Lean Construction Pivot Strategies: A Sri Lankan Perspective

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Abstract

This study explores the effectiveness of Lean Construction practices within Sri Lanka's building construction sector, addressing the need to overcome barriers that hinder successful implementation. Although global literature highlights multiple benefits of lean principles, the Sri Lankan construction industry faces significant challenges due to limited awareness and familiarity with these methods creating a clear research gap. To assess the applicability and impact of Lean tools, the study employed both quantitative and qualitative approaches, with statistical analyses conducted using SPSS. Findings reveal that several tools such as 5S, Visualization, Just-In-Time (JIT), Total Quality Management (TQM), and Value-Based Management (VBM) are suitable for local adoption. Among these, Visualization proved most effective in enhancing project quality, cost control, and time efficiency. The results emphasize the importance of education and training initiatives to promote broader lean adoption and realize its full potential in improving Sri Lankan construction performance.

Keywords: Construction; Lean concept; Quality; Sri Lanka; Visualization

Introduction

Among the industries that contribute most to the economies of various countries is the construction sector. However, being one of the biggest pollutants, the sector also plays a major role in deteriorating the environment (Alia, Zain, & Ahmad, 2015). The construction industry faces ongoing challenges such as excessive wastage, delays, budget overruns, and quality control issues(Nowotarski, Paslawski, & Matyja, 2016).Here are where cutting-edge lean construction techniques may be able to change the game; the objective of this study is to make an empirical effort to comprehend this occurrence(Jagannathan, Vijay, & Reddy, 2024).However, the projects are complicated due to its unclear nature, lack of knowledge, restricted location for building, and low stakeholder involvement. Reducing the environmental impact of construction activities is also important to green and sustainable growth. However, fully sustainable buildings are still far away from being produced using existing construction processes (Nahmens & Ikuma, 2012). Lean Construction is a management philosophy aimed at minimizing non-value-adding activities while enhancing value-adding activities in construction projects, as established by the Lean Construction Institute (ILC)(Garcés & Pérez, 2023).

Lean construction differs significantly from traditional construction by focusing on production-oriented project delivery, employing pull planning, utilizing contingency reserves to reduce system variability,

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and aligning stakeholder interests through fair risk-reward sharing and collaborative planning (Ballard & Howell, 2003). Low adoption of lean principles limits Sri Lankan construction efficiency, so this study aims to discover the implementation of lean principles to overcome the difficulties of projects in Sri Lanka by establishing a framework, as the lean concept effectively deals with complex and uncertain projects (Fernando, Dissanayake, & Kumaraswamy, 2024).

Objectives of the Study

Followings are the objectives of this study,

I. To identify the applicable lean techniques within the Sri Lankan construction industry.
II. To analyse the benefits & barriers associated with using lean principles of the country's building construction sector.
III. To assess the most suitable lean techniques impact for Sri Lankan building projects efficiency.

Literature Review

The core idea of the phrase "Lean" is to reduce waste at every stage of the process and to try to make tasks as easy as practicable to understand, start, and manage (Kawmudi & Karunarathne, 2023). The Lean Construction model, derived from Lean Manufacturing, seeks to enhance production efficiency in construction by identifying and minimizing workflow disruptions, ultimately reducing waste and rework (Aureliano, Almeida, & Costa, 2019). A well-managed project will help meet and even surpass the clients' expectations. That will make the best use of all available resources and work to ensure that the project is completed successfully on schedule and within budget (Ansah, Sorooshian, & Mustafa, 2016). Time, money, and quality are the three benchmarks of sustainable project management that a construction project must meet to satisfy the client (Hettiaarachchige, Ranasinghe, & Nandasena, 2022). Previous studies have identified Lean construction methods to enhance delivery systems and protocols through the elimination of waste, the promotion of productivity, and the improvement of health and safety. well as meeting client expectations.

i. 5S - On building sites, the 5S housekeeping technique is frequently employed and is comparable to lean manufacturing. On a construction site, the material layout is frequently employed to implement the 5S methodology (Salem, Solomon, Genaidy, & Minkarah, 2005).

ii. JIT - Manufacturing and construction are distinct production types and because construction is more complex than manufacturing, the application of Just-In-Time (JIT) to construction differs significantly from that of manufacturing as well as construction uncertainties (Howell & Ballard, 1995).

iii. Visualization -Through information accessibility for all project participants, visual management promotes organizational transparency. It makes information easier to interpret for all project stakeholders by using visual indicators instead of words (Kawmudi & Karunarathne, 2023).

iv. TQM -Total Quality Management (TQM) is attained by staff members at all levels working together to continually improve performance to raise customer satisfaction offers the environment and culture necessary for technological advancement and innovation (Gunaydin & Doğan, 1997).

v. VBM - Building project briefs usually include a definition of values, along with needs, goals, and expectations. Achieving these standards specified by the building customer and users is the primary objective. Market value and utility value are the two types of values. The impact on human behaviour is the central idea of Value Based Management (VBM) (Bejder & Wandahl, 2003).

Implementing the Lean Concept in the construction industry has faced challenges globally, but some sectors have identified opportunities for improvement. The primary advantage of Lean implementation is waste reduction (Mohan & Iyer, 2005). By putting off waste inside the creation, Lean Concept encourages the following:

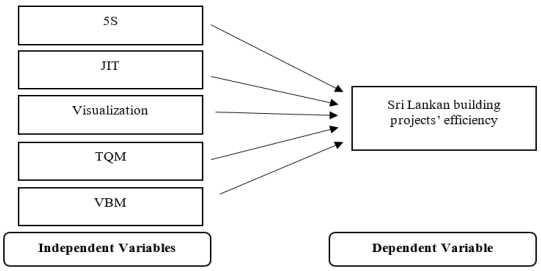
- Minimise double handling and movement of system and employees
- Balance team, coordinate flows
- Take off fabric constraints,
- Minimise variance in input
- Minimise changeovers and hard setups
- Reduce interpersonal dynamics

Methods

The research is firmly grounded in a mixed research methodology (qualitative and quantitative), seeking to identify the primary Lean Technique for the Sri Lankan construction industry. To accomplish the research objectives, a comprehensive literature review, Questionnaire survey and semi-structured interviews were utilized as data collection techniques. Nine interviews were conducted with construction professionals possessing at least a Bachelor of Science qualification along with relevant professional credentials and over five years of experience using purposive sampling. The data obtained from the interviews were categorized into six distinct groups, which encompass awareness of the lean concept and Lean Techniques, prior utilization of Lean Techniques in their respective firms, the most comprehensible Lean Technique, the most easily applicable Lean Technique, the most effective Lean Technique post-implementation, and the key barriers to applying these techniques within the Sri Lankan Construction industry. A designated questionnaire was circulated among the expert professionals in the Sri Lankan construction sector. A questionnaire (Google form) was designed and shared via email and social media amongst construction industry professionals actively employed in the industry. The respondents were requested to rank the extraordinary viewpoints in keeping with a "Likert Scale". The questionnaire shared amongst 30 wide variety of specialists (decided on via stratified random sampling technique). A sample size of 30 was selected due to the limited knowledge and awareness of the lean concept among construction professionals as a limitation.

The collected data were analysed using the SPSS (Statistical Package for the Social Sciences) data analysis tool. The overall research methodology of this study is based on below conceptual framework.

Figure 7
Conceptual Framework



Source: Literature Review Data

Following that, statistical techniques such as regression analysis and correlation were utilized to observe quantitatively the links between Lean

Construction techniques and challenge performance criteria. Using thematic analysis interview data and the literature review data were analysed.

Results and Discussion

A. Correlation analysis

The data gained from the questionnaire survey were analysed through SPSS software to examine the above-mentioned hypothesis between independent and dependent variables. Because the "Pearson Correlation Coefficient" indicates linear correlations between two variables, it was utilized in this study using the SPSS software. variables having a -1 to +1 range. A positive correlation between two variables indicates that when the value of one grows, so does the value of the other. When there is a negative correlation between two variables, it means that when one variable increases, the other variable's value decreases. The significance value (P) will determine whether or not the correlation coefficient is met. If P is less than 0.05, there is a relationship between the DV and the specific IV; if P is greater than 0.05, there is no association.

Table 8

Correlation Analysis

Correlations

		AIV	AJIT	AVZ	ATQM	AVBM	ADV
AIV	Pearson Correlation	1	.933**	.370*	.439*	0.357	.433*
	Sig. (2-tailed)		0.000	0.044	0.015	0.052	0.017
	N	30	30	30	30	30	30
AJIT	Pearson Correlation	.933**	1	0.331	.466**	0.333	.402*
	Sig. (2-tailed)	0.000		0.074	0.009	0.072	0.027
	N	30	30	30	30	30	30
AVZ	Pearson Correlation	.370*	0.331	1	.702**	.966**	.886**
	Sig. (2-tailed)	0.044	0.074		0.000	0.000	0.000
	N	30	30	30	30	30	30
ATQM	Pearson Correlation	.439*	.466**	.702**	1	.730**	.721**
	Sig. (2-tailed)	0.015	0.009	0.000		0.000	0.000
	N	30	30	30	30	30	30
AVBM	Pearson Correlation	0.357	0.333	.966**	.730**	1	.879**
	Sig. (2-tailed)	0.052	0.072	0.000	0.000		0.000
	N	30	30	30	30	30	30
ADV	Pearson Correlation	.433*	.402*	.886**	.721**	.879**	1
	Sig. (2-tailed)	0.017	0.027	0.000	0.000	0.000	

N	30	30	30	30	30	30

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

**. Correlation is significant at the 0.05 level (2-tailed).*

Where,

a) N = No. of respondents
b) AIV= Average of 5 S
c) AJIT= Average of JIT
d) AVZ = Average of Visualization
e) ATQM = Average of Total Quality Management
f) AVBM = Average of Value-based Management
g) ADV= Average of Dependent Variable

According to the above table all variables' Pearson correlations range from -1 to +1 and P < 0.05, it may be concluded that every independent variable and dependent variable are related.

B. Regression analysis

Table 9

Regression Analysis

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1	(Constant)	-1.214	0.829		-1.465	0.156
	AIV	0.213	0.513	0.105	0.415	0.681
	AJIT	-0.030	0.585	-0.013	-0.052	0.959
	AVZ	0.631	0.409	0.530	1.541	0.136
	ATQM	0.217	0.213	0.140	1.016	0.320
	AVBM	0.293	0.448	0.232	0.654	0.519

a. Dependent Variable: ADV

The regression's unstandardized β value or coefficients show how much of the building project's efficiency (DV) is reflected by tools for lean construction (IV). The β values were explained to illustrate the practical significance of each lean tool's impact. According to the above table, there is a 29.3% (β = 0.293) variance in between Vale based management system lean technique and the Sri Lankan building projects' efficiency. With the increase of properly implemented 5S lean tool building projects efficiency increases by 21.3%. (β = 0.213) With the proper visualization lean technique, the building projects' efficiency can be increased by 63.1% (β = 0.631) and the properly implemented Just in Time technique can delay the projects' efficiency by 3% (β = - 0.030).

C. Thematic Analysis

Conducting education efforts for lean construction, testing the tools on a brief project with specialists, and increasing, working together and pushing the company's upper management to apply lean construction tools across the board are two short-term solutions to problems with lean construction tool implementation. Long-term recommendations for the effective application of lean construction tools in Sri Lanka include creating a government institute for lean construction, encouraging the construction sector to adopt new technologies, creating an appropriate framework for implementation, carrying out a case study to determine the advantages of lean construction, and offering appropriate lean construction education and training.

Conclusion

A study indicates that visualization is the most practical and widely applied Lean Construction technique in Sri Lanka's construction sector. Both qualitative and quantitative analyses revealed that visualization significantly enhances cost control, time efficiency, and overall project quality, positively impacting performance. Despite these benefits, the study identified a major barrier to wider adoption: limited awareness and unfamiliarity with Lean techniques among construction professionals. To address this, the findings emphasize the need for developed education and training to foster understanding and implementation of Lean Construction, thereby promoting more sustainable and efficient project outcomes. The study recommends structured training programs, government-industry collaboration to institutionalize lean practices, pilot projects to demonstrate practical benefits, and inclusion of lean modules in construction management curricula. Future research should focus on larger sample sizes, case-based validation, and integration with digital tools such as Building Information Modelling (BIM) to further optimize Lean Construction applications in Sri Lanka.

Acknowledgement

I want to express my sincere gratitude to everyone who helped me along the way. I want to sincerely thank all of the professionals who assisted me by answering our questionnaire and conducting interviews.

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