advances in Technology

Adv. Technol. 2025, 5(1), 27-31

Full Paper

Implementation of Lean Principles in Building Construction Industry, Sri Lanka

H.M.K.A. Senevirathne[a,*] and B.A.D.S. Wimalasena[b]

[a]Department of Construction Technology, Faculty of Technology, Wayamba University of Sri Lanka, Kuliyapitiya 60200, Sri Lanka

[b]Department of Civil and Environmental Engineering, Faculty of Engineering, University of Ruhuna, Galle 80000, Sri Lanka

Corresponding Author: kushanisenevirathne97@gmail.com

Received: 07 May 2023; Revised: 12 August 2024; Accepted: 12 August 2024; Published: 19 March 2025

Abstract

Lean construction has been introduced into the Sri Lankan construction industry to address critical challenges, including waste management and high construction costs due to high material costs and lack of skilled labor. The aim of this study is to investigate the extent to which lean construction is implemented in the Sri Lankan building construction industry. This paper presents the findings of a study that investigated the state of lean construction implementation in the Sri Lankan building construction industry using quantitative and qualitative research methods. A questionnaire survey was conducted to obtain the opinions of construction professionals on the types of tools and techniques that support the implementation of lean construction, stages of application of lean methods, and benefits of lean construction to the projects. In addition, interviews were carried out to obtain expert views on the implementation of lean construction, including challenges encountered in the Sri Lankan building construction industry. Primary data collected include 51 completed questionnaires and five expert interviews with building construction industry professionals using a simple random sampling method. The collected data were analyzed using descriptive analysis and the chi-square goodness of fit test. The investigation revealed that the 5S concept is the most used lean tool in the industry. It was also revealed that many of the lean methods are applied during the construction stage knowingly and sometimes unknowingly. It is important to note that the results suggest that the reduction of waste is the dominant benefit that the building construction industry receives due to the adaptation of lean construction techniques in Sri Lanka. Lack of technical knowledge, employee resistance to adapting to lean culture, and lack of cooperation were identified as the main challenges. Overall, this study reveals moderate awareness among Sri Lankan construction industry professionals of lean construction and the findings will help the Sri Lankan construction industry to establish strategies for implementing lean construction in line with their project goals to achieve higher productivity.

Keywords: building construction, construction efficiency, construction productivity, lean construction, lean tools and techniques

Introduction

Lean construction is a concept derived from the manufacturing industry. It focuses on continuously improving workflow, adding value throughout the system, and eliminating waste. Conventional methods have not been successful in removing waste and non-value-added activities from construction processes; they are a major cause of declining productivity. The construction industry seeks effective ways to reduce construction inefficiencies to improve their productivity. To survive in the competitive market, it is essential for construction companies to improve the quality of work, increase work efficiency, reduce waste and costs, and increase profits [1]. Lean construction (LC) is appropriate as an

alternative to eliminate major weaknesses in the Sri Lankan construction industry [2]. LC has so far proven to be a reliable management philosophy for improving construction productivity and removing waste from construction [3].

To address these challenges, lean construction has been introduced into the Sri Lankan construction industry; however, it is still in its infancy and needs to grow more. Therefore, this paper summarizes the findings of a study aimed at assessing the extent to which lean construction is implemented in the Sri Lankan building construction industry. More specifically, the study investigated the current lean practices in the Sri Lankan building construction industry, identified the benefits and challenges of implementing lean construction, and generated recommendations for implementing lean in building construction projects in Sri Lanka.

Literature Review

The credit for lean as a production philosophy truly goes to the president of the Toyota Production System [4]. The main objective of Lean production is to improve production efficiency and deliver the best value for high-quality products to the customer. In Western countries, the same concept has been adopted with the term "lean thinking" [5]. It is also borrowed by the construction and manufacturing industries, hence the terms "lean construction" and "lean manufacturing", respectively. Unlike the manufacturing industry, the construction industry has a project-based production process that has also been considered a temporary-based production system [6]. A Temporary-based production system needs to be designed, produced, and delivered to project goals within a specified time. Lean construction involves ways of designing production systems to minimize waste in materials, time, and human effort, intending to generate maximum cost-effective value [7]. In general, lean construction tools aim to reduce waste, increase productivity, health and safety, and improve delivery systems to meet client needs [8]. Lean practices implemented in the construction industry are management practices that seek to address economic issues and enhance the quality of construction projects and client satisfaction as social issues [9].

Materials and Methods

To investigate the implementation of lean construction in the Sri Lankan building construction industry, a structured online questionnaire survey and phone interviews were conducted. A total of 90 questionnaires were distributed using a simple random sampling method to professionals such as Project Managers, Site Managers, Contractors, Engineers, Consultants, Assistant Engineers, Foremen, Quantity Surveyors, and Supervisors registered with the Construction Industry Development Authority (CIDA) in grades CS2, CS1, C1 and C2. From this total, only 57% of the professionals were involved as respondents for this study. Sri Lankan construction industry experts in the roles of Project Managers, Site Engineers and Engineers with knowledge and industry experience in the area of study were selected for the phone interviews.

Data analysis was carried out using Microsoft Excel and IBM SPSS Statistics 25.0 software package. The descriptive statistical analysis and the Chi-square statistical test were mainly used.

Results and Discussion

The sample data was found to be a true representative of the population, which was determined after conducting the Chi-square goodness of fit test with a 0.05 level of significance. Major findings of the study have been organized into the following sections: (i) Awareness about LC, (ii) Usage of lean tools and stages of application, (iii) Benefits and challenges of lean implementation.

Awareness of Lean Construction

The knowledge and awareness about lean construction principles are of great importance to any implementation. The summary of the awareness statistics which is presented by Figure 1 reveals that more than two-thirds of the population has knowledge in the range of "good" to "excellent". Therefore, the construction professionals in the construction industry seem to be aware of lean construction concepts.

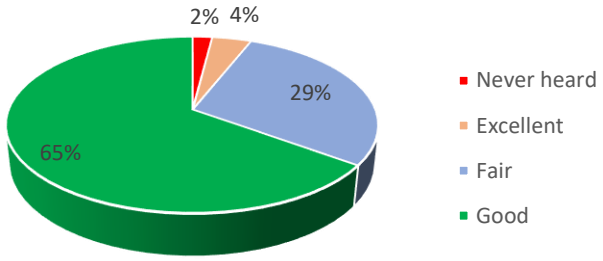

Figure 1. Respondents' Knowledge of Lean Construction

Application of Tools that Support the Implementation and Stages of Application in Building Construction Projects

Table 1 below shows how often different lean methods are currently implemented in the Sri Lankan building construction industry.

Table 1. Analysis summary of the level of lean tool usage

Lean tool	N	Percentage	Ranking
Last Planner System	13	18.1%	3
5S Concept	26	36.1%	1
Construction Process Analysis	17	23.6%	2
Six Sigma	5	6.9%	5
Value Stream Mapping	11	15.3%	4
Total	72	100.0%	

The results reveal that the "5S concept" is the most used tool for lean implementation in Sri Lanka which affirms the previous study [10]. Authors tie this finding to the applicability of 5S in various construction processes such as monitoring, auditing and sorting materials, equipment and tools on-site, regular housekeeping and cleaning, and removal of waste from the site [11]. Other techniques the industry seems to have employed include; Computer-aided designing, Visual management, Weekly

huddle meetings, and SMART process. The qualitative analysis identified different companies that have developed different tools based on their drivers such as cost reduction, reduce project duration, improve productivity, and profit margin.

All stages in a construction project: planning, designing, construction, operation and maintenance, and handover are needed to be carefully monitored to achieve the intended benefits of the lean application. The study findings reveal that lean construction is implemented in all the stages while most common was during the construction stage, and the least during the handover stage. Previous research studies suggest the reason for such a skewed implementation during the construction stage is because of the large number of activities that contribute significantly to project time, resources, and cost [6, 12].

Benefits and Challenges in Lean Construction

The top five benefits the industry is getting as a result of lean implementation are waste reduction, cost reduction, saving time, maximizing productivity, and customer satisfaction. It is evident that the reduction of waste is the most significant benefit of building construction contractors are benefiting from lean. The study also identified improved company image, improved site safety, enhanced efficiency of work and increased profitability as the benefits of lean implementation.

The qualitative study found that the key challenge persisting in the industry is the resistance to change from traditional work practices to a lean culture. Lack of knowledge, the excessive time taken for the implementation process, lack of employee involvement, and support from the management are obstacles.

Conclusion

This paper summarizes important findings of a study on the state of lean construction implementation in the Sri Lankan building construction industry. It was revealed that the '5S concept' is the most implemented lean principle in construction projects. It was also evident that lean construction methods were implemented mostly during construction. The study revealed that the reduction of waste is the dominant benefit due to the adaption of lean construction by Sri Lankan building contractors. Other benefits include maximizing the project efficiency and thereby increasing competitiveness. Majorly, Sri Lankan construction companies encountered some challenges in the implementation of lean construction. The highest-rated ones are lack of technical knowledge, employee resistance to adopting the lean culture and lack of corporation of employees. This study's results show that almost lean methods are used in the construction industry, but they are not fully functioning due to lack of support from construction organizations and lack of knowledge. Many respondents who use these lean techniques are not fully aware of the specific functions that make them up. The research suggests that there is little awareness of lean construction and 98% of respondents are willing to know about lean construction principles and possible applications if opportunities are available in the future. Lean construction is still in its beginning stage, but it requires a lot of effort to implement lean principles properly. To achieve the desired drivers needed to implement lean construction within the organization, education and staff training on the elements of lean construction should adopt strategies identified as a way to overcome the challenges faced by organizations. Also, the involvement of all

stakeholders to implement lean principles in the organization. Overall, this study reveals moderate awareness among Sri Lankan construction industry professionals of lean construction.

Conflicts of Interest

No potential conflict of interest was reported by the authors.

Acknowledgement

The authors gratefully acknowledge the industry professionals who actively participated in the questionnaire survey and discussion sessions for this study.

References

[1] Thilakarathna, N. and Senaratne, S., *A preliminary literature review into lean construction implementation, World Constr*, in *Conf. 2012 - Glob. Challenges Constr. Ind*. **2012**.

[2] Senaratne, S. and Wijesiri, D., Lean construction as a strategic option: Testing its suitability and acceptability in Sri Lanka. Lean Construction Journal, **2008**, 34-48.

[3] Gao, Z., Aslam, M., and Smith, G., *Strategies to Increase Adoption Rate of Lean Construction*. 2020, EasyChair. p. 364-354.

[4] Ballard, G. and Howell, G. *What kind of production is construction*. in *Proc. 6 th Annual Conf. Int'l. Group for Lean Construction*. **1998**. pp. 13-15.

[5] Womack, J.P. and Jones, D.T., Beyond Toyota: How to Root Out Waste and Pursue Perfection. Harvard Business Review, **1996**, 1-16.

[6] Sarhan, J.G., Xia, B., Fawzia, S., and Karim, A., Lean Construction Implementation in the Saudi Arabian Construction Industry. Construction Economics and Building, **2017**. 17*(1)*, 46-69. 10.5130/AJCEB.v17i1.5098.

[7] Howell, G. What is lean construction. In *Seventh Conference of the International Group for Lean Construction* **July 26-28, 1999**. University of California, Berkeley, CA, USA pp. 1–10.

[8] Ansah, S.R.H. and Sorooshian, S., Lean construction: An effective approach for project management. ARPN Journal of Engineering and Applied Sciences, **2016**. 11*(3)*, 1607-1612.

[9] Babalola, O., Ibem, E.O., and Ezema, I.C., Implementation of lean practices in the construction industry: A systematic review. Building and Environment, **2019**. 148, 34-43. 10.1016/j.buildenv.2018.10.051.

[10] Thilakarathna, N. and Silva, L.D. *Significance of minimizing non-value adding activities construction processes using lean techniques*. in *The First International Conference of the CIB Middle East and North Africa Research Network* **2014**. Abu Dhabi, United Arab Emirates pp. 685-701.

[11] Fauzan, M. and Sunindijo, R.Y., Lean construction and project performance in the Australian construction industry. IOP Conference Series: Earth and Environmental Science, **2021**. 907*(1)*, 012024. 10.1088/1755-1315/907/1/012024.

[12] Salem, O., Solomon, J., Genaidy, A., and Luegering, M., Site Implementation and Assessment of Lean Construction Techniques. Lean Construction Journal, **2005**, 1-21. 10.60164/e2i9e2h1d.