

# Investigation of Circular Construction Waste Management (CCWM) Practices in Malaysia

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## Abstract

This research investigates the adoption of Circular Construction Waste Management (CCWM) practices in Malaysia, focusing on the environmental and economic challenges posed by construction waste. The study aims to identify key challenges, determine effective waste management practices, and propose sustainable solutions to enhance resource efficiency. A quantitative survey was conducted with data analyzed using SPSS for reliability and descriptive insights involving 130 construction personnel such as those engineers, project managers, main contractors, construction manager, site consisting of workers, and supervisors. The findings reveal that the high cost of recycled materials mean value 4.85 are the most critical barriers to adopting circular economy principles. Among the recommended practices, the "3R" approach Reduce, Reuse, Recycle emerged as the highly effective practice with the highest mean value of 4.89. By adopting these practices, stakeholders can reduce environmental impacts, improve resource efficiency, and achieve a more sustainable construction industry.

## 1. Introduction

The construction industry in Malaysia significantly contributes to the economy but also generates substantial waste, primarily managed through unsustainable practices like landfilling and illegal dumping, leading to environmental concerns such as resource depletion, overflowing landfills, and greenhouse gas emissions (MHLG, 2020). The concept of a Circular Economy (CE) offers a promising alternative by promoting waste reduction, reuse, and recycling, keeping resources in use longer (Yuan et al., 2018). However, the adoption of CE in Malaysia's construction sector faces challenges, including weak regulations, a lack of stakeholder awareness, and inadequate infrastructure for recycling (Looi et al., 2017; Wong et al., 2020; Ajalekoko et al., 2022). Studies also highlight the unsustainability of traditional waste disposal methods, emphasizing the need for a more sustainable waste management framework (Ismail et al., 2019). With construction waste comprising 20-30% of landfill content (MHLG, 2020) and a recycling rate of only 15% (NSWMD, 2021), Malaysia's current waste management system struggles to meet sustainability targets. This study aims to address these challenges by investigating Circular Construction Waste Management (CCWM) practices, identifying obstacles, and proposing effective strategies for the sector. By focusing on a diverse group of stakeholders, including managers, engineers, and contractors, the research will provide insights into current practices and recommend solutions to reduce waste and improve sustainability. The findings will help bridge the knowledge gap, offering practical ways for Malaysia's construction industry to adopt CE principles, enhance resource efficiency, reduce costs, and minimize environmental impact, contributing to a more sustainable future.

## 1.1 Circular Construction Waste Management

The construction industry globally encounters with managing the significant amount of waste it generates. Traditional methods often prioritize disposal, leading to environmental concerns. CCWM offers a more sustainable solution, embracing the principles of a CE (Akhtar & Reza, 2023). This approach focuses on maximizing resource efficiency throughout the construction lifecycle. CCWM prioritizes minimizing waste generation at the source. This includes detailed planning and design optimisation, along with the selection of materials that minimize waste generation. Additionally, CCWM encourages on-site material reuse whenever feasible.

## 1.2 Circular Construction Waste Management Challenges

The challenges in implementing Circular Construction Waste Management (CCWM) in Malaysia stem from four key elements: low awareness, waste generation causes, implementation hurdles, and the need for behavioral change. Public awareness regarding waste management remains low (Abdul Rahman et al., 2020), hindering the adoption of sustainable practices. Waste generation is exacerbated by traditional construction methods and poor site management (Hamid et al., 2021). Implementation hurdles include poor enforcement of existing regulations and market constraints like the fluctuating prices of recycled materials (Rahman et al., 2022). Finally, achieving sustainable construction requires a cultural shift within the industry, where responsible waste disposal and resource efficiency are embraced through education and training (Abdul Hamid et al., 2021).

## 1.3 Circular Construction Waste Management Practices

Circular construction waste management practices incorporate four key elements: Life Cycle Assessment (LCA), the 3R principles (Reduce, Reuse, Recycle), Site Waste Management Plan (SWMP), and the Industrialised Building System (IBS). LCA helps identify waste-heavy stages of construction by analyzing environmental impacts, enabling informed decisions about recycling and reuse (Gan et al., 2020). The 3R principles focus on minimizing waste through design phase interventions and reusing materials like formwork and aggregates, while recycling processed waste for other uses (Turkyilmaz et al., 2019). SWMP ensures proper waste handling with clear processes for waste removal, segregation, and storage on-site (Gálvez-Martos et al., 2018). Finally, IBS promotes prefabrication methods to reduce on-site waste significantly, contributing to the sustainable management of construction materials (Rahman et al., 2022).

## 2. Methodology

This study applied quantitative approaches. A questionnaire survey method has been selected to identify the major challenges of construction waste and the best practice to mitigate waste generation in Malaysia. The study sent data to 180 respondents who participated in this survey. A quantitative questionnaire survey was the primary method of data collection, targeting key stakeholders within the construction industry players. The structured questionnaire, designed with closed-ended questions contains 17 questions including in section A, section B, and section C for a total of 130 questionnaires received. The surveys assessed the background of respondents, current company CCWM satisfactory, challenges faced and best practices to be implemented in future.

The research method in this study on identify circular construction waste management challenges and practice. A literature review is conducted to gather relevant knowledge regarding the types of CCWM practices and challenges faced in Malaysia. Next, the methodology involves constructing a pilot study by collecting verifications from experts in construction industry. A questionnaire survey performed to collect data and the data analysis will be performed using appropriately selected statistical methods, and the data analysis will be performed using Statistical Package for Social Science (SPSS). Finally, the research concludes with recommendations for proposing CCWM practices, reducing construction waste, and fostering a more sustainable and efficient construction industry in Malaysia.

### 2.1 Data Collection

The data collection involve in this study is questionnaire survey method. The targeted population for the survey including several construction personnel around Peninsular Malaysia. The utilization of the questionnaire survey approach to gather organized data for a significant finding about the research issue. This established method, leveraging sample surveys (Sekaran & Bougie, 2016), effectively gathered crucial data from a representative population, allowing for a comprehensive analysis of CCWM implementation across various project stages. The study collected data using an online questionnaire, which focused on identifying potential causes of construction waste creation and implementing solutions in Malaysia. The questionnaire based on the Likert scale. The ranking consists of five levels (1) strongly disagree (2) disagree (3) neutral, (4) agree, and (5) strongly agree. The questionnaire responses were analyzed using SPSS, and the mean importance ratings from the survey were computed and statistically analyzed to determine their relevance.

## 2.2 Questionnaire Survey

In this study, the questionnaire survey is divided into 4 sections section A, B, C and D. This study used Likert scale to gather data. A Likert scale in this study ranges from strongly disagree to strongly agree for both sections C and D. The use of a Likert scale allowed this researcher to gather quality quantitative data on respondents. Section A focused on the respondents' demographic characteristics, such as gender, age, working experience, education level, employment position, and company size. Multiple-choice answers were offered, and respondents were asked to choose the most applicable alternative. Section B inquired about the respondents' company's waste-management policies and practice. They asked to rate their satisfaction with construction waste management in company and indicate whether their organisation had implemented a system. Section C was designed to collect challenges to adapting CCWM in respondents company. Respondents rated challenges faced at construction site in Malaysia. Section D emphasized on waste management practices. This section aimed to gather information on various practices, that had proven successful in reducing, reusing, and recycling waste. The goal was to identify key factors that contributed to efficient waste management and highlight best practices that could be implemented in other contexts.

## 3. Result and Discussion

In this chapter, data analysis was conducted after the completion of the data collection process to ascertain the fulfillment of the research objectives.

### 3.1 Reliability Test by Cronbach's Alpha

This study evaluated the internal reliability by Cronbach's alpha analysis. In determining the level of instrument reliability and item consolidation in the questionnaire, Cronbach's Alpha test was conducted by the researcher.

**Table 1** Cronbach's Alpha analysis

Item	Cronbach's Alpha	N of Items
Identify circular construction waste management challenges	0.825	4
Circular construction waste management best practice in Malaysia	0.818	4

Cronbach's Alpha value for identifying circular construction waste management challenges is 0.825, and for circular construction waste management best practices in Malaysia, it is 0.818. These values demonstrate that the instrument used for data collection has a satisfactory level of reliability. According to Cronbach's Alpha Coefficient (George and Mallery, 2003), the ( $\alpha$ ) value should fall between zero and one, with a value greater than 0.8 considered to indicate consistency and reliability. In this case, both values exceed the threshold of 0.8, signifying that the survey items used to assess the challenges and best practices related to circular construction waste management are reliable and provide consistent results.

### 3.2 Respondent's Demography

In this research, for the Respondents' Demography section, the respondents were asked to provide information such as gender, age, working experience, education level, employment position, and company size.

**Table 2** Demographic data

	Description	Percentage (%)
Age	18-25 years	32.3
	26-35 years	38.5
	36-45 years	18.5
	46-55 years	7.7
	56+	3.1
Gender	Male	71.5
	Female	28.5

**Table 2** (Continued)

Education Level	Diploma	72.4
	Bachelor's Degree	13.8
	Master's	9.2
	PhD	4.6
Employment Position	Engineer	42.3
	Contractor	16.9
	Project Manager	18.5
	Construction Manager	8.5
	Procurement Officer	7.7
	Site personnel (workers, supervisors)	6.2
Working Experience	3 years and below	16.9
	4 – 6 years	50.1
	7 – 9 years	19.2
	10 years and above	13.8
Size of company	Small (less than 50 employees)	36.2
	Medium (50-200 employees)	38.5
	Large (more than 200 employees)	25.4

### 3.3 Analysis The Challenges of Circular Construction Waste Management

The first objective of the research is to Identify circular construction waste management challenges. To achieve and satisfy the first objective in this section, respondents are required to choose the biggest challenge of construction waste management in Malaysia construction industry.

**Table 3** Challenges of circular construction waste management

Challenges of circular construction waste management	Mean	Rank
Lack of Awareness and Public Perception	4.79	3
Improper site management practices	4.82	2
Weak Enforcement of waste management regulations	4.78	4
High cost of recycled construction materials	4.85	1

The findings revealed that the high cost of recycled construction materials was the most critical challenge in adapting circular economy (CE) practices, with a mean ranking of 4.85. This highlights that economic factors play a pivotal role in the reluctance of the construction industry to embrace sustainable practices. The high initial investment and perceived cost disparities between recycled and virgin materials discourage industry players from implementing CE principles. This finding aligns with global challenges faced in adopting CE, particularly in developing countries, where financial constraints often outweigh environmental considerations (Ajayi et al., 2017c). Ranking second with a mean score of 4.82, improper site management practices emerged as another significant barrier. Poor coordination, lack of training, and inadequate waste segregation systems often lead to inefficient resource utilization and increased waste generation. Effective site management is a cornerstone for achieving CE goals, as it directly influences material handling and waste minimization.

The third and fourth challenges, lack of awareness and public perception mean ranking 4.79 and weak enforcement of waste management regulations mean ranking 4.78, highlight the socio-regulatory hurdles. A lack of education and advocacy regarding the benefits of CE leads to limited stakeholder buy-in. Additionally, weak regulatory frameworks fail to incentivize compliance or penalize negligence, creating an environment where unsustainable practices persist.

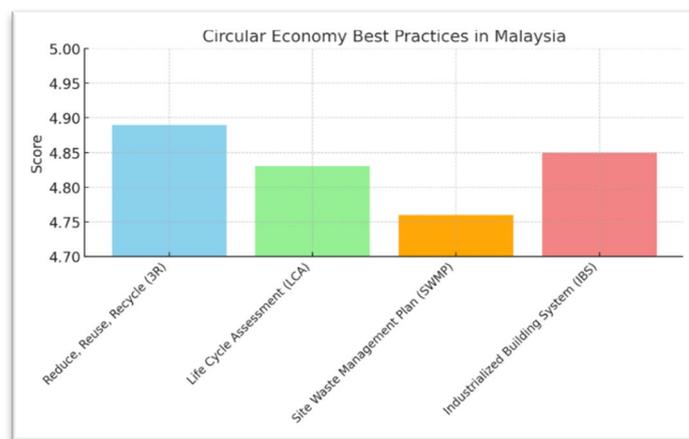
Globally, these challenges mirror the struggles faced by industries in transitioning to CE principles. In countries like Germany and the Netherlands, strong regulatory enforcement and financial incentives have significantly alleviated these barriers, driving successful CE implementation (Gálvez-Martos et al., 2018).

Similarly, Malaysia can address these challenges by introducing subsidies for recycled materials, enhancing site management through training programs, and strengthening enforcement mechanisms. Such steps will align Malaysia's construction industry with global trends and accelerate its progress toward sustainable construction practices

### 3.4 Analysis The Practices Of Circular Construction Waste Management

**Table 4** Practices of circular construction waste management

Challenges of circular construction waste management	Mean	Rank
Reduce, Reuse, Recycle (3R)	4.89	1
Life Cycle Assessment (LCA)	4.83	3
Site Waste Management Plan (SWMP)	4.76	4
Industrialized Building System (IBS)	4.85	2



**Fig. 1** Circular economy best practices in Malaysia

The respondents ranked 'Reduce, Reuse, Recycle (3R)' as the most effective circular economy practice in Malaysia, with the highest mean score of 4.89, emphasizing the importance of reducing waste, reusing materials, and recycling to minimize environmental impact. Following closely, the 'Industrialized Building System (IBS)' ranked second (4.85), showcasing the benefits of prefabrication and modular construction in reducing material wastage. The 'Life Cycle Assessment (LCA)', ranked third (4.83), highlights the importance of evaluating environmental impacts throughout the construction lifecycle to optimize resource use and minimize waste.

Lastly, the 'Site Waste Management Plan (SWMP)', with a mean ranking of 4.76, was identified as a key strategy for organizing and managing on-site waste effectively. Overall, the findings reflect the industry's growing recognition of the need to adopt best practices to address construction waste management. By combining these practices, Malaysia's construction sector can enhance its sustainability efforts, reduce environmental harm, and align with international circular economy standards.

## 4. Conclusion

Circular construction waste management (CCWM) is essential for sustainable development, addressing economic, social, and environmental challenges in the construction industry. This study has successfully identified key challenges and highlighted best practices as effective solutions for reducing waste. By adopting these practices, stakeholders can minimize waste generation, enhance resource efficiency, and contribute to a more sustainable construction sector.

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## Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

## Author Contribution

*The authors are responsible for the study conception, research design, data collection, data analysis, result interpretation and manuscript drafting.*

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