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APPLICATION OF LEAN CONSTRUCTION PRINCIPLES AS A PANACEA TO IMPROVING BUILDING PROJECT DELIVERY IN ANAMBRA STATE, NIGERIA

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ABSTRACT

The Construction industry in Nigeria, particularly in Anambra State, continues to perform poorly, characterized by project delays, a high rate of waste, and poor quality. This is due to the use of inappropriate project management techniques and a failure to apply Lean Construction Principles in their project delivery system. This study aims to examine the application of Lean Construction Principles as a means to improve building project delivery in Anambra State, Nigeria, with a focus on the adoption of these principles and their benefits within the local context. This study employed a quantitative research approach; data were collected through structured questionnaires administered to 205 registered construction professionals, of which 160 valid responses were received and analyzed. The descriptive method of analysis was used to analyze the data obtained from the survey. The result obtained shows the following as the most significant enablers for the Implementation of LC principles. These are (1) generating value, (2) respect for people, (3) eliminate waste, (4) continuous improvement, (5) pull planning and scheduling, and (6) simplify processes with mean values of 4.76, 4.69, 4.46, 4.44, 3.95, and 3.86, respectively. The study recommended that investment in training programs, enhanced collaboration, top management support, and commitment to the adoption of Lean Construction Principles be ensured by ensuring teamwork among stakeholders to enhance quality, reduce waste, and achieve client satisfaction.

Keywords: Lean Construction Principles, Stakeholders, Construction Industry, And Project Delivery.

1. INTRODUCTION

The construction industry sector in Nigeria is crucial, significantly affecting national development and economic growth. However, it is known for being highly fragmented and often suffers from adversarial relationships, poor project performance in terms of productivity, gross inefficiency, frequent rework, disputes, inadequate innovation, and stakeholder dissatisfaction (Lee, 2013; Villanueva, 2018). In developing countries like Nigeria, the construction industry continues to struggle (Sospeter and Kikwasi, 2017). Ineffective project management techniques and the failure to implement lean construction methods contribute to the poor performance of the construction industry, marked by projects completed over budget and beyond the anticipated timeline, a high rate of waste, and low quality (Sospeter and Kikwasi, 2017). Many approaches have been suggested to tackle some of these challenges.

Lean Construction (LC) emerges as a promising approach to address these issues. The shortcomings of traditional project management methods have led to the rise of Lean Construction, which significantly enhances project outcomes and management practices (Oladapo, Ogunbiyi, and Goulding, 2019). Lean Construction represents an innovative paradigm that emphasizes the implementation of Lean principles within the construction industry (Oladapo et al, 2019). In the manufacturing sector, particularly in the automotive industry, the lean management philosophy has already shown excellent performance (Mohammed, Anas, and Abdelali, 2017). The Lean manufacturing production system is primarily rooted in the Japanese industrial sector, specifically the Toyota production system (Antunes and Gonzalez, 2015). Its principles emphasize generating value for customers while minimizing waste at every stage of the building process. (Chukwuemeka, Ajaelu, and Chukwuenye, 2025). Key principles include value identification, waste reduction, continuous flow, full-based production, and continuous improvement (Chukwuemeka et al, 2025). In contrast to conventional building methods, Lean Construction fosters collaboration and adaptability, allowing teams to effectively respond to project changes. Various studies have indicated that the application of Lean methodologies can positively enhance project performance in terms of cost, time, quality, stakeholder satisfaction, and health and safety (Nwaki and Eze, 2020; Yaro; Adams, Saidu, and Anifowose, 2024).

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Despite the benefits demonstrated by researchers, Lean construction is still not widely adopted in Anambra State, Nigeria. Due to non-application, construction projects in Anambra State suffer from inefficiencies that lead to delays, budget excesses, and compromised quality. Therefore, this paper aims to assess the application of Lean construction principles as a solution for improving building project delivery in Anambra State. This assessment will include evaluating current practices, identifying Lean construction principles, and proposing strategies that will enhance construction project delivery in Anambra State.

2. LITERATURE REVIEW

2.1 Project Delivery Practices

According to the Construction Management Association of America (2012), defines project delivery method as a system designed to achieve the satisfactory completion of a construction project from conception to occupancy. It is a process by which a construction project is fully designed and built for an owner, including project scope definition, organization of designers, constructors, and various consultants, sequencing of design and construction operations, execution of design and construction, close-out, and start-up. Project delivery refers to all contractual and organizational interactions between stakeholders in a construction project, such as the client, consultants, and contractors (Memen, Rahman, and Aziz, 2020).

The major types of project delivery practices utilized throughout construction projects are Design-Bid-Build, Design and Build (DB), Construction Management at Risk (CMAR), and Integrated Project Delivery (IPD) (Construction Management Association of America, 2012). Hall and Scott (2016); Perlberg (2019) argue that project delivery methods, including design-build, Design-Bid-Build, and construction management, have been standard practices in the construction industry for decades. However, professionals and stakeholders have expressed dissatisfaction with the results. These methods are seen as inadequate due to their failure to adapt to modern trends, leading to issues such as low quality, time and cost overruns, and dissatisfaction (Viana, Hadikusumo, Mohammed, and Kahvandi, 2020). When combined with suitable project delivery practices, Lean Construction offers an effective approach to improving project delivery by reducing inefficiencies in cost, time, quality, safety, and stakeholder satisfaction (Obodoh, Ọnwụliri, Umeokana, and Makụọchukwu 2025).

2.2 Lean Construction

Lean Construction is a philosophy derived from the principles of Lean manufacturing that involves controlling and improving the construction process to effectively deliver what the client needs (Yaro *et al*, 2024). Lean is a mindset that emphasizes waste reduction in construction (Kuchera, 2015).

Lean construction (LC) has undergone continuous development overtime and constitutes a systematic approach to the design and management of production system, to discourage, minimizing and ultimately eliminating waste whether in the form of materials, time, or labour to enhance the generation of maximum value (Mohammad, Igwe, Amador-Jimenez and Nasiri, 2020). LC refers to the application and adaptation of the concepts and principles of the Toyota Production System (TPS) to construction (Mohammadi *et al*, 2020). According to Shah and Ward (2007), LC is an Integrated Socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability.

As shown in Figure 1, Lean Construction is the practical application of Lean thinking in the building sector. The Lean Construction Institute (ILC) defines Lean Construction as a philosophy that aims to optimize construction output by eliminating non-value-added activities and focusing on those that contribute to developing tools for project execution and constructing a waste-reducing manufacturing system (Graces and Pena, 2023). LC aims to optimize transformation by reducing or eliminating material flows to maximize value in end products (Avelar, Meirino, and Tortorella, 2019).

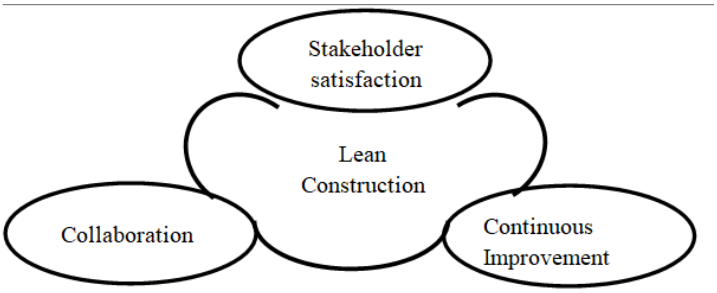

Figure 1: Lean Thinking Applied to Construction Projects

Source: Al Taie *et al* (2024)

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LC seeks to overcome the inefficiencies and problems of traditional construction processes. This method promotes a coherent and integrated project environment, leading to improved cost and time performance (Mohammad and Marah, 2025).

2.3 Lean Construction Tools

Lean thinking applied to construction enhances outcomes and adapts to keep pace with the ever-growing complexity of the built environment (Al Taie *et al*, 2024). Ballard and Tommelein (2016) found that Lean Construction enhances planning, maximizes customer value, eliminates waste, and improves workflow dependability, resulting in greater competitiveness. Lean Construction utilizes a variety of tools and techniques that support its core principles. These tools aim to maximize value, minimize waste, and improve the project outcome. Here are some of the tools and techniques employed in Lean Construction.

a) Last Planner System (LPS)

The last planner system is a tool within the LC approach, which reduces waste by improving workflow reliability in construction work (Ansah and Sorooshian, 2017). LPS is a collaborative planning tool that involves those closest to the work in the scheduling process, promoting reliable workflow and reducing planning uncertainties (Al Taie *et al*, 2024).

b) Just-in-Time (JIT) Delivery

These techniques reduce storage costs, optimize project materials, and improve site organization. This method lowers inventory holding costs and lessens the risk of overproduction, excess inventory, and product obsolescence (Heizer, Render, and Manson, 2016). JIT enables teams to work with only the resources necessary for each stage.

c) Value Stream Mapping (VSM)

Value Stream Mapping (VSM) is a visual tool that illustrates all processes in the construction workflow, from pre-construction to completion. VSM allows construction professionals to map a project's entire value stream, pinpointing waste and inefficiencies for enhancement (Ramani and KSD, 2019). According to Obodoh *et al* (2025), VSM enhances decision-making and collaboration among stakeholders for continuous process improvement. Implementing VSM in construction projects increases productivity, minimizes delays, and fosters better communication.

d) 5S System

The 5S approach—sort, set in order, shine, standardize, sustain—is an organizational technique that keeps job sites tidy, productive, and organized. Originally developed in the manufacturing industry, 5S reduces wasted time by ensuring that tools and materials are always in their proper places (Lean Construction Institute, 2025). This approach seeks to enhance efficiency by eliminating waste, improving flow, reducing process inconsistencies, and maximizing output through an orderly workplace and the use of visual signals to create consistent operational results (Kuklare and Hedaoo, 2017).

e) Kaizen (Continuous Improvement

Kaizen, meaning continuous improvement, and the PDCA (Plan-Do-Check-Act) cycle are essential to Lean's emphasis on adaptability. Muniz *et al* (2024) state that the Kaizen philosophy is widely recognized in construction since it aligns with lean objectives of eliminating waste and enhancing value delivery. It encourages teams to regularly examine their processes, make adjustments, and assess the impact of those changes.

2.4 Lean Construction Principles

Lean Construction has been characterized as the adoption and use of Lean manufacturing ideas and practices in building construction. Wodalski, Benjamin, Whited and Hanna, (2011) categorized the main principles of lean into five as (1) define customer value; (2) define the value stream; (3) make it flow; (4) pull from the customer back toward the company; and 5) strive for excellence. Abdullah, Abdul-Razak, Abubakar, and Mohammad (2009) stated the six principles of lean construction as 1) identify value from the customer's point of view; 2) Define the value stream; 3) Eliminate waste; 4) Flow of work processes; 5) Continuous Improvement and 6) Pull planning and scheduling by focusing on these principles, lean construction aims to enhance project delivery by reducing delays, minimizing costs and improving quality.

In practice, LC promotes early participation of all project participants, ongoing learning, and adaptability to change. It also advocates for the use of visual management technologies to enhance communication and collaboration on building sites (Salem, Solomon, Genaidy and Luegring, 2005). Bocquet, Dubouloz and Chakor (2019) added that lean construction aims to eliminate waste, promote continuous improvement and create value through collaboration and transparency among stakeholders. The Lean Construction Institute (LCI) emphasizes that Lean Principles can be applied to any project by focusing on six core tenets (see figure 2).

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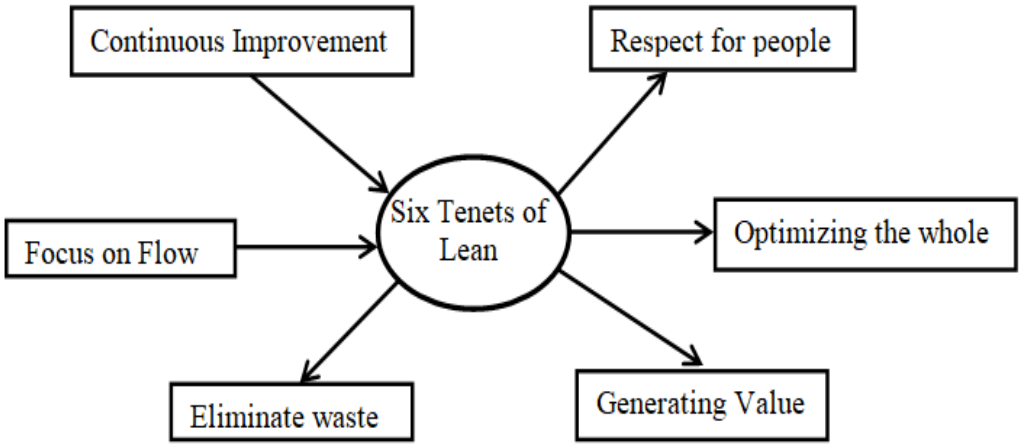

Figure 2: The Six tenets of Lean (LCI, 2025)

Lean Construction principles are vital for project success. They help teams maximize stakeholder value by focusing on what truly matters. These principles minimize waste, saving both time and money (Madanayake, 2015).

2.5 Lean Construction: A Solution to Project Delivery Challenges

Lean Construction has emerged as an effective strategy for addressing the ongoing challenges of building project execution in Anambra State, Nigeria. By emphasizing waste reduction, increased collaboration, and continuous improvement, lean construction practices optimize project workflows and enhance overall efficiency. According to Adamu and Adulhamid (2016), a case study of a housing project in Nigeria, Lean Construction adoption resulted in a 17.24% increase in productivity and project completion six weeks ahead of schedule, suggesting the potential for significant time savings and better resource management. Lean Construction improves quality outcomes by fostering a culture of continuous improvement, and involving all stakeholders in process optimization leads to higher quality outcomes (Obodoh *et al*, 2025).

Additionally, Lean approaches promote openness and teamwork, which are vital to project success, by encouraging a cooperative culture that breaks down conventional silos between suppliers, designers, and contractors (Ahiakwo, Oloke, Suresh and Khatib, 2013). Quality improvements are consistently highlighted as a major advantage of Lean Construction. The culture of continuous improvement (Kaizen) and early detection of defects helps minimize rework and enhance the overall quality of workmanship (Erazo-Rondinel, Ccoyllar, Huaecha, and Barrantes, 2023).

3. METHODOLOGY

This study employs a quantitative research design to examine the application of Lean Construction Principles for improving building project delivery in Anambra State. A descriptive survey design was utilized to gather quantitative data from a purposive sample of construction registered professionals, including Engineers, Builders, Architects, and Quantity surveyors actively involved in building projects within Anambra State. The purposive sampling technique ensured that respondents possessed relevant experience and knowledge of Lean Construction Principles. A total of 205 copies of questionnaire were distributed both electronically and in person across the various target populations, with 160 valid responses received and analyzed (78% response rate). The questionnaire, adapted from validated instruments, employed a five-point Likert scale to identify the Lean construction principles and their benefits to enhance project delivery in Anambra State.

Reliability testing confirmed the instrument's consistency (Cronbach's Alpha > 0.7). Data were analyzed using descriptive statistics, including the mean and standard deviation. This facilitated easy interpretation of responses. The structured format of the questionnaire ensured consistency and made it easier to compare responses across different groups.

4. RESULT AND INTERPRETATION

The results of the demographic profile of the respondents, out of 160 respondents, 42% were builders, 36% were Engineers, 14% were architects, and 8% were quantity surveyors. Most respondents (70%) had over 5 years of experience, indicating that the data reflects competent professionals in the construction sector of Anambra State.

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Table 1: Lean Construction Principles

S/No	Principles	Mean	Standard Deviation	Ranked
1.	Generating value	4.79	0.646	1st
2.	Respect for people	4.69	0.583	2nd
3.	Eliminate waste	4.46	0.797	3rd
4.	Continuous improvement	4.44	0.966	4th
5.	Pull planning & scheduling	3.95	1.203	5th
6.	Simplify processes	3.86	1.222	6th
7.	Flow efficiency	3.84	1.201	7th
8.	Optimizing the whole	3.84	1.201	7th
9.	Transparency among stakeholders	3.69	1.102	9th
10.	Training	3.69	1.157	9th
11.	Modularization	3.50	1.172	11th
12.	Teamwork	3.13	1.268	12th
13.	Use multifunctional materials	2.88	0.839	13th
14.	Strive for Excellence	2.72	0.614	14th

Source: Field Work (2025)

Table 1 shows the extent of agreement of registered construction professionals in Anambra State with principles of lean construction. Several factors were identified as primary principals of lean construction. Factors such as Generating Value, Respect for people, Eliminate waste, Continuous improvement, pull planning and scheduling and simplify processes. These were ranked 1st, 2nd, 3rd, 4th, 5th and 6th with mean scores of 4.79, 4.69, 4.46, 4.44, 3.95, 3.86, respectively and standard deviation values of 0.646, 0.583, 0.797, 0.966, 1.203, and 1.222, respectively. This suggests that generating value, Respect, Eliminate waste, Continuous improvement, pull planning and scheduling and simplify processes are the major principles of Lean Construction. The study conducted by Bocquet et al (2019) agreed with the findings, their findings categorized Lean construction principles into themes including eliminate waste, promote continuous improvement, and creation of value. The finding also align with the six core tenets of lean construction by Lean Construction Institute which are respect for people, optimizing the whole, eliminating waste, generating value, continuous improvement, and focus on flow.

Sarhan, Fox and Sharp (2018); Bayhan and Ergen (2019) provided additional support for the findings by highlighting waste reduction, flow optimization, pull planning and respect for people as the key principles of Lean Construction implementation. The findings further show that other principles of lean construction include flow efficiency, optimizing the whole, Transparency, Training, modularization, Teamwork, with mean scores of 3.84, 3.84, 3.69, 3.50 and 3.13, respectively. This reveals that construction professionals also agreed that the aforementioned factors are enablers of Lean Construction Implementation. Furthermore, the results show that use of multifunctional materials and strive for Excellence with mean scores of 2.88 and 2.72 are the least significant enablers of lean construction in enhancing building project delivery in Anambra State Construction Industry.

Table 2: The Benefit of Lean Construction.

s/no	Benefit	Mean	SD	Rank
1	Waste Reduction	4.69	0.583	1st
2	Increased cooperation and collaboration	4.44	0.966	2nd
3	Quality improvements	4.06	1.197	3rd
4	Improved resource Management	4.01	1.199	4th
5	Openness and teamwork	3.81	1.073	5th
6	Stakeholder Satisfaction	3.76	1.195	6th
7	Early detection of defects	3.50	1.172	7th
8	Time saving	3.31	1.044	8th
9	Increased Lbour productivity	3.125	1.268	9th
10	Motivation and decentralization	2.88	0.839	10th

Source: Field Work (2025)

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Table 2 shows that waste reduction, increased cooperation and collaboration, quality improvement; improved resource management, openness and teamwork, and stakeholder satisfaction were ranked 1st, 2nd, 3rd, 4th, 5th, and 6th, with mean scores of 4.69, 4.44, 4.06, 4.01, 3.81, and 3.76, respectively, and standard deviation values of 0.583, 0.966, 1.197, 1.199, 1.073, and 1.195, respectively. This indicates that the aforementioned factors are the major benefits of Lean Construction that will improve building project delivery in Anambra State. The results also reveal that early detection of defects; time savings, increased labor productivity, motivation, and decentralization have mean scores of 3.5, 3.31, 3.13, and 2.88, respectively, with standard deviations of 1.172, 1.044, 1.268, and 0.839, respectively. This shows that these factors are the least beneficial aspects of Lean Construction that will enhance project delivery in Anambra State. The study conducted by Chukwuemeka *et al* (2025) agreed with the findings that the following are the benefits, which include project efficiency, enhanced quality, and increased client satisfaction. The findings revealed that addressing implementation challenges could open significant value for enhancing project delivery in Anambra State.

This paper tested the hypothesis which states that the application of lean construction principles has no significant effect on building project delivery in Anambra State, Nigeria. To achieve this, Pearson correlation analysis was employed as the statistical tool to measure the strength and significance of the relationship between lean principles and their associated benefits to project delivery. Based on the decision rule, the null hypothesis was to be rejected if the p-value was less than 0.05.

Table 3: Descriptive Statistics of Lean Construction Principles and Project Delivery Benefits

Variable Group	N	Minimum	Maximum	Mean	Std. Deviation
Lean Construction Principles	**10**	**2.72**	**4.79**	**3.91**	**0.668**
Project Delivery Benefits	**10**	**2.88**	**4.69**	**3.78**	**0.633**

Source: Field Work (2025)

Descriptive statistics, as presented in Table 3, reveal the central tendencies and variability of the ratings for both lean construction principles and the corresponding benefits to project delivery. The mean score for lean construction principles was 3.91 with a standard deviation of 0.668, indicating a generally high level of agreement among respondents on the relevance and application of these principles in building projects across Anambra State.

Similarly, the mean score for the project delivery benefits associated with lean construction was 3.78 with a standard deviation of 0.633, also demonstrating strong agreement on the positive impact of lean practices. The closeness of these mean values to the upper boundary of the 5-point Likert scale (which ranges from 1 = strongly disagree to 5 = strongly agree) suggests a favorable perception of both the implementation and the outcomes of lean construction practices.

Furthermore, the relatively low standard deviation values in both cases reflect a consistent pattern of responses among the sampled professionals, thereby enhancing the reliability of the data. These descriptive insights set the stage for inferential testing, particularly the correlation analysis which confirms whether the observed relationship is statistically significant.

Table 4: Summary of correlation analysis

Correlations

		Lean Principles	Project Delivery Benefits
Lean Principles	Pearson Correlation	1	.921**
	Sig. (2-tailed)		.000
	N	10	10
Project Delivery Benefits	Pearson Correlation	.921**	1
	Sig. (2-tailed)	.000	
	N	10	10

**. Correlation is significant at the 0.01 level (2-tailed).

The Pearson correlation analysis, as presented in Table 4, reveals a strong and statistically significant positive correlation ($r = 0.921$, $p < 0.01$) between the application of lean construction principles and improvements in building project delivery. This suggests that a higher adoption of lean principles corresponds to greater benefits in delivery performance, such as waste reduction, quality improvements, and enhanced collaboration.

Given that the p-value is less than 0.01, the null hypothesis (which posits no significant relationship) is rejected. Consequently, the alternative hypothesis is accepted, affirming that the implementation of lean construction principles significantly improves building project delivery in Anambra State

5. CONCLUSION

This study was conducted to evaluate the application of Lean Construction Principles as a solution for enhancing building project delivery in Anambra State, Nigeria. The findings indicate that Lean Construction has significant potential to improve building project delivery in Anambra State by increasing efficiency, minimizing waste, enhancing quality, and promoting better collaboration among stakeholders and their satisfaction.

From the findings, the respondents rated generating value, respect for people, eliminating waste, continuous improvement, pull planning, and simplifying processes as the six most significant principles for practicing lean construction in the Anambra State construction industry. These principles correspond with findings from previous researches in similar contexts, underscoring the importance of the aforementioned principles in adopting lean construction as a way to enhance the project delivery and performance in Anambra State construction sector.

The study recommends that construction firms in Anambra State and stakeholders invest in training programs to enhance skills related to Lean Construction Principles. Top management in the construction sector should support Lean Construction Principles by encouraging teamwork, preventing corruption, and adopting new methods. It is essential to establish integrated project delivery frameworks that promote openness, communication, collaboration, and teamwork among stakeholders in the construction sector. The government should encourage construction firms to implement Lean Construction Principles since they reduce waste and improve quality through incentives and motivation. Adopting digital tools that complement lean practices, such as Building Information Modeling (BIM), can enhance planning and real-time collaboration.

This study contributes to the knowledge of Lean Construction by providing localized, evidence-based insights into the challenges and benefits of Lean Construction implementation in Anambra State. Based on the current study and existing literature, future studies should explore the integration of Lean Construction with digital technologies like BIM and IoT to enhance project delivery in Anambra State.

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