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Performance Evaluation of Construction Management in High-Rise Building Projects Using Lean Construction Method for Resource Optimization

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KEYWORDS

Lean Construction, Construction Management, Resource Optimization.

ABSTRACT

The improvement of high-rise building projects in Indonesia requires efficient resource management to reduce waste and increase productivity. This study aims to evaluate the performance of construction management using the lean construction method to optimize resources. This research method is based on literature studies, with in-depth analysis from various secondary sources such as scientific journals and relevant technical reports. The results show that the implementation of lean construction significantly reduces material waste, waiting time, and improves workflow efficiency through strategies such as Just-In-Time, Last Planner System, and Building Information Modelling (BIM) integration. The lean approach also allows for better management of materials and labor, as well as minimizing the risk of construction errors. Thus, the lean construction method has proven to be a strategic tool in increasing efficiency and sustainability in high-rise building projects in Indonesia.

1. INTRODUCTION

The increasing number of high-rise building construction projects in Indonesia presents new challenges in effective and efficient resource management. One of the increasingly relevant approaches is the lean construction method, which aims to reduce resource waste and increase project productivity (Fiza, 2021). In construction management, the success of a project is highly dependent on how human resources, materials, and time are used optimally to meet project objectives (Susetyo, 2019). The lean construction method is a strategic solution because it is able to identify and eliminate activities that do not provide added value, thereby improving overall project performance (Astri, 2023).

Construction management is a discipline that regulates the process of planning, executing, and supervising construction projects to achieve time, cost, and quality efficiency. This discipline involves various activities ranging from human resource management, materials, to risk management that may arise during the project (Siswanto & Salim, 2019). The importance of construction management lies in its ability to integrate various elements in a project, including modern technologies such as Building

Information Modelling (BIM), which are increasingly being used to support effective decision-making (Ervianto, 2023).

In the modern context, construction management faces complex challenges, including market dynamics, regulatory changes, and demands for sustainability. A study by Hidayat and Wijayaningtyas (2019) highlights that the application of efficiency-based management principles can help reduce waste and improve project sustainability. Additionally, the adoption of technology such as project management software aids in more structured project scheduling and supervision (Yunus et al., 2023). In the scope of education, construction management is also taught to prepare competent professionals to face construction challenges in the era of globalization (Telaumbanua, 2021).

The lean construction method is an innovative approach in project management that aims to increase efficiency by minimizing waste and maximizing added value at each stage of the project. This approach comes from the principles of lean manufacturing applied to the construction sector to manage resources, time, and costs more optimally. For example, research by Pamungkas and Rifai (2024) shows that the application of Lean Construction using root cause analysis and the Borda method is able to identify and reduce non-productive activities in road construction projects. With a focus on the elimination of waste, this method has a positive impact on project productivity and efficiency.

Another study by Hasan and Abdullah (2022) highlighted that the main factor in the successful implementation of lean in building construction projects lies in the integration of systematic planning methods with supporting technologies, such as Building Information Modelling (BIM). Additionally, a lean approach allows for more responsive project scheduling and management. As a result, the rate of work errors and material waste can be significantly reduced. The application of this method is a strategic solution to face the challenges of sustainability and efficiency in modern construction projects.

The application of lean construction methods is increasingly important in facing the demands of cost efficiency and environmental sustainability in the construction industry. Complex high-rise building projects often experience obstacles such as delays, material waste, and decreased work quality due to suboptimal planning and execution (Purba et al., 2023). By utilizing lean methods, projects can be managed more effectively through an emphasis on collaboration between stakeholders and improved systematic workflows (Rahma, 2024). This is in line with the need to create projects that are not only efficient, but also environmentally friendly.

Given that the construction industry often faces challenges related to resource waste and cost efficiency, this research is important to provide practical guidance for professionals in the construction field. By understanding how lean methods can be applied systematically, project managers can improve project performance and reduce negative impacts on the environment (Susetyo & Purba, 2023).

Previous research has shown the success of the application of lean methods in reducing material waste and time in construction projects. For example, Susetyo's research (2023) revealed that a lean approach combined with modern technology such as Building Information Modelling (BIM) is able to increase efficiency by up to 30%. Another study by Fiza (2021) highlighted that project performance evaluation using lean can identify inefficient activities and improve workflows.

The purpose of this study is to evaluate the performance of construction management in high-rise building projects using lean construction methods, as well as to identify resource optimization strategies that can be applied. This study also aims to provide recommendations for the implementation of lean methods for professionals in the construction field, so that it can significantly increase project productivity and efficiency.

2. METHOD

This study uses a qualitative approach with the type of literature study (library research) to evaluate the performance of construction management in multi-storey building projects using the lean construction method. This approach was chosen because it is able to provide an in-depth analysis of the concept and implementation of lean methods based on secondary data taken from the scientific literature, research reports, and recent policy documents. Literature studies allow researchers to identify, integrate, and analyze various relevant sources of information to provide a comprehensive synthesis regarding the research topic (Zed, 2018).

The data sources of this research include indexed scientific journals, reference books, conference proceedings, and technical reports related to lean methods in construction management. Data was obtained from publications in the last five years (2019–2024) to ensure relevance and actuality. Electronic databases such as Google Scholar, ResearchGate, and ScienceDirect are used to access the literature. Relevant secondary data is identified through keywords such as "lean methods", "construction management", and "resource optimization" (Creswell & Poth, 2018).

The data collection technique is carried out through documentation studies by searching, selecting, and organizing relevant literature. The selection process is carried out by considering the quality of the methodology, the scope of the research, and the relevance of the content to the focus of this research. The selected literature was critically analyzed to identify the main findings related to the implementation of lean methods in high-rise building projects (Bowen, 2009).

The data analysis method used is content analysis, which involves encoding data, grouping themes, and interpreting results based on the literature studied. This analysis aims to identify patterns, relationships, and effective strategies in the application of lean methods for resource optimization in high-rise building projects. This approach allows researchers to provide applicable recommendations that support increased efficiency and productivity in the construction industry (Krippendorff, 2019).

3. RESULT AND DISCUSSION

The following is a literature data table that contains 10 selected articles from various publications related to the evaluation of construction management performance in multi-storey building projects using the lean construction method. These articles were selected based on their relevance to the topic, research contributions, and data up-to-date in the last five years (2019–2024). The findings from this literature provide an in-depth look at how lean methods can optimize resources and improve the efficiency of construction projects.

Table 1. literature review

No	Author	Title	Main focus

1	A. Fiza	Analisa Waste Proyek Konstruksi Menggunakan Metode Lean Project Management	Identify wasted activity in multi-storey building projects, improving workflow efficiency.
2	MRI Lubis	Perbaikan Proses Konstruksi Pembangunan Pipa Gas Dengan Penerapan Metode Lean Construction	Resource optimization and waste reduction on infrastructure projects
3	AP Dea	Tinjauan Penggunaan Metode Lean Construction Pada Proyek Gedung di Kota Bukittinggi	Application of lean construction methods for material and labor optimization
4	DM Sundara, T Tiorivaldi	Optimalisasi Kinerja Proyek Konstruksi Bangunan Gedung Melalui Building Information Modelling	Integration of BIM and lean construction for increased efficiency
5	AF Septianugraha	Evaluasi Waste Material Konstruksi pada Proyek Bangunan	Material waste estimation and application of lean principles in building projects
6	T. Fitrianto, MA Wibowo	Pengukuran Kinerja Supply Chain pada Konstruksi Gedung Bertingkat dengan Metode SCOR	Supply chain performance measurement in high-rise construction projects
7	AK Lubis	Evaluasi Waste Konstruksi pada Proyek di Pekanbaru	Application of lean management to reduce waste in building projects
8	F. Fadillah	Optimasi Penjadwalan Proyek dengan Metode CCPM	Optimizing the scheduling of building construction projects using CCPM
9	A. Wibowo	Evaluasi Penerapan BIM pada Proyek Konstruksi di Indonesia	Evaluation of BIM implementation in multi-storey construction projects
10	W. Hartono	Analisis Faktor yang Mempengaruhi Rantai Pasok Material Proyek Konstruksi	Supply chain analysis and the application of lean to large projects

The selected articles in the table above illustrate an in-depth approach to the evaluation of construction management performance in multi-storey building projects through the application of lean construction methods. Each article contributes to a discussion on how to optimize resources, reduce waste, and improve efficiency in construction projects. The following elaboration will elaborate each article based on its focus, providing richer and deeper insights.

The first article, Waste Analysis of Construction Projects Using the Lean Project Management Method by A. Fiza (2021), focuses on waste analysis in construction projects by highlighting the role of lean project management. This study shows that lean methods are not only effective in reducing waste, but also increasing productivity through more efficient use of resources. The results of this study are relevant for high-rise building projects, where challenges such as material waste and time are often major constraints.

The second article, Improving the Construction Process of Gas Pipeline Construction with the

Application of the Lean Construction Method by MRI Lubis (2016), discusses how the application of the lean construction method can reduce waste in infrastructure projects such as gas pipelines. This article provides practical insights into how a lean approach can be applied to identify areas of waste in workflows and optimize resource usage. These findings emphasize the importance of performance evaluation to achieve efficiency in large-scale projects.

Meanwhile, the third article by AP Dea (2024), Review of the Use of Lean Construction Methods in Building Projects in Bukittinggi City, focuses on the implementation of lean construction in building projects at the city level. This research highlights how lean can improve operational efficiency through better management of human resources and materials. The study underscores the importance of workforce training and the use of technology to support lean optimization.

The fourth article, Optimizing Building Construction Project Performance Through Building Information Modelling by DM Sundara and T Tiorivaldi (2024), explores the integration of Building Information Modelling (BIM) with lean construction. This combination is seen as an innovative solution to overcome the complexity of multi-storey building projects. This article highlights how BIM technology can be used to support better decision-making, help reduce the risk of design errors, and improve efficiency in time and cost management.

The fifth article, Evaluation of Construction Material Waste in Building Projects by AF Septianugraha (2021), makes an important contribution in understanding the role of lean in managing construction waste. This study uses empirical data to show how lean methods can be used to reduce wasted materials and optimize the overall construction process.

The sixth article, Supply Chain Performance Measurement in the Construction of High-rise Buildings with the SCOR Method, by T. Fitrianto and MA Wibowo (2020), takes a different approach by using the SCOR framework to measure supply chain efficiency in multi-storey construction projects. This article emphasizes the importance of supply chain performance evaluation to support the successful implementation of lean construction.

The seventh article by AK Lubis (2021), Evaluation of Construction Waste on Projects in Pekanbaru, highlights how waste in building projects can be minimized through the application of lean principles. This study shows that waste not only impacts costs but also overall productivity.

The eighth article, Project Scheduling Optimization with the CCPM Method by F. Fadillah (2024), discusses the application of Critical Chain Project Management (CCPM) to support lean in building construction projects. This article shows how scheduling optimization can reduce project delays and improve time efficiency.

The ninth article, Evaluation of the Application of BIM in Construction Projects in Indonesia by A. Wibowo (2021), explores the application of BIM technology to support construction project management. This article provides evidence that the use of BIM can significantly reduce risk and waste on large-scale projects.

The last article, Analysis of Factors Affecting the Material Supply Chain of Construction Projects by W. Hartono (2024), explores the factors that affect the material supply chain in high-rise building projects. This study provides in-depth insights into the importance of collaboration

between stakeholders to support the successful implementation of lean construction.

Overall, these articles show that the application of lean construction methods to high-rise building projects can provide significant results in terms of resource optimization, waste reduction, and overall efficiency improvement. These studies provide a solid foundation for understanding how lean construction can be a strategic tool in improving construction management performance in Indonesia.

Discussion

Construction Management Performance Evaluation with Lean Methods

Performance analysis shows that the application of lean construction methods provides significant results in improving the efficiency of multi-storey building projects. Some of the key findings are:

1. Improved Time Efficiency: Identification of waste, such as material lead times and schedule discrepancies, was successfully addressed by using lean techniques such as Just-In-Time (JIT) and Last Planner System. Processing time can be reduced by up to 20% compared to traditional methods.
2. Workflow Optimization: A lean approach makes it easier to identify bottlenecks in workflows, allowing for process improvements and reduced idle time at various stages of the project.
3. Quality Improvement: The poka-yoke (error prevention) technique helps to suppress construction errors, so the quality of the results is improved.

Resource Optimization Strategy

1. Efficient Material Management: With the lean method, materials are managed in Just-In-Time, reducing the risk of overstorage and material damage. The use of Value Stream Mapping (VSM) helps identify activities that do not provide added value, so that material resources can be used more effectively.
2. Optimal Workforce Utilization: The implementation of Visual Management allows the workforce to understand tasks more clearly, increasing productivity and collaboration in the field.
3. Digital Technology Integration: The use of lean-based project management software, such as Building Information Modeling (BIM), facilitates coordination between teams, improves design accuracy, and reduces unnecessary revisions.

Recommendations for the Implementation of Lean Methods

To significantly increase the productivity and efficiency of a project, construction professionals are advised to:

1. Lean Competency Enhancement: Conduct special training for project managers and workforce regarding the application of lean methods to ensure effective implementation.
2. Adoption of Supporting Technology: Encourage the use of technologies such as BIM, which support waste identification and workflow integration, as well as accelerate the decision-making process.
3. Strengthening Team Collaboration: Implementing the Last Planner System to improve communication and collaboration between teams, ensuring that each member understands their targets and responsibilities.
4. Continuous Monitoring and Evaluation: Conduct regular monitoring of the results of the implementation of lean methods to evaluate the success of the strategy and identify areas that still need improvement.

4. CONCLUSION

This study concludes that the lean construction method significantly improves the construction management performance in multi-storey building projects. This approach has been proven to identify and reduce unproductive activities, optimize workflows, and utilize resources more efficiently. The use of strategies such as Just-In-Time, Last Planner System, and the integration of BIM technology results in reduced waste and increased efficiency by up to 30%. In addition, lean construction improves the quality of construction results through better management of labor and materials.

As a suggestion, strengthening training and improving workforce competencies related to lean methods is very important to ensure successful implementation. In addition, the application of modern technologies such as BIM needs to be continuously encouraged to support project integration and efficiency. Strengthening collaboration between stakeholders is also key to success, by using management tools such as the Last Planner System to improve communication. Continuous monitoring and evaluation of the application of lean methods must be carried out systematically to ensure continuous improvement. This is important to make construction projects more efficient, productive, and sustainable in the future.

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