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A Review on Implementing Lean Construction Technique in Construction Industry

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Abstract: *In this literature review the concept of lean construction and its impact on time, cost, and resource management in construction projects are explored. The study examines various research articles and academic papers in the field of lean construction to identify the primary themes and findings. The review indicates that lean construction practices can have a positive effect on time, cost, and resource management by reducing waste, enhancing communication, and encouraging collaboration among stakeholders. The implementation of lean construction principles has been demonstrated to lead to shorter project durations, lower costs, and better resource allocation. However, the review also acknowledges the challenges associated with implementing lean construction in the construction industry, such as resistance to change, limited knowledge and understanding, and difficulties in assessing its impacts. In conclusion, this literature review concludes that lean construction has the potential to enhance time, cost, and resource management in construction projects, and proposes the need for further research to overcome the challenges and facilitate its adoption.*

Keywords: Lean construction, Time, cost, resources management

I. INTRODUCTION

Lean is a production and management strategy that places a strong emphasis on cutting out waste from operations and providing customers with value. Organizations have embraced it broadly to increase their effectiveness, quality, and competitiveness. However, a number of variables, including corporate culture, employee engagement, leadership support, and technology use, affect how well lean is implemented. To identify and prioritize the issues affecting lean adoption, the SWARA (Step-wise Weight Assessment Ratio Analysis) method can be employed. SWARA is a multi-criteria decision-making (MCDM) method that assesses choices in light of a number of factors and their relative weights. It enables decision-makers to rank the options and decide which is most suited to their preferences. In this study, we will apply the SWARA method to identify and prioritize the factors affecting lean implementation. We will first select the relevant criteria and their respective weights based on expert opinions and literature review. Then, we will use the SWARA method to evaluate the factors and determine their relative importance. The assessing the validity and reliability of the questionnaire using statistical tests, were performed to identify significant differences between ranked data and determine the key factors impacting waste management. Finally, we will rank the factors and provide insights for decision-makers to prioritize their lean implementation efforts.

II. KEY CONCEPTS OF LEAN CONSTRUCTION

Lean construction is an approach to project management and construction that focuses on reducing waste and increasing efficiency in the construction process. Lean construction aims to optimize the value provided to clients while minimizing waste in terms of time, materials, and resources. This approach shares many principles with lean manufacturing, which focuses on removing waste and generating value for customers. Lean construction requires ongoing improvement and cooperation among all parties involved, including the owner, designer, contractor, and subcontractors, to achieve optimal outcomes.

Some key concepts of lean construction include:

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- **Pull Planning**: Rather than traditional "push" planning where the schedule is imposed, pull planning involves the team collaboratively creating a schedule based on the project's end date and working backwards.
- **Value Stream Mapping**: This involves mapping out the flow of materials and information through the construction process to identify areas of waste and inefficiency.
- **Last Planner System**: This is a collaborative approach to scheduling that involves the team at the job site, who are most familiar with the work, in the planning process.
- **Continuous Improvement**: Lean construction is an iterative process that requires continuous improvement and optimization of the construction process. The principle of lean philosophy include eliminating waste and variability in activities, identifying the precise value proposition from the 3 end customer's perspective, clearly identify the value flow process that delivers this proposition, and eliminating all non-value-creating steps to enhance the overall value proposition for the customer.

III. REVIEW OF JOURNALS

Nasiri, A., Mansory, A., & Mohammadi, N. (2022), This research aims to identify and evaluate effective factors for implementing Green Supply Chain Management (GSCM) at Fanavaran Petrochemical Company. Through a literature review and survey of 55 experts and senior managers, 11 factors were selected and evaluated using the SWARA technique. The most important factor was designing products to reduce energy and material consumption, followed by materials compliance and procurement, while total environmental quality management was the least important [1].

G. Nilay Yücenur, Kaan Senol. (2021),This study aimed to create a lean construction system by selecting appropriate lean techniques to eliminate waste and increase process efficiency. The problem involved 8 main criteria and 24 sub-criteria related to construction waste, and 5 alternative lean techniques. The SWARA method was used to determine criteria weights and importance order of waste, while Fuzzy VIKOR method evaluated lean techniques. Faulty construction and operational mistakes were identified as the most important waste, and Kanban and Visual Management were determined as the most suitable lean techniques for construction processes [2].

Cristian Huaman-Orosco1 and Andrews A. Erazo-Rondinel. (2021), This study aims to identify and classify the obstacles to Lean Construction (LC) implementation in Peru. A literature review and consultation with six experts with ten years of experience in LC implementation in various projects identified 32 barriers, divided into four types. A survey of 124 engineers from different projects ranked the main obstacles, revealing "lack of government policies," "lack of alliances between academy and organizations," and "high use of time and cost with no return" as the main barriers. The study generates a roadmap and lines of research to overcome these barriers [3].

M Fauzan and R Y Sunindijo (2021), The objective of this research is to analyze the adoption of lean construction techniques in the Australian construction industry, with the aim of enhancing project performance. The study evaluates the effectiveness of four lean construction tools, namely Just in Time, Last Planner System, Six Sigma, and 5S Management, by collecting data through a questionnaire survey of construction practitioners located in Sydney. The results demonstrate satisfactory implementation of these tools and a positive correlation between lean construction and improved project performance. The study also identifies opportunities for further improvement and offers detailed recommendations to enhance the implementation of lean construction techniques[4].

Zulfiquar N. Ansari, Ravi Kant, Ravi Shankar, (2020),This research aims to identify and rank solutions for mitigating sustainable remanufacturing supply chain (RSC) risks through a hybrid MCDM framework using fuzzy SWARA and COPRAS. The framework was applied to a case organization and identified management initiatives and collaboration with government and stakeholders as the most effective solutions to manage risks. Sensitivity analysis was conducted to ensure the robustness of the framework. The results provide practical insights for decision-making in RSC for practitioners and researchers [5].

Sevilay Demirkesen, Nadia Wachter, Svenja Oprach, and Shervin Haghsheno (2019),The paper categorizes barriers to implementing Lean philosophy in construction and identifies the top three obstacles as lack of top management support, misperception about Lean practices, and lack of information sharing and change control. Removing these barriers could 11 improve efficiency and productivity, according to the study's findings based on a questionnaire administered to professionals [6].

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Olajide Faremi and Olabode Ogunsanmi. (2019), The objective of this research is to analyze the obstacles to efficient cost and time management in construction projects through a survey of 80 project managers in Lagos, Nigeria. The study identified design and documentation issues, poor labor productivity, and financial resource management as the three primary factors affecting cost and time control. To achieve better cost and time performance, the study recommends prioritizing quality work, focusing on project tripod constraints, and ensuring that workers have adequate skills [7].

Edgar P. Small, Khaled Al Hamouri, Husameddin Al Hamouri. (2017), The primary objective of this paper is to examine the possibility of applying lean construction principles in the United Arab Emirates (UAE) and to analyze the reasons for the low level of implementation, despite the interest expressed by construction executives. The study confirms previous research conducted in Dubai, which identified obstacles to the implementation of lean construction and ranked them according to their potential impact on lean principles. The paper suggests strategies for overcoming institutional resistance and highlights potential avenues for future research aimed at raising awareness of lean construction practices. The study aims to provide additional insight into the needs of the construction community in the UAE and the desire for lean implementation [8].

S. Dinesh, R. Sethuraman & Shruthi Sivaprakasam. **(2017)**,This paper reviews the literature on lean construction, which is a management approach aimed at minimizing waste and improving productivity in the construction industry. The study highlights the importance of understanding the concept of lean, proper implementation, and sustainability in achieving the benefits of lean construction. The authors use relevant methods to analyze and describe the available literature on the subject. The paper emphasizes the potential of lean construction to bring about positive changes in the construction industry [9].

Yunus, R., Noor, S. R. M., Nagapan, S., Hamid, A. R. A., Tajudin, S. A. A., & Jusof, S. R. M. (2017), The paper explores how incorporating lean thinking in the Industrialised Building System (IBS) can enhance productivity in the manufacturing of building components by identifying critical success factors (CSFs). In the context of construction, the emphasis of lean thinking is on both the production process and meeting the client's needs. The study gathered data from contractors, manufacturers, developers, and local authorities in Malaysia through a questionnaire survey. A total of 31 CSFs for lean thinking in IBS were identified, and a conceptual model was created to analyze their 14 influences. The study's goal is to assist construction industry stakeholders in improving their IBS manufacturing processes by eliminating unnecessary activities and focusing on essential processes, while minimizing physical and non-physical waste. [10].

Mohammed Al Manei, Konstantinos Salonitis, Yuchun Xu. (2017), This paper discusses the challenges of implementing lean manufacturing in small and medium enterprises (SMEs) are discussed in this paper, which highlights that existing frameworks are primarily designed for large companies. While lean implementation can bring benefits, unsuccessful attempts can impact resources and employee confidence. The paper reviews well-known lean implementation frameworks and evaluates their relevance to SMEs [11].

Ansah, R. H., Sorooshian, S., & Mustafa, S. B. (2016), This paper discusses the challenges faced by the construction industry in managing fast, complex, and uncertain projects with long, complicated supply chains and multiple process design changes. The traditional tools and techniques of construction management have been criticized as deficient in handling these challenges, resulting in various forms of waste. The paper emphasizes the need for the adoption of lean production systems, specifically Lean Construction (LC), as a practical and robust approach to project management. The benefits and importance of implementing LC are discussed, highlighting its ability to improve project flow management and reduce waste [12].

Bhargav Dave, Juho-Pekka Hämäläinen, Sergio Kemmer, Lauri Koskela, Anssi Koskenvesa. (2015), Last Planner System (LPS) is a popular lean construction tool for production management on construction sites. However, LPS does not directly address task continuity and lacks visual tools, unlike Line of Balance (LOB) approaches. The authors suggest the need for a robust theory of planning and scheduling is necessary and propose combining the use of Last Planner System (LPS) and Line of Balance (LOB) to develop a more effective approach for construction scheduling. In general, a more extensive and inclusive solution is required to address the critical issues related to planning and scheduling functions in construction projects. [13].

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Jaapar, A., Marhani, M. A., & Ahmad Bari, N. A. (2015), By conducting a thorough review of the available literature, the paper has identified a lack of knowledge regarding the implementation of green lean construction (GLC) tools in the Malaysian construction industry. To address this gap and enhance project performance, the paper recommends the development of a GLC implementation framework that can effectively address the challenges of lean construction. The adoption of GLC tools is expected to promote sustainable construction practices and lead to better quality projects, which can ultimately enhance the quality of life. To further explore this topic, future research will be conducted. [14].

Dallasega, P., Rauch, E., Matt, D. T., & Fronk, A. (2015),The construction sector in Italy is made up of small and medium-sized enterprises, and coordination between different disciplines is often a challenge. A methodology for demand predictability is proposed, which consists of three modules: Planning, Actualization, and Progress. The methodology uses a Rolling-Forecast approach to align tasks with budget specifications, measure deviations from the budget, and monitor construction progress. A Constant Work in Process (CONWIP) control loop is described for aligning the engineering, prefabrication, and installation of Engineer-to-Order (ETO) components, and a continuous improvement process based on the plan-do-check-action (PDCA) cycle is presented for increasing productivity on-site. The methodology is practically implemented in the expansion project of the central hospital of Bolzano in North Italy, and the scientific findings and expected outcomes are discussed [15].

Abubakar M. Bashir, Subashini Suresh, David A. Oloke, David G. Proverbs and Rod Gameson (2015),The aim of this study is to explore the challenges of implementing Lean principles in the UK construction industry and suggest solutions to overcome them. The research involved conducting semi-structured interviews with Lean construction practitioners from 10 contracting organizations. The study identified 10 challenges and 13 strategies to address them, which could improve understanding and facilitate Lean implementation in the UK construction industry [16].

Cano, S., Delgado, J., Botero, L., & Rubiano, O. (2015), In this study, 110 barriers and 51 critical success factors were identified from 83 academic articles on Lean Construction (LC) published between 1998 and 2014. These factors were grouped into six "Master Factors" and analyzed using a cause-effect matrix and structural analysis. The study found that the criticality of these factors is linked to the level of LC's application evolution in Colombian construction companies [17].

Søren Wandahl.(2014), Despite its success, implementing Lean Construction has been challenging due to misconceptions and partial implementation. A survey of 500 practitioners in Denmark compares the extent to which Lean Construction is applied with recent IGLC research on implementation challenges. The research aims to provide valuable knowledge on Lean Construction implementation for further research on the theory and implementation of Lean in the construction industry [18].

Mohd Arif Marhani, Aini Jaapar, NorAzmi Ahmad Bari, Mardhiah Zawawi. (2013), This paper explores the concept of Lean Construction (LC) and its effectiveness in managing construction projects by eliminating waste. The literature review highlights the need for a more holistic approach to LC implementation, including health and safety and six sigma. It also emphasizes the importance of systematic training and research to improve collaboration with stakeholders. Finally, the paper concludes that LC has the potential to enhance sustainability and improve the quality of life in the Malaysian construction industry [19].

Usama HamedIssa. (2013), By implementing lean construction principles using the last planner system, this study successfully minimizes the impact of risk factors that cause time-overrun in an industrial project in Egypt. PET and PPC measurements are used to evaluate the effectiveness of the implementation, with significant risk factors identified and assessed. Results demonstrate a 15.57% decrease in total project time and improved PPC values, confirming the success of lean techniques in reducing risk factors [20].

Milberg, C., & Walsh, K. D. (2012), This paper explores the concept of Lean Production in the construction industry. The authors propose three hypotheses: that the meaning of Lean in construction is ambiguous, that the origins of Lean Construction can be traced to academics and consultants rather than industry, and that sustained efforts to engage people in meaningful learning experiences are necessary to prevent Lean Construction from being viewed as a fad. The authors review relevant literature and 13 provide evidence to support their hypotheses. The paper concludes by discussing how researchers and practitioners can promote sustained learning and change within the construction industry [21].

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Sasitharan Nagapan, Ismail Abdul Rahman, Ade Asmi. (2011),This paper identifies various causes of construction waste generation and management in the construction industry, which negatively impact the environment, costs, time, productivity, and social aspects of a country. The study groups 63 waste factors into seven categories: Design, Handling, Worker, Management, Site condition, Procurement, and External. The most frequent causative factor, according to past research works, is a frequent design change that contributes to large generation of construction waste. By identifying important causes, the construction industry can avoid and alert how waste is generated, resulting in economic, social, and environmental benefits[22].

Amnon Katz, Hadassa Baum (2011),This paper proposes a methodology for estimating the evolution of construction waste during the construction of new residential buildings. The authors collected data from 10 large construction sites and developed a model based on their observations, which predicts that waste accumulates exponentially over time. The authors found good correlation between their model predictions and actual data from the field survey [23].

Henry Mwanaki Alinaitwe. (2009),The study investigates the obstacles to implementing lean construction initiatives in Uganda by presenting 31 barriers and examining their impact on success. Technical managers of building firms were interviewed to evaluate their perception of the barriers. The study identifies the provision of inputs when required as the most potent barrier, and The most significant obstacles to achieving successful waste reduction in the construction industry are a dearth of designs that are feasible to build and a management style that involves the workforce in decision-making. [24].

IV. CONCLUSION

Despite the potential benefits of lean construction for enhancing project efficiency and reducing waste, there remain significant knowledge gaps related to time, cost, and resource management, while lean construction can reduce costs by minimizing waste and inefficiencies, research is still required to effectively manage costs across the entire project lifecycle. The factors which influence the most are the objectives of this study were to review the literature on Lean construction and to develop a methodology for evaluating its performance. The literature review revealed that Lean construction has been widely studied and implemented in various sectors. The criterial factors which influence the most are identified. The methodology developed in this study aims to evaluate the Lean construction in terms of time, cost, and resource which affect the activities and analysis using multi-criteria decision-making. Overall, this study contributes to the understanding of Lean construction and study provides valuable insights for the construction industry to implement lean construction practices effectively.

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