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Strategies to Minimise Construction Waste: A Contractor's Perspective

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ABSTRACT

The generation of construction waste has become a pressing issue in Malaysia, making waste reduction crucial due to its environmental and financial impacts. This research aims to identify the factors that hinder effective construction waste management and to propose strategies to improve waste management practices in Selangor and Kuala Lumpur. The study focused on CIDB-registered contractors working on residential and commercial projects. Six respondents from various projects were selected for this qualitative study, and data were analysed using thematic analysis. The research identified several key factors contributing to poor construction waste management, including inefficient material management, inadequate planning, low awareness, insufficient training, and weak communication among project stakeholders. Based on these findings, the study recommends strategies that contractors can adopt to minimise construction waste. These strategies include optimising material usage, adopting lean construction practices, using prefabrication and modular construction techniques, implementing waste segregation and recycling, enhancing project planning and coordination, and fostering a culture of waste reduction within the organisation. Although contractors recognise the importance of effective waste management, the study highlights a need for government support to help them implement these strategies.

INTRODUCTION

Construction waste poses a substantial environmental threat, with consequences ranging from high energy consumption to solid waste generation, soil erosion, and an increase in Green House Gas (GHG) emissions (Esa et al., 2017). The increase in suburbanisation and industrialisation has turned construction waste into a significant element of urban solid waste. This waste, produced during the project's design, construction,

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and operational stages, may be harmless or industrial, with the latter being substantial and frequently containing impurities or hazardous chemicals (Hou et al., 2023).

Industrial workshops contribute significantly to the generation of construction waste, exhibiting traits of both hazardous and pervasive waste due to their vast quantity and high environmental threats. The common practice before recycling construction debris involves isolating and processing waste materials. In Malaysia, a country grappling with 26,000 tons of construction waste daily, efficient construction waste management remains a pressing issue (Zulzaha, 2014). Developing nations like Malaysia still grapple with awareness and implementation of effective waste management strategies, leading to the proliferation of illicit dumping sites and environmental challenges in local communities (Esa et al., 2016).

Studies emphasise the need to prioritise increased recycling rates in industrialised countries to mitigate the impact of construction waste (Olanrewaju & Ogunmakinde, 2020). The Industrialised Building System (IBS) emerges as a contemporary construction technique, promoting increase in rates of recycling. IBS involves constructing building components in a factory and transporting them to the site, reducing waste generation during construction. However, many developing countries, including Malaysia, still adhere to a linear economy-based approach, contributing to the improper management of construction and demolition waste.

It is crucial to embrace a new approach in construction operations to minimise the generation of construction and demolition waste. This transition entails moving away from the prevalent "take-make-consume-dispose" method commonly observed in developing countries, where resources are considered abundant and easily disposable. The focus of the research is on developing a comprehensive management plan for construction waste in Malaysia. Through the adoption of up-to-date technologies and principles, the construction industry can significantly contribute to promoting sustainability and alleviating the adverse impacts of construction waste on the environment.

Problem Statement

The construction industry in Malaysia serves as a crucial driver for societal and economic development, contributing significantly to the nation's wealth (Saadi et al., 2016). Despite its pivotal role, the industry faces formidable challenges, particularly in the realm of construction waste management, which poses hurdles to its growth and progress. Construction waste, if not managed effectively, can result in environmental pollution and public health concerns.

The environmental impact of construction waste is substantial, as highlighted by Esa et al., (2017). With an increasing demand for effective waste management actions, construction costs and resource waste escalate. Addressing this issue requires the adoption of optimal and effective concrete waste management technologies, offering a long-term approach to reducing building costs, controlling the depletion of natural aggregate supplies, mitigating landfill issues, and preserving the natural environment (Wong et al., 2019).

Globally, the construction sector is a significant contributor to waste generation, particularly through construction and demolition activities, forming a substantial portion of solid waste. Factors like population growth, urbanisation, and increased infrastructure development contribute to the escalating volumes of construction waste. In the absence of effective waste management practices, this surge poses environmental risks and strains existing systems (Ekanayake et al., 2022).

In Malaysia, the illegal dumping of construction waste is a prevalent issue, presenting substantial environmental and public health threats (Rahim et al., 2017). The problem is exacerbated by the lack of

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proper waste management infrastructure and the enforcement of regulations. While the Malaysian government has introduced policies and regulations to promote sustainable construction practices and waste management, there is a pressing need for more effective implementation and enforcement, given that the construction waste management infrastructure in Malaysia is still in its early stages and requires substantial improvement (Saadi et al., 2016).

Currently estimated at approximately 4.5 million tons per year, the construction waste generated in Malaysia is expected to increase (Harinderan, 2023). The high demand for construction projects, coupled with inadequate waste management strategies and the reluctance of Malaysian contractors to invest in improved waste management, contributes to this escalating issue (Esa, 2018).

To overcome these challenges, it is crucial for the Malaysian government and construction industry stakeholders to collaborate closely. The implementation and enforcement of policies and regulations that advocate for sustainable construction practices and efficient waste management are essential. The construction sector should embrace a comprehensive approach that includes waste reduction, reuse, recycling, and proper disposal. Stakeholders need to be prepared to invest in upgraded waste management practices to ensure effective handling of construction waste in Malaysia.

A significant impediment to recycling initiatives is the inadequate segregation of waste at its source, as many construction sites lack designated areas for separating different types of waste due to insufficient awareness among construction workers and contractors (Lu et al., 2019). Another pivotal aspect for enhancing construction waste management involves establishing standardised regulations and policies across various jurisdictions.

The construction industry grapples with challenges stemming from inconsistent waste management practices and diverse legal frameworks. Consequently, it is vital to formulate comprehensive rules, policies, and enforcement mechanisms to encourage sustainable construction practices and waste reduction (Saadi et al., 2016). Nevertheless, companies may encounter resistance due to additional costs associated with implementing proper waste management practices, such as the need for specialised equipment, labour, and waste disposal services, leading to increased project expenses. The absence of financial incentives and limited market demand for recycled construction materials further deters companies from investing in waste management initiatives.

Addressing cost implications and offering incentives for sustainable practices can motivate improved waste management (Hua et al., 2022). Construction waste is generated at various stages, including site clearance, material damage, equipment uses, non-utilisation of materials, excess procurement, and human errors (Mahayuddin & Wan Zaharuddin, 2013). Common types of building debris encompass wood, alloy, concrete waste, plastics, paper and cardboard, glass, hazardous waste, and others (Lee et al., 2023).

In summary, challenges related to construction waste in the Malaysian construction industry involve issues like illegal dumping, inadequate waste management infrastructure, increased waste generation, ineffective waste management strategies, and a reluctance to invest in improved waste management. Collaborative efforts between the Malaysian government and construction industry stakeholders are indispensable for ensuring sustainable construction practices and waste management. The essential steps include the implementation and enforcement of policies and regulations, adoption of a holistic waste management approach, promotion of waste reduction and recycling, and encouragement of stakeholders to invest in improved waste management practices, paving the way for a more sustainable future in the Malaysian construction industry.

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METHODOLOGY

The study involves open-ended interviews utilising unstructured formats as a data collection tool. Employing verbal techniques, the raw data is recorded and transcribed before undergoing analysis. The primary focus of data collection in this study centres on the open-ended interviews, with interviewees selected through snowball sampling.

Snowball sampling is an effective method for identifying respondents in a specialised or hard-to-access populations. It relies on existing study participants to recruit further respondents, facilitating access to individuals with the required expertise or experience. Snowball sampling leverages initial participants' networks to identify others with similar qualifications and insights, thereby ensuring that all respondents have the necessary background to provide valuable information (Naderifar et al., 2017). The emphasis is often on obtaining rich, detailed data rather than achieving a large, representative sample. Although there is no strict rule for the minimum number of respondents, a guideline suggests that in-depth interviews with 5-10 respondents can provide sufficient data saturation for focused, exploratory studies (Aziz & Zainon, 2023). When data saturation is reached, the sample size is considered adequate. For more complex studies, saturation may require more respondents, but six can be a sufficient number in narrowly scoped or specialised areas of research.

Thematic Analysis is applied for data analysis to thoroughly categorise and characterise participants' perspectives. This qualitative approach aims to understand and outline the characteristics of a specific research area. The open-ended interview is utilised to gather information on perspectives, views, or opinions relevant to the study objectives. Considering that the study aims to identify the factors that impede construction waste management and to identify the strategies to enhance construction waste management in Selangor and Kuala Lumpur, the qualitative study approach is an appropriate method for conducting this research. This methodology enables a more profound and comprehensive exploration of the factors and strategies aligned with the research objectives as shows in Figure 1.

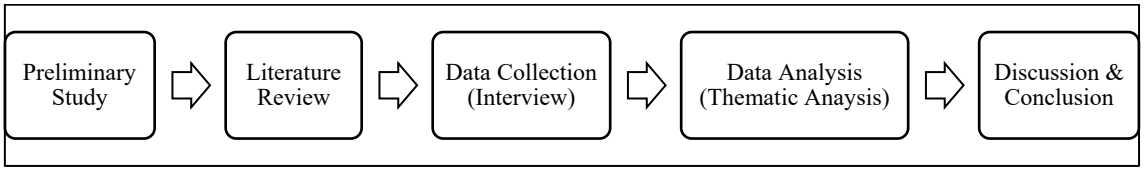

Fig. 1. Research Procedure

Source: Authors (2025)

The study participants consist of contractors involved in the construction of new buildings. The snowball sampling method begins by selecting a small group of individuals relevant to the research questions and asking them to identify others with pertinent experience or characteristics (Arowoiya & Oyefusi, 2023). These individuals then recommend additional participants, creating a chain. Utilising snowball sampling in this study provides the advantage of accessing the interconnected network of individuals within the construction industry.

Thematic Analysis is a data analysis technique that employs codes to identify themes with broader meanings. The decision is made to explore themes aligned with the data patterns. In contrast, Narrative Analysis gathers data through formal or informal interviews, aiming to compare and contrast different data sources, identify interpretations, establish connections, and ultimately generate new explanations. Thematic Analysis was chosen for this study as it is a widely used methodology in qualitative data analysis. Following

the interviews, transcripts must be prepared, which can be done manually or using software like NVivo. A thorough review of the transcripts is crucial to document any significant information revealed during the process. The focus of data collection revolves around the open-ended interviews, chosen for the ability to capture valuable perspectives, views, and opinions related to the study objectives.

Respondents in the study are contractors involved in new building projects. Contractors play a pivotal role in construction waste management, given their direct involvement in the construction process—from planning and material procurement to onsite activities and waste disposal—contractors possess firsthand knowledge of the factors influencing waste generation, handling, and management. Their unique perspectives help illuminate the obstacles encountered in implementing effective waste management practices. It also aligns with the research objectives as contractors help identify specific factors that impede efficient construction waste management provide feedback on current practices and potential improvements to formulating targeted strategies for the context of Selangor and Kuala Lumpur. Furthermore, their input enables the research to pinpoint practical, industry-driven solutions that are grounded in experience, thereby supporting the development of realistic and effective strategies to enhance waste management in the region.

The utilisation of snowball sampling proves beneficial in this context, involving the selection of a small group of personnel relevant to the research and subsequently leveraging their connections to identify others with sufficient experience or expertise (Bryman, 2016). This iterative process allows for an interconnected exploration within the construction industry, a fitting approach given the focus of the study on construction waste projects.

Following the completion of interviews, data analysis was performed by thematic analysis, aiming to identify and understand the broader themes that emerge from the data patterns. This qualitative technique aligns with the study's goals, allowing for a comprehensive exploration of participants' perspectives. Thematic analysis involves the use of codes to categorise and characterise these perspectives thoroughly. As the study progresses, the selected data collection and analysis techniques provide valuable insights into factors influencing construction waste management and strategies for waste minimisation among contractors.

MAIN FINDINGS

Demographic Background

The data derived from interviews highlights the viewpoints, understanding, and involvement of respondents in projects related to construction waste management. These entities belong to the private sector and are primarily engaged in or advocate for waste minimisation within the Malaysian construction sector. The positions of the individuals surveyed varied, including roles such as project manager, site manager, and contractors actively participating in the construction industry. The varied professional backgrounds of the interviewees have contributed diverse perspectives, which are valuable for the exploratory aspect of this study. Table 1 shows background of respondents, represented with initials according to the respective interview.

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Table 1. Background of Respondents

Interviewee	Project Name	Project Type
Project manager	(A) 41-Storey Office Building in Putrajaya	Commercial
Site manager	(B) 2-Storey Landed House in Petaling Jaya	Residential
Safety manager	(C) 38-Storey 2 Blocks Apartment in Bangi	Residential
Project Manager	(D) 2-Storey Shop Lot in Beranang	Commercial
Assistant Project Manager	(E) 2-Storey Semi-Detached House in Bangi	Residential
Project Engineer	(F) 1-Storey Light Factory in Puchong	Commercial

Source: Authors (2025)

Factors That Lead to Construction Waste Management Construction of references

Upon conducting the qualitative interviews, the results were transcribed and analysed by using the NVivo Software. The outcome of the thematic analysis is presented in Figure 2. The coding process utilised nodes to identify the factors contributing to construction waste. Referring to Figure 2 and Figure 3, the concept of a "child" typically refers to sub-themes that are derived from broader themes within the data. In this context, “child” themes represent more specific aspects or dimensions of larger "parent" themes. This hierarchical structure helps researchers organise and interpret data in a way that captures both broad patterns and finer details (Andrić et al., 2019). The analysis revealed the presence of four main subcategories originating from the data: on-site materials management, site management and practices, materials storage, handling, and transportation, and design and contract documents.

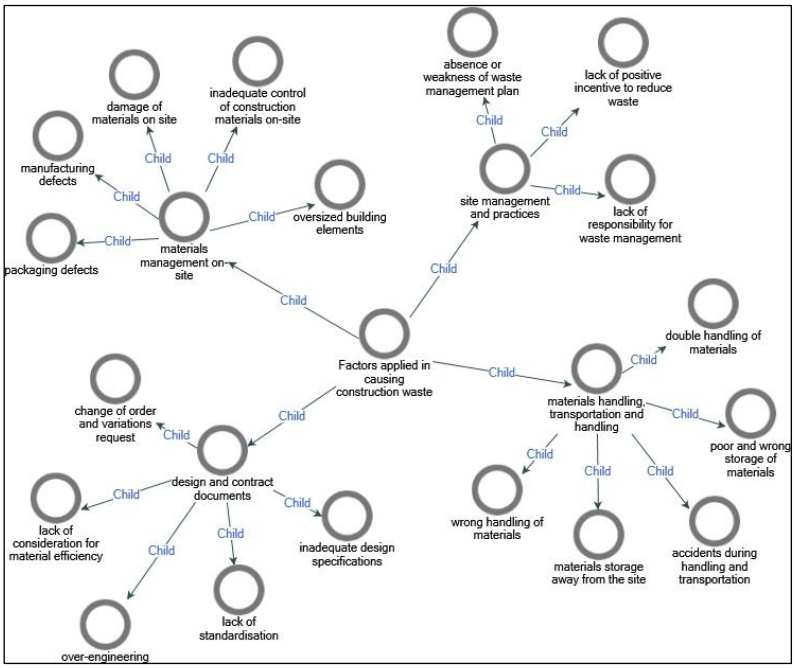

Fig. 2. Theme Representing Findings on RO1

Source: Authors (2025)

The themes are organised into subcategories under primary nodes based on their characteristics. Management of materials on-site encompasses concerns such as damage to materials, defects in manufacturing and packaging, inadequate control over construction materials, and oversized building elements. Site management and procedures involve the absence of a plan for waste management, a deficiency in positive incentives to minimise waste, and a lack of accountability for waste management. Issues related to materials storage, handling, and transportation include mishandling, improper storage, accidents during handling and transportation, materials stored off-site, and mishandling. Design and contract documents related concerns involve issues like order changes, insufficient consideration for material efficiency, lack of standardisation, inadequate design specifications, and over-engineering. The themes shall be discussed in the following parts.

Materials Management On-Site

The analysis revealed several concerns related to on-site materials management, including material damage, manufacturing and packaging defects, insufficient control of materials, and issues with oversized building elements. Improper handling, storage, and transportation contribute to these problems, often resulting in damaged or unusable materials and increased waste. For instance, Soni et al. (2022) found that poor handling practices are a major cause of product damage, while Tu et al. (2023) highlighted manufacturing defects as a significant contributor to waste in the construction industry. Supporting this, Engebø et al. (2017) demonstrated that inadequate packaging can lead to product failures.

Inaccurate inventory management, limited storage space, and organisational shortcomings can also cause materials to be misplaced or become unusable. Zhang et al. (2023) emphasised the importance of accurate inventory systems in preventing loss due to misplacement or spoilage. Zhou and Piramuthu (2015) presented a case study identifying factors that increase waste and reduce supply chain efficiency. Additionally, some respondents pointed out that measurement inaccuracies during construction lead to oversized building elements, creating further waste (Engebø et al., 2017).

Materials Handling, Transportation, and Storage

Ineffective handling practices, such as dropping or mishandling materials, can result in breakage, contributing to waste. Albert et al. (2022) examined how rough handling negatively impacts project quality. Poor storage conditions—such as exposure to moisture or extreme temperatures—also degrade materials, a point emphasised by Micheal et al. (2023). Frequent transportation increases the risk of material damage, as highlighted by Albert et al. (2018), and unnecessary handling of materials can lead to accidents and further waste. Training personnel to handle materials carefully can mitigate these issues (Albert et al., 2021). Winanda et al. (2024) also underscores the need for proper training, equipment maintenance, and safety protocols to prevent workplace accidents related to material handling.

Site Management and Practices

A lack of accountability for waste management and inadequate oversight was identified as factors that contribute to waste. Ramos et al. (2023) found a strong link between organisational responsibility and waste reduction. Effective supervision, as discussed by Tafesse et al. (2022), has a positive impact on reducing waste by ensuring compliance with waste management practices. Inefficient practices, such as poor segregation and ineffective recycling, also contribute to waste generation. Nawaz et al. (2023) demonstrated that formal waste management plans help reduce waste and improve sustainability, while Hao et al. (2022) emphasised the importance of structured segregation, recycling, and disposal procedures.

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Design and Contract Documents Related

Waste reduction depends significantly on precise design specifications. Over-engineering, due to incomplete or imprecise design documents, leads to excessive material usage. Waqar et al. (2023) identified a strong correlation between design accuracy and waste reduction. Standardising designs can minimise inconsistencies and improve efficiency, as noted by Domingo and Batty (2021). Changes in project scope or design alterations can disrupt planned material quantities, resulting in increased waste, as Liu et al. (2022) found in their research on the impact of scope changes on waste in construction projects.

The study identified several key factors contributing to construction waste generation across different areas of project management. In materials management on-site, waste generation is often due to material damage caused by improper handling, manufacturing, and packaging defects, and inaccurate measurements that lead to oversized building elements. Poor handling, storage, and transportation practices increase the likelihood of damage, making materials unusable. Similarly, materials handling, transportation, and storage practices, such as rough handling, inadequate storage conditions, and excessive transportation, also contribute significantly to waste. Ensuring that personnel are trained in proper handling and equipped with the right tools can mitigate this waste.

In terms of site management and practices, the findings suggest that a lack of accountability for waste management, coupled with insufficient supervision, hinders effective waste reduction. Poor waste segregation and recycling practices, along with the absence of structured waste management plans, were highlighted as additional factors that exacerbate waste generation. Lastly, design and contract documents play a crucial role in minimising waste. Precise and standardised design specifications help reduce inconsistencies and unnecessary material use, while design changes and over-engineering tend to increase waste. Together, these findings indicate that improvements in materials handling, site management practices, and accurate design documentation are essential strategies for effectively reducing construction waste.

Strategies for The Contractors to Minimise Construction Waste

The research results reveal a few strategies to minimise waste. Through the thematic analysis, the themes are categorised into construction and demolition phase, procurement design, post-construction, and planning design phases. Figure 3 shows the summary of the strategies analysed from the thematic analysis.

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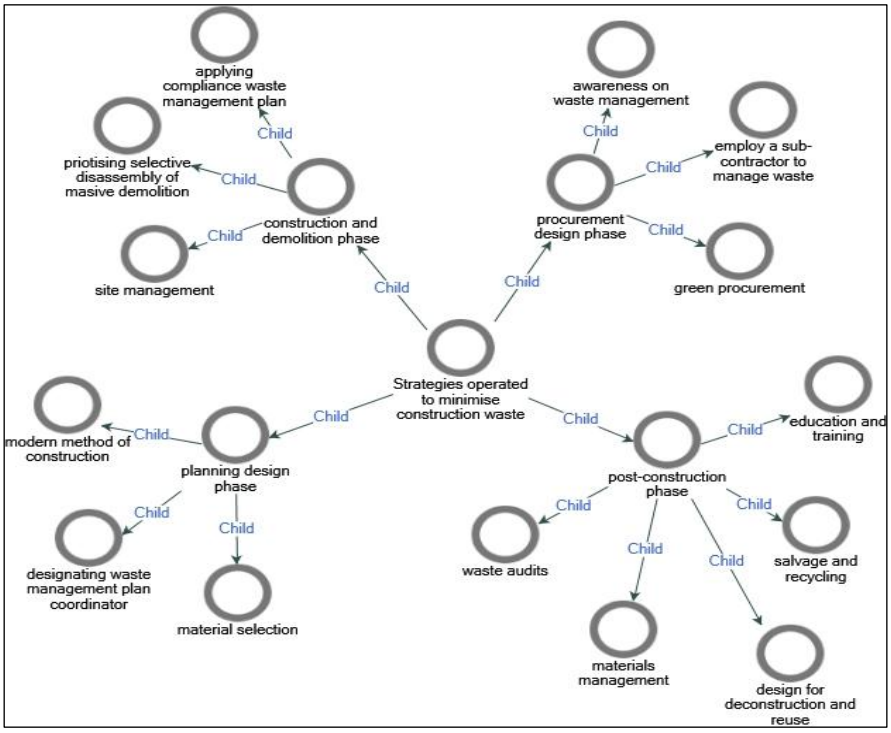

Fig. 3. Theme Representing Findings on RO2

Source: Authors (2025)

Procurement Design Phase

During the procurement design phase, it is essential for contractors to raise awareness and provide training on waste management to their team members. Industry studies show that most construction professionals lack knowledge of waste management, and training programs significantly impact team practices in this area (Ismail et al., 2023). To address this gap, contractors should offer workshops and educational programs, which are effective in promoting best practices for waste reduction and disposal among workers (Soto-Paz et al., 2023). Integrating sustainability criteria into procurement processes is also recommended, favouring suppliers who provide environmentally friendly materials with minimal packaging to reduce waste. Selecting sustainable suppliers has been shown to reduce environmental waste and support sustainable procurement practices in construction (Mojumder et al., 2022; Wu et al., 2023).

Design and Planning Phase

In the design and planning phase, contractors should prioritise sustainable materials and appoint a waste management plan coordinator responsible for overseeing on-site waste practices. Research indicates that selecting sustainable materials significantly reduces waste and enhances environmental performance (Oliveira & Souza, 2023). Establishing a coordinator role specifically for waste management ensures the effective implementation of waste reduction efforts and enhances collaboration among subcontractors and suppliers (Yu et al., 2020). This coordinated approach helps drive waste reduction initiatives, as collaboration among stakeholders is highly beneficial in promoting sustainable construction practices (Opoku et al., 2022).

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Construction and Demolition Phase

In the construction and demolition phase, selective disassembly should be prioritised over indiscriminate demolition. Selective disassembly focuses on carefully separating usable parts for recycling or reuse, significantly reducing waste. This approach has shown to be highly effective in promoting sustainable demolition practices (Ramos et al., 2024). Additionally, contractors should emphasise material salvaging, which reduces waste sent to landfills and supports recycling (Allam & Nik-Bakht, 2023). Compliance with the waste management plan developed in the planning phase is also essential for achieving waste reduction and maintaining sustainability (Opoku et al., 2022).

Post-Construction Phase

After construction, contractors can conduct waste audits to assess waste generation, identify improvement areas, and refine strategies for future projects. Modern waste audit tools are valuable in evaluating waste generation patterns and guiding reduction efforts (Hoang et al., 2022). Additionally, incorporating design principles for deconstruction and reuse into projects can greatly reduce waste (Lu et al., 2016). Ongoing education and training sessions on waste management are crucial for minimising waste after project completion, as they foster a culture of sustainability within construction organisations (Aslam et al., 2020). Cultivating a waste reduction culture within organisations helps promote sustainable practices and supports waste reduction initiatives (Christensen et al., 2022).

Through the interviews, contractors agreed that the design and planning phase is the most critical stage for minimising construction waste. Addressing potential waste issues early—through material efficiency, specifying recyclable or reusable materials, and designing for deconstruction—significantly reduces waste during construction. Detailed design specifications further contribute to reducing errors and waste by providing precise guidelines. Implementing these strategies across all phases—from procurement to post-construction—can enable contractors to minimise waste effectively and promote sustainable practices across construction projects.

CONCLUSION

The analysis highlights key factors that hinder effective construction waste management and proposes strategies to address them. Findings of objective 1 identifies the main issues impeding waste reduction, which include inefficient materials management, inadequate site management, poor materials handling and storage, and imprecise design and contract documents. Addressing these issues requires a comprehensive approach that includes stronger coordination among stakeholders, targeted training programs, the integration of waste management considerations early in the design phase, and the establishment of clear contractual responsibilities for waste management. Adopting these measures has the potential to greatly reduce construction waste and support a more sustainable construction industry.

Meanwhile, objective 2 focuses on identifying strategies to improve waste management. By prioritising waste reduction across the procurement, design and planning, construction and demolition, and post-construction phases, contractors can play a critical role in advancing a more sustainable construction sector. Implementing these strategies requires the collaboration of project stakeholders, continuous training, and a commitment to incorporating waste management into project planning and execution. The successful execution of these strategies can lead to substantial waste reduction, improved resource efficiency, and a more environmentally responsible construction industry.

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Ultimately, the design and planning phase is identified as the most crucial stage for minimising construction waste. Early consideration of material efficiency, the use of recyclable and reusable materials, and designing for deconstruction can lead to substantial waste reduction during construction. Effective materials management is another essential factor; proper handling, storage, and transportation practices help prevent damage, making materials more likely to be used and less likely to be wasted. Furthermore, accountability in site management, where specific roles and responsibilities are clearly defined for waste management, ensures that sustainable practices are implemented consistently. Standardised and precise design documentation also plays a critical role, as accurate plans help avoid over-engineering, minimise material excess, and reduce construction errors. Finally, the importance of training and awareness programs cannot be overstated; regular training helps instil sustainable waste management practices in construction teams, fostering a culture of sustainability within the industry. These strategies contribute to reducing waste, enhancing resource efficiency, and promoting an environmentally responsible construction sector. By focusing on these areas, contractors can significantly reduce waste and foster a culture of sustainability in the construction industry.

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CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

AUTHORS' CONTRIBUTIONS

Mohamad Zahierruden Ismail conceptualised and led the research, authored the main findings of the article, and managed its submission to the journal. Meanwhile, Mohd Saidin Misnan and Nur Fadilah Darmansah contributed to the drafting and revision of the manuscript.

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