean construction does not follow a one-size-fits-all model. Various tools—such as the Last Planner

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 10, October - 2025

System, Integrated Project Delivery, Building Information Modeling (BIM), 5S, and Kaizen Events—can be used individually or in combination to support Lean implementation.
This flexibility provides practitioners with a diverse set of strategies that can be tailored to the specific needs of each project.

1. Understanding Value from the Customer's Perspective
   Unlike traditional construction methods that concentrate solely on delivering what is outlined in the plans and specifications, Lean construction goes further by emphasizing the importance of understanding *why* the customer wants the project built in the first place. It acknowledges that true value lies not just in the physical outcome but in aligning the final product with the customer's deeper goals and needs. Achieving this level of insight requires building trust among all stakeholders from the earliest planning stages.
   Lean construction fosters collaboration by involving all key participants—such as the owner, architect, engineers, general contractor, subcontractors, and suppliers—right from the start. This integrated project team works collectively to not only fulfill the client's explicit requirements but also to offer expert input, manage expectations, and continuously refine value delivery throughout the project lifecycle. Nevertheless, there are core principles that guide organizations toward achieving key outcomes such as cost reduction, shorter construction durations, increased productivity, and more effective project management. These principles promote a comprehensive, integrated approach to managing construction processes.

2. Defining the Value Stream
   After establishing a clear understanding of what constitutes value from the customer's perspective, the next step is to map out all the processes required to deliver that value—this is known as defining the value stream. Each activity within the value stream is examined in terms of the labor, information, equipment, and materials it requires. This approach helps organizations concentrate on what genuinely contributes to customer satisfaction, allowing them to better prioritize and allocate their resources.
   By identifying steps or elements that do not add value, companies can take targeted actions to eliminate, reduce, or optimize these inefficiencies. Doing so not only minimizes wasted time and effort but also improves the efficiency and effectiveness of value delivery throughout the construction project.

3. Eliminating Waste
   One of the core objectives of Lean construction is to systematically eliminate or minimize waste wherever it occurs throughout the construction process. Lean identifies eight key types of waste that commonly undermine efficiency and productivity on job sites:
   - Defects: Mistakes or errors that require rework, resulting in wasted time, labor, and materials because tasks were not done correctly the first time.
   - Overproduction: Completing work ahead of schedule or before subsequent tasks are ready can create inefficiencies and disrupt workflow.
   - Waiting: Delays caused when workers are idle due to missing materials, incomplete prerequisite tasks, or poor coordination are a major source of waste.
   - Not Utilizing Talent: Underutilizing the skills and knowledge of workers by assigning tasks that do not match their capabilities leads to wasted human potential.
   - Transport: Unnecessary movement of materials, equipment, or personnel—especially before they are actually needed—results in wasted effort and can increase costs.
   - Inventory: Holding more materials than necessary ties up capital, requires additional storage space, and increases the risk of material degradation or loss.
   - Motion: Excessive or inefficient movement by workers, such as traveling long distances between workstations or tools, contributes to time and energy waste.
   - Extra Processing: Performing more work or using more resources than required by the client or specifications adds no value and should be avoided.

   By identifying and addressing these wastes, Lean construction aims to streamline operations, improve productivity, and ensure resources are used as efficiently and effectively as possible.

4. Flow of Work Processes in Lean Construction
   In Lean construction, the ultimate goal is to maintain a continuous and uninterrupted workflow that is both reliable and predictable. Sequencing is crucial—tasks must follow a logical order, such as ensuring that the footings are completed before starting on the frame. Effective communication between all stakeholders is key to achieving this seamless flow. If one aspect of the project falls behind or gets ahead of schedule, it is critical to communicate this promptly to everyone involved. This allows for adjustments to be made in real time, helping to minimize wastes like waiting, unnecessary motion, and excess inventory, ultimately improving overall project efficiency and timelines.

5. Pull Planning and Scheduling in Lean Construction
   Creating reliable workflows in Lean construction relies on the principle of releasing work based on downstream demand. This approach acknowledges that those directly performing the tasks, often subcontractors, are best positioned to determine when work should begin. The process emphasizes close communication and collaboration among all participants, who work together to establish a coordinated task schedule. This collaborative effort is vital as it ensures that all team members are aligned with the project's goals and objectives, allowing the work to be efficiently coordinated and synchronized, which minimizes delays and maximizes overall productivity.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 10, October - 2025

6. Continuous Improvement in Lean Construction

At the core of Lean construction is the belief in the continuous pursuit of process improvement and waste elimination. This philosophy encourages teams to consistently identify areas for enhancement throughout a project and take proactive steps to address them. The lessons learned and improvements made during the current project are then applied to future projects, fostering a culture of ongoing growth and refinement. This commitment to continuous improvement helps ensure that each project becomes more efficient, effective, and aligned with the goals of Lean construction.

The construction industry often faces a natural resistance to change, with many firms adhering to traditional methods. However, the numerous benefits of the Lean approach are encouraging more companies to embrace this change. By delivering projects on time, within budget, and meeting the customer's expected value, Lean construction creates positive outcomes for all parties involved, leading to improved efficiency, customer satisfaction, and overall project success (Banna, 2023).

Research conducted in Banda Aceh shows that the level of Lean Construction implementation in project management reached 61.77%**,** with the largest contribution coming from the execution method at 17.59%**.** This result emphasizes the importance of the execution method as a key factor in the successful implementation of Lean Construction in construction projects (Husna N, et al., 2022).

Furthermore, a study conducted in Aceh Province by Malikussaleh University found that Lean Construction factors significantly affect construction project productivity, with a contribution of 62.96%**.** The most dominant variables in this study were time management and execution, which are critical to improving project productivity (Sari, T.R., 2020). Additionally, research at the Sepuluh Nopember Institute of Technology (ITS) revealed that the success of Lean Construction implementation is mainly influenced by three key factors: organizational policies at 46.2%**,** teamwork at 29.6%**,** and leadership at 23.9%**.** These findings highlight the importance of organizational aspects and human resources in effectively supporting Lean Construction implementation (Shintarini, A.P., 2022).

IV. CONCLUSION

In conclusion, the implementation of Lean construction in construction projects in Indonesia is becoming increasingly vital as the industry faces growing challenges such as inefficiency, delays, and cost overruns. According to Ubaidillah, M (2023), The results of a national survey of construction practitioners in Indonesia indicate that the level of awareness regarding the concept of Lean Construction is high, with 69.56% of respondents reporting a high or very high understanding of the concept. However, the level of Lean Construction implementation in the field remains relatively low, with only 23.6% of respondents stating that they have significantly applied Lean principles in their construction projects. This indicates a gap between the level of knowledge and actual implementation, which may present a major challenge in optimizing lean practices within Indonesia's construction sector. Besides that, According to Ferdinandus et al. (2019), a study conducted in the regions of West Java, DKI Jakarta, and Banten showed that the implementation of Lean Construction made a significant contribution to minimizing waste in construction projects, with an effectiveness rate of 79.3%**.** This finding indicates that Lean Construction plays an important role in enhancing the efficiency and effectiveness of project execution by reducing non-value-adding activities.

Lean construction offers a comprehensive approach to optimizing resources, improving productivity, and minimizing waste by focusing on value delivery and continuous improvement. By adopting Lean principles, construction firms in Indonesia can not only streamline processes but also enhance collaboration among stakeholders, ensuring that projects are completed on time, within budget, and to the desired quality standards. Furthermore, Lean construction helps in addressing environmental concerns by reducing waste generation and optimizing the use of materials and labor. As the Indonesian construction industry continues to grow, embracing Lean methodologies will be essential in fostering a more sustainable, efficient, and competitive sector, ultimately benefiting both the industry and the communities it serves.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to all those who contributed to the completion of this paper. First and foremost, I would like to thank LPPM UMJ for guidance, support, and expertise throughout the research process. I am also deeply grateful to the construction industry professionals and organizations who provided insightful data and case studies, which were crucial to the development of this paper. My heartfelt thanks go to my family and friends for their continuous encouragement and understanding. Finally, I would like to acknowledge the resources and references provided by various researchers and scholars whose work laid the foundation for this study. Without the support of all these individuals and institutions, this paper would not have been possible.

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