 p-ISSN 2827-8585
e-ISSN 2827-8062

International Journal of Multidisciplinary Research and Literature
IJOMRAL
Vol. 4, No. 1, January 2025 pp. 114-123
Journal Page is available at http://ijomral.esc-id.org/index.php/home

DESIGNED WASTE MANAGEMENT SYSTEMS CONSTRUCTION AND DEMOLITION TO IMPROVE WASTE MANAGEMENT AND RECYCLING

Budi Harta Winata[1*], Edison Hatoguan Manurung[2], Dwi Purwanto[3]
[1,2,3]Universitas Mpu Tantular, Indonesia
Corresponden Email: *budihartawinata@yahoo.co.id*[1]

Abstract

This study aims to design a construction and demolition waste management system that can improve waste management and support material recycling in construction projects in Indonesia. Effective construction waste management is essential to reduce environmental negative impacts and improve material use efficiency in construction projects. Nonetheless, waste management in Indonesia remains constrained by insufficient infrastructure, limited awareness among construction industry stakeholders, and ineffective enforcement of current regulations. This research employs a qualitative methodology, incorporating literature reviews and interviews with industry practitioners to discern challenges and opportunities in construction waste management. The results show that technologies such as Building Information Modeling (BIM) can be essential in planning and managing waste. In contrast, implementing an occupational health and safety (OHS) management system that includes waste management will improve worker safety and project efficiency. This study suggests the importance of infrastructure development, increasing industry awareness, and strengthening regulations to improve waste management and support sustainable construction material recycling.

Keywords: Construction Waste Management, Recycling, Building Information Modeling (BIM), Occupational Safety and Health (K3), Infrastructure

INTRODUCTION

Construction and demolition (C&D) waste is one of the significant environmental challenges worldwide. According to a World Economic Forum (WEF) report, the construction and infrastructure sector accounts for nearly 40% of global waste. The sector generates enormous volumes of waste, including scrap materials such as concrete, wood, metal, glass, and plastic, which are often disposed of without proper management. In developed countries, despite strict regulations on waste management, implementing recycling and waste reduction practices in the construction sector still faces significant barriers, especially in costs and inadequate waste management infrastructure. Furthermore, in many developing countries, construction waste management is still at an early stage, with minimal policies supporting construction waste recycling (Saka et al., 2024).

"Construction waste" refers to a wide range of materials left over after construction and demolition projects have been completed. These materials include bricks, concrete, wood, and metal. In many cases, this waste is not managed correctly. Instead, It is dumped in landfills, which poses a threat of polluting the soil and water and contributing to the acceleration of climate change. Implementing a more effective waste management system, which includes sorting, recycling, and

reusing materials that are still usable, is one approach that can be taken to address this troublesome situation.

With the increasing awareness of the importance of sustainability and natural resource management, many countries are now focusing on developing systems that can reduce construction waste and increase material recycling rates. Recent technologies such as Building Information Modeling (BIM) and Machine Learning (ML) offer great potential in predicting and managing construction waste more efficiently (Saka et al., 2024).

This research will focus on construction projects in Indonesia, especially in big cities like Jakarta, which is experiencing rapid infrastructure and housing development. As the capital city with a very high number of construction projects, Jakarta faces significant challenges in terms of construction waste management. Based on the data, Jakarta produces much construction waste, most of which has not been appropriately managed. Construction and renovation projects of high-rise buildings and other infrastructure produce large amounts of garbage that require special attention in its management. Therefore, designing a more effective waste management system is essential to improve recycling efficiency and waste reduction.

Policy decisions made by the government, the level of awareness among industry participants, the availability of technology, and the availability of trained human resources are all factors that influence construction waste management. Policies that encourage effective waste management in the construction industry are essential to guarantee that the waste generated is not only disposed of but also has the potential to be recycled and reused. In addition, construction industry players need to increase their awareness of the importance of responsible waste management. Technology, such as BIM and AI-based software for waste prediction, can also improve efficiency in waste management and facilitate recycling (Sanjaya, 2019; Saka et al., 2024).

The phenomena in the field show that although awareness of the importance of construction waste management is increasing, implementation in the field is still limited. Many construction projects do not have an effective waste sorting system, which causes many materials that can be recycled or reused to be wasted. Another phenomenon is the lack of construction waste recycling facilities in Indonesia, which hinders the process of processing waste into materials that can be reused in construction projects. This is also related to the lack of policies that support the use of recycled materials in new construction (Hermawan, 2020).

Several significant problems are faced in construction waste management: The adequate waste management infrastructure in Indonesia is still minimal, with many construction projects not equipped with an effective waste management system, which causes waste to accumulate at project sites. In addition, construction industry players' awareness of the importance of sustainable waste management is still low, so the practice of sorting and recycling materials at construction sites is sporadic. Although there are several regulations regarding construction waste management, their implementation in the field is still weak and inconsistent. On the other hand, although advanced technologies such as

Building Information Modeling (BIM) can help plan and manage waste more efficiently, the use of this technology in Indonesia is still limited, especially in the small and medium-scale construction sector (Ervianto, 2015 Purwandi, 2019).

Several previous studies have examined construction waste management, both from technical and managerial aspects. Sanjaya (2019) discussed construction waste management in construction projects in Bali and found that many projects did not have a well-organized waste management system. Another study by Putra et al. (2018) showed that high-rise building projects often face challenges in effective waste management, primarily related to material sorting. A survey by Saka et al. (2024) highlighted the importance of using BIM and machine learning to predict and improve the recycling rate of construction waste materials. In addition, Manurung (2020) examined occupational health and safety (OHS) planning in the construction sector and highlighted the importance of good waste management in supporting a safe working environment. Ricardo et al. (2022) also conducted a risk analysis on a flat construction project in North Jakarta, which showed that poor waste management can increase the risk of accidents and environmental impacts on construction projects.

Although many studies have been conducted on construction waste management, there is still a gap in developing a system that can be widely implemented in construction projects in Indonesia. Many previous studies have focused more on technical aspects or case studies in developed countries. In contrast, research on construction waste management systems to improve recycling in developing countries such as Indonesia is still limited. Therefore, this study aims to design a construction waste management system that can improve waste management efficiency and support material recycling practices in construction projects in Indonesia.

LITERATURE REVIEW

Construction Waste Management

Construction waste management involves processes to minimize environmental impacts and increase resource use efficiency. This process includes sorting, collecting, transporting, and disposing of waste generated during construction and demolition. A waste management system is needed that can reduce material waste and maximize material recycling. It aligns with the importance of technology and policies that support efficient waste planning and management (Manurung, 2020). An organized system also provides additional benefits in reducing project costs and time (Ricardo et al., 2022).

Building Information Modeling (BIM) System in Waste Management

Building Information Modeling (BIM) technology has become a very effective tool in the planning and managing construction projects, including waste management. Using BIM, construction professionals can visualize material usage, identify waste, and plan for waste sorting and treatment

earlier in the project cycle. It can increase efficiency and reduce the project's environmental impact. construction (Sanjaya, 2019; Abdullahi Saka, et.al., 2024). In addition, Saka et al. (2024) highlighted that integration with machine learning technology can improve the accuracy in predicting the potential for recycling construction waste. Thus, the use of these two technologies together not only reduces the waste generated but also increases the efficiency of material use, which has a positive impact on the sustainability of construction projects.

Occupational Safety and Health (K3) in Construction

Occupational safety and health (OHS) aspects in construction projects involve more than worker protection; they also include safe waste management. Construction waste that is not managed correctly has the potential to increase the risk of work accidents and reduce the quality of the work environment. Manurung (2020) emphasized that OHS planning that includes proper waste management is essential to reduce the risk of accidents in the workplace and improve worker welfare in construction projects. Handling construction waste is also a challenge in high-rise building projects. Putra et al. (2018) showed that effective and systematic waste management can minimize the risk of accidents and increase efficiency in material use. This study emphasizes the importance of good waste sorting and management at the project site to support work safety and reduce negative impacts on the surrounding environment.

Construction Waste Management Regulations

Regulations governing construction waste management in Indonesia still face challenges regarding consistent implementation. Although various laws have been issued to reduce environmental impacts, their implementation in the field is often not optimal. Ricardo et al. (2022) revealed that the main obstacle to implementing construction waste management regulations is the lack of adequate supervision and awareness of construction industry players regarding the importance of compliance with these regulations. In addition, research by Widhiawati et al. (2019) on construction waste management in Bali shows that a significant challenge in building construction projects is the low awareness of the importance of efficient waste sorting and management. The results of this study indicate that although there are regulations that govern it, practices in the field still do not fully reflect these policies, which impacts the effectiveness of waste management.

METHOD

This research method uses a qualitative approach to design a practical construction and demolition waste management system to improve waste management and recycling. This study integrates several data collection techniques, including literature review, interviews, field observations, and case studies. The qualitative approach was chosen because it can provide an in-depth

understanding of the context and factors that influence waste management in the construction industry, which are difficult to measure with a quantitative approach.

Literature Review

The first step is to conduct a literature review related to construction waste management, which includes various previous studies, technologies used in waste management, and policies implemented in Indonesia and other countries. This study aims to understand the basic theory and identify related studies to provide a basis for designing a better system (Putra et al., 2018; Widhiawati et al., 2019; Saka et al., 2024). This study will also identify research gaps in construction waste management.

Qualitative Approach with In-depth Interviews

The in-depth interview method is the primary data collection technique in this study. Interviews were conducted with various parties directly involved in the construction project, such as contractors, project managers, and field workers. This interview aimed to explore information about waste management practices applied in the field, the challenges faced, and their perceptions and views on the existing waste management system. With this qualitative approach, researchers are expected to gain a more profound and contextual understanding of the problems faced in construction waste management.

Field Observation

This study also uses field observations to identify waste management practices applied in construction projects. Observations were conducted directly at several project locations, focusing on waste material sorting, collection, transportation, and waste management during the construction and demolition phases. The data obtained through these observations will provide an accurate picture of the challenges and gaps in waste management in the field. They can be used as evaluation material in designing a more efficient and organized system.

Case study

This research will also use a case study approach to analyze waste management in specific construction projects. The selected projects will represent various scales and types of construction, such as high-rise buildings and infrastructure development. The case studies aim to explore further the challenges and solutions applied in waste management in each project and to understand the local context that influences the success or failure of waste management system implementation. These case studies are expected to provide deeper insights into the diversity of existing waste management practices.

Data analysis

Data collected through interviews, observations, and case studies will be analyzed using thematic analysis. This technique allows researchers to identify key themes, patterns, and relationships between factors that influence construction waste management. This process will produce findings explaining existing challenges and potential solutions for designing a more effective waste management system. The results of this analysis will form the basis for creating a more efficient waste management system and increasing material recycling.

Waste Management System Development

Based on the data analysis results, this study will design a construction waste management system to improve efficiency and increase recycling rates. This system will integrate material sorting at the beginning of the project, the use of technology such as BIM for more efficient planning, and policies that support sustainable waste management. In addition, occupational safety and health (K3) planning related to waste management will also be considered so that construction projects remain safe for workers and the environment.

This study will evaluate the effectiveness of the designed waste management system by comparing the results obtained with the implementation of the existing system. This evaluation will provide an overview of the successes and challenges in implementing the system and recommendations for improving the waste management system in future construction projects. With this qualitative approach, the study is expected to contribute significantly to designing a more efficient and sustainable construction waste management system, reducing environmental negative impacts, and increasing cost efficiency in construction projects.

RESEARCH RESULTS AND DISCUSSION

Research result

This study aims to design a more effective and sustainable construction and demolition waste management system. Based on observations, interviews, and data analysis, several key findings were obtained, indicating the main challenges in construction waste management in Indonesia.

1. Lack of Organized Waste Management System

   Field observation results show that many construction projects in Indonesia do not have a well-organized waste management system. Most projects only focus on construction implementation, while waste management is often ignored. This finding is similar to Sanjaya's (2019) research, which also stated that construction projects in Bali face identical obstacles in terms of unorganized waste management. It causes waste to accumulate at the project site without clear sorting, which poses a risk to the environment and the surrounding community's health.

2. Minimal Waste Sorting and Recycling

   Based on interviews with workers and contractors, it was found that waste material sorting in the field was very minimal. Most of the construction waste produced, residual and recyclable

materials, was not separated from the start. It is related to a lack of understanding of the importance of waste sorting to support more efficient recycling and resource management. This finding is also supported by research by Putra et al. (2018), which revealed that high-rise building construction projects in Bali face similar challenges related to minimal waste material sorting.

3. Challenges in Using Technology for Waste Management

   This study also found that although technologies such as Building Information Modeling (BIM) can be used to plan and manage construction waste, its application in Indonesia is still very limited. Significant projects in big cities use this technology to plan material management, but this technology has not been widely implemented in small and medium-scale projects. These results confirm the findings of Saka et al. (2024), which show that although BIM can improve efficiency in planning and managing waste, its adoption is still limited, especially in small and medium-scale construction projects. Therefore, more training and understanding are needed to encourage the adoption of this technology in the broader construction sector.

4. Compliance with Waste Management Regulations

   The results of interviews with construction industry players found that although there are several regulations related to construction waste management, their implementation in the field is still very weak. Many projects do not fully comply with existing rules due to the lack of adequate supervision and low awareness of industry players regarding the importance of good waste management. This finding is very similar to what Ricardo et al. (2022) expressed, which stated that the main obstacle in implementing construction waste management regulations is the lack of adequate supervision and understanding of industry players regarding compliance.

5. Occupational Safety and Health (K3) in Construction

   The results of this study confirm the findings of Manurung et al. (2021), which stated that poor construction waste management can increase the risk of accidents. Although OHS regulations already exist, their implementation is still not optimal. Many projects do not integrate waste management into the safety system, which increases the potential for accidents. Therefore, waste management needs to be combined with strict OHS standards. A holistic approach involving worker education and using technology such as BIM can minimize material waste and the risk of accidents. Collaboration between government, industry, and the community is essential to improve waste management and support material recycling.

DISCUSSION

The research findings suggest that managing waste from construction projects in Indonesia faces several significant obstacles. One of the most critical issues discovered is that the project's location does not have a well-organized waste management system. Consequently, waste accumulates without the appropriate separation or handling, ultimately threatening the surrounding area's environment. It

aligns with the findings of Sanjaya (2019), who states that many construction projects in Bali do not have an organized waste management system.

Waste sorting practices in the field are still minimal. The study's results showed that many projects did not sort waste materials from the start, which should have supported increased recycling rates. Putra et al. (2018) also noted the same thing, namely that high-rise building construction projects often face challenges in waste management, primarily related to material sorting. Proper material sorting is essential to support efficient material use and reduce the amount of waste produced.

Another challenge is the limited use of technology, such as BIM, to plan and manage construction waste. This study found that although BIM has excellent potential to improve waste management efficiency, its adoption in construction projects in Indonesia is still limited. Saka et al. (2024) also expressed a similar thing, namely that although BIM and machine learning can help increase recycling rates, the use of this technology in small and medium-scale projects in Indonesia is still very minimal. It further shows the need to encourage technology application in the construction sector. Low compliance with waste management regulations is also a significant problem. The findings of this study are in line with the research of Ricardo et al. (2022), which states that the lack of supervision and awareness of industry players is a significant obstacle to implementing effective regulations. Therefore, efforts are needed to improve supervision and understanding of the importance of compliance with existing rules to achieve better waste management.

In addition to the main findings outlined above, this study also found a close relationship between construction waste management and occupational safety and health (OHS) aspects in construction projects. As explained in the survey by Manurung, Sawito, and Yushadi (2021), the implementation of occupational safety and health management (OHSMS) in construction projects is greatly influenced by safe and well-structured waste management. Construction waste that is not managed correctly can increase the risk of work accidents and threaten worker safety, for example, through piles of materials that can cause heavy objects to fall or accidents related to hazardous chemicals.

The results of this study align with the findings of Manurung et al. (2021), which state that poor waste management is detrimental to the environment and can also increase the risk of accidents at project sites. In this context, project managers must pay attention to occupational safety by introducing waste management procedures that comply with established K3 standards. In many cases, poorly managed construction waste can worsen working conditions, cause long-term health risks for workers, and increase the potential for work accidents.

This study shows that although OHS regulations and guidelines exist, their implementation in the field is often not optimal. Similar to the findings in Manurung et al. (2021), this study also found that construction projects in Indonesia usually face difficulties in complying with OHS standards related to waste management. Many projects do not effectively integrate waste management into the

broader safety management system. A more holistic approach is needed in this case, namely combining occupational safety planning with efficient waste management.

Therefore, integrating environmentally friendly waste management with strict OHS procedures is crucial in preventing potential risks of accidents and diseases due to waste exposure at construction sites. Manurung et al. (2021) also emphasized the importance of educating workers and contractors about waste management to support workplace safety. Better education on safe waste management methods and the use of proper personal protective equipment (PPE) can help reduce the risks associated with construction waste. More profound knowledge of safe waste management and related technologies, such as BIM that can identify and manage construction waste more efficiently will be instrumental in supporting OHS programs in construction projects. With technology that helps visualize material use and potential waste from the planning stage, construction projects can reduce waste and possible accidents, as stated by Saka et al. (2024) in previous research.

Thus, the results of this study indicate that although awareness of the importance of construction waste management already exists, many challenges still need to be overcome. Collaboration between government, industry players, and the community is required to improve construction waste management and support more effective material recycling.

CONCLUSION

The objective of this research is to develop a waste management system for construction and demolition projects that has the potential to enhance waste management and provide support for material recycling in construction projects. According to the study, managing waste from construction projects in Indonesia faces several obstacles. These obstacles include a lack of adequate waste management infrastructure, awareness among those involved in the construction industry, and a lack of effective implementation of regulations. A poorly organized waste management system risks causing waste accumulation at project sites and increasing negative impacts on the environment and worker safety.

The findings of this study also show the great potential of technology, especially Building Information Modeling (BIM), in planning and managing construction waste more efficiently. Integrating BIM with machine learning can predict and increase the recycling rate of construction waste, which will reduce material waste and improve resource use efficiency. In addition, implementing an adequate occupational safety and health (OHS) management system by including waste management in safety planning is very important to reduce the risk of work accidents and ensure worker safety.

The study concludes that to improve construction waste management, greater attention is needed to develop appropriate infrastructure, increase awareness of the importance of sustainable waste management, and strengthen regulations and technologies that support waste recycling. Thus, effective

construction waste management will reduce environmental impacts and improve safety and efficiency in construction projects in Indonesia.

REFERENCES

Abdullahi Saka, Ridwan Taiwo, Nurudeen Saka, Benjamin Oluleye, Jamiu Dauda, Lukman Akanbi. (2024). *Integrated BIM and Machine Learning System for Circularity Prediction of Construction Demolition Waste*. DOI: 10.48550/arXiv.2407.14847

Ervianto, W. I. (2015). Manajemen Limbah dalam Proyek Konstruksi (Perencanaan, Pelaksanaan, Dekonstruksi). *Jurnal Teknik Sipil, 12*(1), 15-25.

Hermawan, S. I. (2020). Analisis Sisa Material Besi Tulangan pada Proyek Konstruksi. *Jurnal Rekayasa Teknik Sipil, 8*(2), 123-130.

Manurung, E. H. (2020). *Perencanaan K3 Pekerjaan Bidang Konstruksi*. Jurnal Rekayasa Konstruksi Mekanika Sipil (JRKMS), 3(1), 49-54.

Saka, A., Taiwo, R., Saka, N., Oluleye, B., Dauda, J., & Akanbi, L. (2024). Integrated BIM and Machine Learning System for Circularity Prediction of Construction Demolition Waste. *arXiv preprint arXiv:2407.14847*. https://arxiv.org/abs/2407.14847

Sanjaya, I. K. A. (2019). Pengelolaan Limbah Konstruksi pada Proyek Pembangunan di Bali. *Prosiding Seminar Nasional Arsitektur, Budaya dan Lingkungan Binaan (SEMARAYANA), 1*, 135-142.

Purwandi, M. A. (2019). Perancangan Sistem Reverse Supply Chain untuk Limbah Elektronik dengan Aplikasi RevME dan Algoritme Vehicle Routing Problem (VRP). *Karya Ilmiah Fakultas Teknologi Industri, Institut Teknologi Sepuluh Nopember*. Tersedia di: https://repository.unika.ac.id/26586/8/17.B1.0006-Jovana%20Neilkelvin-DAPUS_a.pdf

Putra, I. G. P. A. S., Dharmayanti, G. A. P. C., & Dewi, A. A. D. P. (2018). Penanganan Waste Material pada Proyek Konstruksi Gedung Bertingkat. *Jurnal Spektran, 6*(2), 176-185.

Ricardo, J., Manurung, E. H., & Hutagaol, K. (2022). *Analisis Risiko Konstruksi pada Proyek Pembangunan Rumah Susun Padat Karya Jakarta Utara*. Formosa Journal of Science and Technology (FJST), 1(4), 375-392. https://doi.org/10.55927/fjst.v1i4.1049

Widhiawati, I. A. R., Astana, N. Y., & Indrayani, N. L. A. (2019). Kajian Pengelolaan Limbah Konstruksi pada Proyek Pembangunan Gedung di Bali. *Jurnal Ilmiah Teknik Sipil*, 23(1), 55-61. Tersedia di: https://journals.usm.ac.id/index.php/ijces/article/download/10661/4798