The Effect of Lean Construction Practices on Process Effectiveness: A Focus on Rope Access Technicians

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Abstract

The construction industry continues to face challenges in improving operational efficiency and resource utilization. Lean construction offers a systematic approach to addressing these inefficiencies by optimizing processes and minimizing waste. Despite the growing adoption of lean practices in healthcare and manufacturing sectors, their practices in the Philippine private construction industry remain limited. This research explores the effect of five lean practices, namely continuous improvement, leadership support, long-term thinking, waste elimination, and focus on the final user, on process effectiveness in a private construction firm. This study employed a descriptive causal research design and utilized a questionnaire that targeted 120 rope access technicians. The study implemented a total enumeration sampling. Regression analysis revealed that all five lean construction practices significantly affect process effectiveness, with long-term thinking showing the strongest positive effect. Remarkably, waste elimination had a negative effect, suggesting implementation challenges. The study recommends targeted training, pilot testing, and improved coordination to align waste reduction with project goals. Embedding strategic planning, developing leadership, and incorporating client feedback are important steps in realizing the full potential of lean construction.

Keywords: lean construction; process effectiveness; long-term thinking; waste elimination

1. Introduction

1.1. Background of the study

The construction industry significantly contributes to the national economic growth and development (Nwaki & Eze, 2020). The industry generated 8.5% to the Philippine's Gross Domestic Product (GDP) in 2023. Meanwhile, the total value of construction activities increased by 12.7%, from PHP 1,831.8 billion in 2023 to PHP 2,065 billion in 2024 (Fitch Solutions Group Limited, 2024). Despite this growth, there are still persistent difficulties and inefficiencies encountered on most construction projects, such as cost overruns, delays, and construction wastes, which affect profitability and project performance (Yaro et al., 2024; El-Wafa & Mosly, 2024). Research has also shown that shortcomings in leadership (Pidgeon & Dawood, 2023) and a lack of coordination among stakeholders (Bajpai & Misra, 2022) contribute to process inefficiencies and lower value for clients.

One of the major challenges in the construction industry is the frequent occurrence of cost overruns—about nine out of ten projects exceed their budgets, often by around 30% (Bascon et al., 2023). Experts highlight the importance of optimizing value in products and services, minimizing waste, improving process effectiveness (Parfenova et al., 2020), and enhancing stakeholder satisfaction (Bhawani, 2021).

These strategies align with the principles of lean construction—a methodology focused on minimizing non-value-adding activities and enhancing process efficiency in project execution. However, lean construction faces challenges such as resistance to change, high implementation costs, and training needs (Adhi & Muslim, 2023), prompting the need to conduct pilot testing and enhance leadership support during implementation (Noto & Cosenz, 2021).

Globally, lean construction has gained traction—in the United States, adoption rose by 68.75% from 2022 to 2023 (Al Balkhy et al., 2023)—but remains limited in the Philippines (Mascareñas, et al., 2023) due to reliance on traditional methods, resistance to change, and limited awareness of lean principles (Li et al., 2020). Moreover, prior studies have focused mainly on public institutions (Klein et al., 2022) and other sectors like healthcare and manufacturing, lacking an in-depth exploration of the causal relationships between lean practices and overall process effectiveness (Maldonado et al., 2020).

Unlike the manufacturing sector, where processes are highly standardized, the Philippine private construction industry faces unique challenges like high project variability, labor shortages, inconsistent supply chains, and coordination issues. These challenges highlight the need for lean strategies that fit the industry's unique conditions. This study focuses on a private construction firm that specializes in façade restoration and maintenance. Although the company has established experience, it continues to encounter inefficiencies, including project delays, high labor costs, rework, and poor coordination (Norona & Mendoza, 2020). While cost overruns and delays are typically viewed as financial concerns, they also reflect deeper problems related to process effectiveness.

Guided by systems theory and aligned with Sustainable Development Goal 9 (Industry, Innovation, and Infrastructure), this study examines how lean practices—specifically continuous improvement, leadership support, long-term thinking, waste elimination, and focus on the end user—contribute to process effectiveness in façade cleaning operations. The study aims to provide practical insights that can help industry leaders enhance performance through the integration of lean construction principles.

1.2. Literature review

In this study, lean construction is examined through five dimensions namely, continuous improvement, waste elimination, long-term thinking, leadership support, and focus on the final user. These represent the technical and managerial foundations of lean implementation. Each dimension contributes uniquely to improving process effectiveness by shaping behaviors, decision-making, and operational practices within construction organizations.

Continuous improvement (CI) refers to a structured approach aimed at driving ongoing growth and adaptability (Khair et al., 2023). Within the lean construction framework, CI simplifies processes by removing unnecessary steps, in contrast to traditional methods that often add complexity (Amdal & Drevland, 2024). CI strengthens overall process effectiveness by reducing waste, streamlining processes, and increasing value for clients, (Mandic et al., 2024). Organizations that have adopted continuous improvement practices have reported notable gains. For instance, profit margins increased from 25% to 27% (Lameijer et al., 2023), while sales win ratios improved from 11% to 32% (Khan et al., 2020).

Waste elimination focuses on identifying and removing activities that do not add value to improve efficiency (Nadarason et al., 2023). Construction waste includes both physical and non-physical forms (Omotayo et al., 2020), often resulting from inefficiencies in equipment, materials handling, labor management, or capital allocation (Alhawamdeh & Lee, 2021). Physical waste refers to solid materials generated during construction that cannot be reused (Abdulaali et al., 2023), while non-physical waste involves the unnecessary use of time, space, or resources that fail to create value (Omeje et al., 2020). Examples of non-physical waste include overproduction, excessive transportation, unnecessary motion, excess inventory, waiting times, defects, over-processing, and the underutilization of workers' skills (Ramaru, 2020). These inefficiencies hinder productivity, increase project costs, and cause delays. For instance, waiting periods due to poor coordination or over-processing work beyond project needs result in wasted time and resources. According to Ayfokru et al. (2023), non-value-adding activities can account for 30–40% of a project's total duration and 30–50% of its overall cost. By improving workflows and focusing on value-adding activities, organizations can enhance productivity, reduce expenses, and achieve better project performance (Bajjou & Chafi, 2021).

Long-term thinking is vital for process effectiveness in lean construction. It emphasizes sustainability, resource efficiency, and stakeholder collaboration to ensure successful projects (Ramesh & Swaminathan, 2024). Within the lean framework, long-term thinking supports continuous improvement and sustains process advancements over time (Karimulla et al., 2024). It also encourages a balanced approach to improving efficiency by aligning people, technology, and processes (Ahmad et al., 2022). Organizations that prioritize strategic, long-term goals—even when it means setting aside short-term financial gains—can create an environment that supports lean practices and drives process effectiveness (Bigwanto et al., 2024). This approach highlights the importance of sustainability in construction by promoting resource efficiency and ensuring the long-term success of construction projects (Abreu et al., 2024).

Leadership support is another important factor that significantly enhances process effectiveness in lean construction. It ensures that lean principles are consistently applied and aligned with the organization's strategic goals. Top management and leaders provide direction, allocate resources, and help address challenges and sustain progress through timely and informed decisions (Juliani & de Oliveira, 2020). Their active involvement integrates lean principles into daily operations, thereby improving overall organizational performance (Sasikumar et al., 2023). Effective leadership also strengthens employee engagement, motivation, and commitment. These are essential elements to achieve process effectiveness. Leaders who demonstrate respect (Afzal & Roksana, 2024) and prioritize employee well-being create an environment where individual feel valued and empowered to engage in lean initiatives, helping build a culture of continuous improvement (Karimulla et al., 2024; Caiado et al., 2020).

Focusing on the final user is essential for achieving process effectiveness in lean construction, as it places the end user's needs at the center of all lean practices (Tiso et al., 2021). The main goal is to deliver outcomes that meet user expectations, emphasizing that customer satisfaction drives both process efficiency and organizational success (Mandic et al., 2024). In lean construction, every principle and practice operates within a structured framework that aims to maximize customer value. Since the end user defines what is valuable, organizations must align their processes with these expectations (Ariyanti et al., 2021).

Lastly, process effectiveness serves as an essential indicator of project success. It focuses on efficiency, timeliness, and cost-effectiveness as its main components. Klein et al. (2022) define process effectiveness as the ability to deliver consistent results with greater efficiency and reduced costs. Similarly, Saravia-Vegara et al. (2020) added that process effectiveness can be assessed by measuring how well project objectives are met. This assessment looks at the ratio of planned tasks to those completed within a specified timeframe. It highlights the need for disciplined execution, proper resource allocation, and effective time management in achieving optimal project outcomes.

1.3. Research frameworks

Klein et al. (2022) conducted a study among administrative employees of Brazil's National Federation of Federal Police (FENAPEF), which revealed the significance of the five lean practices—continuous improvement, leadership support, long-term thinking, waste elimination, and focus on the final user—on process effectiveness. This framework offers a solid foundation for understanding the application of lean principles that can promote more efficient, cost-effective, and sustainable construction processes.

The results indicated that continuous improvement had the strongest influence, emphasizing the importance of ongoing process improvement. Long-term thinking followed as the second most significant contributor. Additionally, a focus on the final user positively influenced process effectiveness. Leadership support also played a crucial role, particularly in fostering employee engagement. However, a notable finding was that waste elimination did not significantly influence process effectiveness. This was attributed to the organization's early stage of lean implementation, limited awareness of the various types of waste, and the cultural shift required for full adoption of lean principles. The framework is illustrated in Figure 1.

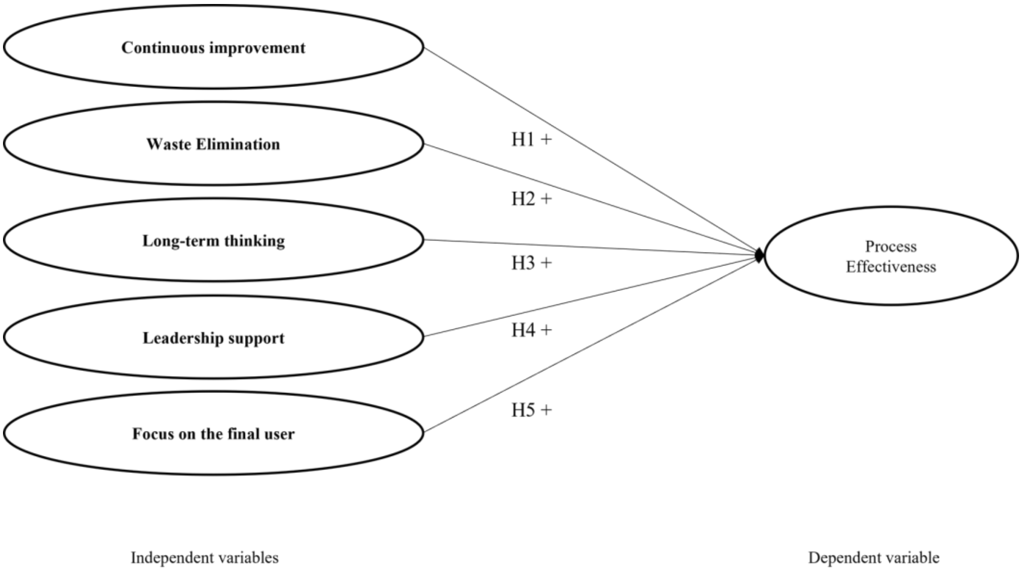

Fig. 1. Conceptual framework
Source: The Influence of Lean Management Practices on Process Effectiveness: A Quantitative Study in a Public Institution (Klein et al., 2022)

This study builds upon the framework of Klein et al. (2022), which examined lean practices in the public sector, by applying to a private sector construction firm in the Philippines. While Klein et al.'s (2022) framework was originally designed for public institutions, the frameworks remain relevant in addressing inefficiencies, delays, and cost overruns in the private sector.

The cross-sectoral adaptability of lean construction practices supports the application of this framework in evaluating the operational effectiveness of technical construction teams, such as rope access technicians. The operational framework, illustrated in Figure 2, outlines five lean construction practices—continuous improvement, leadership support, long-term thinking, waste elimination, and focus on the final user—as independent variables that may affect the dependent variable, process effectiveness.

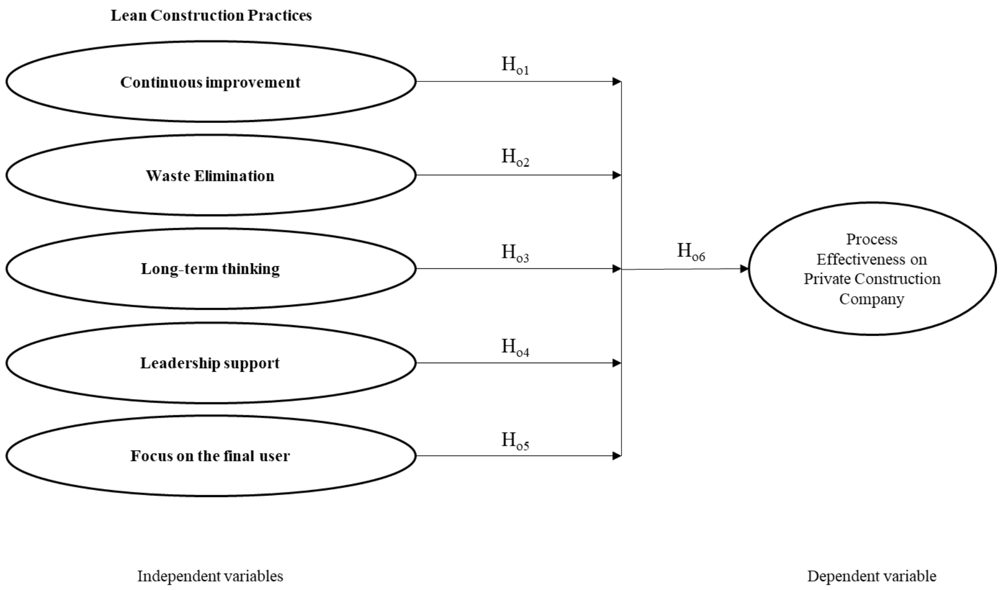

Fig. 2. Operational framework

In addition to examining each practice individually, this study also analyzes the combined effect of these lean practices on process effectiveness. While each practice contributes to improvement, they are typically implemented in an integrated manner. Analyzing their collective effect provides a more comprehensive understanding of how these practices interact to optimize construction processes and enhance overall performance.

1.4. Objectives of the study

The objectives of the study aim to provide a deeper understanding of how lean construction practices affect process effectiveness. Specifically, the study intends to:

1. describe the status of lean construction practices, namely continuous improvement, leadership support, long-term thinking, waste elimination, and focus on the final user, as well as process effectiveness within the private construction company in the Philippines;
2. determine the effect of lean construction practices, namely continuous improvement, leadership support, long-term thinking, waste elimination, and focus on the final user, on process effectiveness of a private construction company;
3. determine the effect of lean construction practices as a whole on process effectiveness of a private construction company; and
4. develop a plan that will enhance process effectiveness through the implementation of lean construction practices.

1.5. Hypotheses

The following hypotheses provide a framework for investigating how different dimensions of lean construction contribute to improving process effectiveness:
Ho1: Continuous improvement has no significant effect on process effectiveness.
Ho2: Waste elimination has no significant effect on process effectiveness.
Ho3: Long-term thinking has no significant effect on process effectiveness.
Ho4: Leadership support has no significant effect on process effectiveness.
Ho5: Focus on the final user has no significant effect on process effectiveness.
Ho6: Lean construction practices, as a whole, has no significant effect on process effectiveness.

2. Methodology

2.1. Research design

The study utilized a descriptive causal research design to examine the effect of lean construction practices on process effectiveness. This approach involved collecting numerical data to quantify the effect of the independent variables— continuous improvement, leadership support, long-term thinking, waste elimination, and focus on the final user—on the dependent variable, process effectiveness within a private construction company.

2.2. Locale of the study

The surveys and interviews were conducted within a private construction firm specializing in the restoration and maintenance of buildings, with a focus on preserving the original aesthetic and structural integrity of various properties. It has built a growing reputation for delivering high-quality results in a competitive market. However, like many companies in the sector, it faces operational challenges such as project delays, rising costs, and reduced productivity. This study is an attempt to address these challenges by exploring how lean construction practices can address these issues and enhance the effectiveness of construction processes.

2.3. Respondents of the study

The respondents of this study were 120 rope access technicians, selected for their direct involvement in project execution and process implementation. Their hands-on experience provides practical and experience-based insights into how lean construction practices are applied in real-world settings. By focusing on this operational group, the study aimed to capture firsthand and task-level perspectives on process effectiveness, offering a grounded understanding of how lean principles affect day-to-day construction activities.

2.4. Sampling design

This study employed a total enumeration sampling method, involving 120 rope access technicians. By including the entire population of technicians, this approach ensured comprehensive data collection from individuals directly engaged in the construction process and operational outcomes. While upper-level personnel or other stakeholders may offer broader strategic perspectives, the study deliberately focused on frontline workers to gain an in-depth understanding of the practical application of lean principles at the task level.

2.5. Research tools and instruments

The study utilized survey questionnaires—adapted from the 2022 research of Klein et al. — and included interview questions to assess lean construction practices and its effect on process effectiveness. The original instrument, initially designed for public administration studies, was contextualized for a private construction environment through expert review and survey face validation with the construction professionals where the study was conducted. The questionnaire measured five key factors using a 4-point Likert scale (4 = Strongly Agree, 3 = Agree, 2 = Disagree, 1 = Strongly Disagree). A 4-point Likert scale was utilized to eliminate neutral responses and encourage more decisive evaluations, especially in performance-based constructs. The questionnaire was administered online via Google Forms, allowing for efficient and automatic response collection. It was divided into six sections, namely: (1) continuous improvement with 6 items, (2) waste elimination with 5 items, (3) long-term thinking with 5 items, (4) leadership support with 5 items, (5) focus on the final user with 5 items, and (6) process effectiveness with 6 items.

2.6. Data analysis and interpretation

Descriptive statistics were employed to assess the current status of lean construction practices—namely continuous improvement, leadership support, long-term thinking, waste elimination, and focus on the final user—as well as process effectiveness. Specifically, the *mean* and *standard deviation* were computed for each factor to examine their central tendency and variability. This analysis offers insight into how the company perceives the different lean practices and overall process effectiveness. The detailed interpretation of these results is shown in Table 1.

For clearer interpretation, the computed *mean* values were classified into descriptive ranges with corresponding verbal interpretations. This method allows for a structured evaluation of respondents' perceptions of lean construction practices and process effectiveness within the organization. Translating numerical results into qualitative descriptions enhances the accessibility and applicability of the findings for both academic analysis and managerial decision-making.

Table 1 Verbal Interpretation of Responses

Mean Ranges	Verbal Interpretation
1.00 – 1.49	Poor
1.50 – 2.49	Fair
2.50 – 3.49	Good
3.50 – 4.00	Very Good

Multiple linear regression was used to analyze the individual effects of lean construction practices—continuous improvement, leadership support, long-term thinking, waste elimination, and focus on the final user—on process effectiveness within a private construction company. A *p-value* < 0.05 was used as the threshold for statistical significance, indicating that the corresponding lean practice has a measurable effect on process effectiveness. The *standardized beta coefficients* were also examined to determine the relative strength of each predictor, identifying which practice contributes the most to improving process effectiveness.

Furthermore, a simple linear regression analysis was conducted to determine how lean construction practices, when viewed collectively, affect process effectiveness. The results showed that a *p-value* < 0.05 indicated a significant positive effect, suggesting that the combined application of lean practices can meaningfully enhance process effectiveness.

2.7. Ethical considerations

The study followed the ethical standards set by the De La Salle Lipa – Research Ethics Review to ensure integrity and accountability throughout the research process. Participation in the study was completely voluntary and all information gathered was treated with strict confidentiality. Before any data were collected, respondents were informed about the purpose of the study and gave their consent to participate. Furthermore, the research avoided any form of harm to participants and maintained full transparency during data analysis. These steps were designed to protect the rights, dignity, and well-being of everyone involved in the study.

3. Results and Discussion

3.1. Descriptive statistics

The study aimed to describe the status of five lean construction practices— continuous improvement, leadership support, long-term thinking, waste elimination, and focus on the final user—along with process effectiveness in a private construction firm. The results, summarized in Table 2, revealed that all five practices were rated as "Good," indicating acceptable but not exceptional adherence to lean principles.

Table 2 Status of Lean Construction Practices and Process Effectiveness

Variable	Mean	Std. Deviation	Mean Interpretation
Continuous Improvement	3.26	0.50	Good
Waste Elimination	3.06	0.49	Good
Long-term Thinking	3.01	0.49	Good
Leadership Support	3.25	0.53	Good
Focus on the Final User	3.19	0.46	Good
Lean Construction Practices	3.16	0.40	Good
Process Effectiveness	3.02	0.46	Good

Continuous improvement, which achieved the highest *mean* score of 3.26 with a *standard deviation* of 0.50, suggests that rope access technicians are familiar with identifying inefficiencies. However, inconsistent application across projects points to gaps in standardization, feedback mechanisms, and alignment with organizational goals (Abreu et al., 2024; Ganeshu et al., 2023). For the second lean construction practice, waste elimination recorded a *mean* score of 3.06 with a *standard deviation* of 0.49. The limited application of advanced tools like Value Stream Mapping and 5S suggests room for improvement. Targeted training and better tool integration can reduce non-value-adding activities and improve cycle times (Lameijer et al., 2023; Zhang & Zou, 2023).

Meanwhile, long-term thinking received the lowest *mean* score among the lean construction practices, at 3.01 with a *standard deviation* of 0.49. This indicated underdeveloped strategic foresight in daily operations. As noted by Mandic et al. (2024), embedding this principle is often challenging. Leadership alignment and a learning-oriented culture can help bridge this gap (Utsev, et al., 2024). Leadership support achieved the second-highest *mean* score of 3.25 with a *standard deviation* of 0.53. This showed strong accessibility and communication practices but revealed inconsistencies across teams. Some employees experience adequate coaching, while others lack guidance or feedback. Development programs focusing on coaching, recognition, and shared goals are recommended

For the variable focus on the final user, the *mean* score was 3.19 with a *standard deviation* of 0.46. This indicated that rope access technicians are responsive to client needs but tend to approach engagement functionally rather than strategically. Improved communication can enhance client satisfaction and project outcomes (Tiso et al., 2021; Vishnu et al., 2023). Lastly, the analysis of process effectiveness revealed an average *mean* score of 3.02 with a *standard deviation* of 0.46. This suggests that the company has reliable service delivery. However, minor inefficiencies persist. Enhancing continuous improvement, communication, and lean integration can further optimize operations (Alhawamdeh & Lee, 2021).

The overall results demonstrated that lean construction practices within the organization are implemented at a "Good" level, suggesting a functional but not yet optimized adoption of lean principles. This finding implies that management has successfully introduced foundational practices but has not fully maximized their strategic potential. The moderate ratings highlight areas where leadership intervention, targeted training, and systematic integration are needed to transition from operational compliance toward value-driven excellence. Strengthening these practices would enhance process effectiveness and position the organization to achieve long-term competitiveness and sustainability in the construction industry.

3.2. Effect of lean construction practices dimensions on process effectiveness

The study aimed to determine the effect of five lean construction practices on process effectiveness. Table 3 shows the *R^2 value* of 0.711, indicating that 71.1% of the variation in process effectiveness can be explained by the five lean construction practices analyzed individually. This demonstrates that these practices are highly predictive of the outcome when considered on an individual basis. The remaining 28.9% of the variability is unexplained by the model and may be attributed to factors outside the scope of this study. This could include external influences such as workforce competency, leadership style, resource availability, and company culture. Additionally, unmeasured lean-related variables—such as standardization, pull planning, 5S, and root cause analysis—may also contribute to process effectiveness.

Table 3 Effect of Lean Construction Practices on Process Effectiveness

Coefficients[a]

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	0.307	0.190		1.617	0.109
	Continuous Improvement	0.170	0.072	0.187	2.363	0.020*
	Waste Elimination	-0.125	0.063	-0.134	-1.991	0.049*
	Long-term Thinking	0.500	0.070	0.539	7.168	0.000*
	Leadership Support	0.164	0.072	0.190	2.285	0.024*
	Focus on the Final User	0.161	0.063	0.163	2.548	0.012*

a. Dependent Variable: Process Effectiveness
b. R^2= 0.711; F-value = 56.080; p-value =0 .000
*c. *Significant*

The *F-value* of 56.080 and *p-value* of 0.000 confirms that the model is statistically significant. To address potential multicollinearity arising from high correlations among lean variables, a Variance Inflation Factor (VIF) analysis was conducted. All VIF values were below the commonly accepted threshold of 5 (Feldman, 2023), indicating that multicollinearity was not a concern and further affirming the reliability of the results.

Continuous improvement, with a *Beta* of 0.187 and a *p-value* of 0.020, had a positive and significant effect. This supports the idea that ongoing refinement of workflows improves resource utilization, reduces waste, and minimizes rework (Nwaki & Eze, 2020; Sasikumar et al., 2023). However, sustained impact depends on leadership commitment, continuous training, and a culture that embraces change.

Waste elimination demonstrates a negative but statistically significant effect on process effectiveness (*Beta* = -0.134, *p-value* = 0.049). Although rope access technicians are trained to identify waste, excessive focus on elimination without flexibility has reportedly disrupted workflows and coordination. This may reflect poor implementation, tool misuse, or misunderstanding waste elimination as cost-cutting rather than process improvement (Ganeshu et al., 2023; Lameijer et al., 2023).

Long-term thinking exhibits positive effect on process effectiveness as well as the greatest contributor, with a *Beta* of 0.539 and a *p-value* of 0.000. This emphasized the value of strategic foresight and early planning in reducing rework and improving client satisfaction (Bascon, et al., 2023). Technicians noted that aligning daily tasks with long-term goals and standards helps maintain progress and prevents recurring issues.

Leadership support has a positive and statistically significant effect on process effectiveness (*Beta* = 0.190, *p-value* = 0.024). This confirmed that effective leadership enhances team motivation, alignment, and performance (Abreu et al., 2024). Investing in leadership training and fostering consistent engagement are key to sustaining lean initiatives.

Similarly, focus on the final user also demonstrates a positive and significant effect on process effectiveness (*Beta* = 0.163, *p-value* = 0.012). Understanding and responding to client needs not only improves project execution but also strengthens trust and adaptability to evolving expectations (Benachio et al., 2021).

In conclusion, the strong effect of long-term thinking shows that when managers set clear priorities and align projects with strategic goals, technicians are better able to carry out tasks in ways that prevent rework and support overall project success.

Continuous improvement and focus on the final user emphasize the value of teamwork. Managers play an important role in providing training, guidance, and direction, while technicians contribute by identifying daily inefficiencies and suggesting practical improvements based on their on-site experience. Leadership support strengthens this relationship, as effective leaders motivate their teams and create an environment where technicians feel confident to share ideas and embrace new methods. On the other hand, the negative effect observed in waste elimination suggests that overly strict implementation may disrupt workflows. Technicians might struggle with rigid standards, and managers could misinterpret waste reduction as merely a cost-cutting measure rather than a way to enhance processes. These findings show that lean practices work best when managers and technicians collaborate, where management provides vision and structure, and technicians applies lean principles in the field, leading to sustainable improvements in process effectiveness throughout the organization.

3.3. Effect of lean construction practices as a whole on process effectiveness

The findings revealed that lean construction practices, when considered collectively, had a strong and statistically significant positive effect on process effectiveness (*Beta* = 0.861, *p-value* = 0.000), as presented in Table 4. This result underscores the substantial effect of integrated lean strategies in enhancing operational efficiency and effectiveness in construction processes.

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The results indicate that the five lean construction practices examined in this study are effectively implemented in combination and play a significant role in enhancing process effectiveness. Research supports the notion that the synergistic implementation of multiple lean practices leads to substantial improvements in productivity, efficiency, and quality. For instance, Bajjou and Chafi (2021) reported that the application of lean principles resulted in a 41% increase in process productivity, a 14% improvement in efficiency, and a 17% reduction in cycle time.

Table 4 Effect of Lean Construction Practices as a whole on Process Effectiveness

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-0.085	0.170		-0.497	0.620
	Lean Construction Practices	0.992	0.054	0.861	18.384	.000*

a. Dependent Variable: Process Effectiveness
b. R^2= 0.741; F-value = 337.980; p-value = 0.000
*c. *Significant*

The *R^2 value* of 0.741 indicates that 74.1% of the variance in process effectiveness can be explained by the lean construction practices included in the study. This suggests a high level of predictive accuracy. The remaining 25.9% of the variance may be attributed to other factors or lean practices not captured in this analysis.

4. Conclusions and Recommendations

The study successfully evaluated the effect of lean construction practices on process effectiveness within a private construction company. Descriptive statistics indicated that all five lean practices—continuous improvement, leadership support, long-term thinking, waste elimination, and focus on the final user—along with process effectiveness, were implemented at a "Good" level within the organization.

Multiple linear regression analysis confirmed that each of these lean practices, both individually and collectively, significantly affected process effectiveness. As a result, the study rejected the null hypotheses H_o1, H_o2, H_o3, H_o4, H_o5, and, H_o6, affirming the relevance of each lean practice in enhancing operational outcomes.

Among the five practices, long-term thinking showed the greatest contribution (*Beta* = 0.539), highlighting the critical role of strategic planning and foresight in optimizing construction processes. This was followed by leadership support (*Beta* = 0.190), continuous improvement (*Beta* = 0.187), and focus on the final user (*Beta* = 0.163), all of which demonstrated positive and statistically significant effects. Interestingly, waste elimination showed a negative effect (*Beta* = -0.134), suggesting that while the principle is theoretically beneficial, its practical implementation may face contextual challenges. This result did not undermine the study but rather emphasized the importance of organizational readiness, maturity implementation, and employee perception in realizing the intended benefits of waste elimination.

To maximize the benefits of lean construction and address existing gaps, this study proposes recommendations that optimize the strengths of each lean practice while addressing the specific challenges identified in their implementation. Given the unexpected negative effect of waste elimination, firms may consider reassessing their current strategies to avoid disrupting workflow. Targeted training on cost-efficient waste reduction and pilot testing on smaller projects is advised. Tools like Value Stream Mapping (VSM) and Failure Mode and Effects Analysis (FMEA) can help identify non-value-adding processes. Improved collaboration among planners, managers, and technicians is key to aligning waste reduction with budget and timeline goals. For long-term thinking, which showed the greatest contribution to process effectiveness, companies may embed strategic foresight into daily operations and promote a forward-thinking culture.

Leadership support can be strengthened through development programs that emphasize recognition, coaching, and constructive feedback. A strong focus on the final user is to be reinforced through feedback loops and transparent communication to reduce rework. Finally, continuous improvement is best embedded in the culture through employee-driven innovation and performance tracking. Future research should explore training and implementation models to enhance lean practice consistency across varying construction settings.

5. Limitations of the Study

This study examined the effects of five lean construction practices—continuous improvement, leadership support, long-term thinking, waste elimination, and focus on the final user—on process effectiveness. However, it has several limitations. The research was limited to a single private construction firm, restricting the generalizability of findings. While the issues studied—inefficiencies, cost overruns, and delays—are common across the Philippine construction sector, future studies may include multiple firms and project types for broader applicability. Finally, future studies may incorporate Confirmatory Factor Analysis (CFA), expert validation, and additional lean variables such as standardization, pull planning, 5S, and root cause analysis to strengthen construct validity and model relevance.

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