

A Survey-Based Assessment of Construction and Demolition Waste Management Practices in Malaysia

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ABSTRACT

The Malaysian construction sector has experienced rapid growth driven by continuous national development. However, this expansion has intensified challenges related to the management of construction and demolition (C&D) waste, as increasing construction activities generate substantial volumes of waste materials. In response, this study aims to minimise the environmental impacts of the construction sector by promoting effective C&D waste management practices within the Malaysian construction industry. Specifically, this study seeks to provide a comprehensive assessment of C&D waste management practices in Malaysia by examining practitioners' awareness, identifying key implementation barriers, evaluating the impacts of inadequate waste management, and proposing targeted strategies for improvement. A quantitative survey approach was adopted, and descriptive analysis was conducted on data collected from 187 Grade 1 to Grade 7 contractors, representing a response rate of 46.75%. The findings revealed that the primary barrier to implementing effective C&D waste management is the lack of knowledge among practitioners regarding waste management practices. In addition, illegal dumping was identified as the most significant environmental impact resulting from poor C&D waste management. The study also found that the most widely supported strategy for improving C&D waste management is the adoption of the waste management hierarchy through the implementation of 3R practices (Reduce, Reuse and Recycle). The findings contribute valuable insights into sustainable construction practices and provide practical guidance for enhancing C&D waste management in the Malaysian construction industry.

Keywords: *Demolition waste, sustainable practice, construction industry, waste management, environmental impact*

1.0 INTRODUCTION

Rapid population growth and accelerated urbanization have intensified the demand for infrastructure and building development to meet human shelter and economic needs. In Malaysia, the total population was estimated at 32.7 million in 2022, compared to 32.6 million in 2021, reflecting an annual growth rate of 0.2% (DOSM, 2022). This steady increase underscores the need for continuous expansion in building construction to accommodate population demands. Consequently, urbanization contributes significantly to economic development while creating employment opportunities and residential spaces.

The construction industry is a vital contributor to national economic growth in Malaysia. According to the DOSM (2022), the value of construction work completed in the third quarter of 2022 increased by 23.2% compared to the same period in 2021, reaching RM30.5 billion. This growth was primarily driven by non-residential buildings, special trade activities, residential projects, and civil engineering works. Regionally, Selangor contributed RM6.9 billion, followed by Wilayah Persekutuan (RM5.3 billion) and Sarawak (RM3.6 billion), collectively accounting for 51.9% (RM15.8 billion) of the total value. Overall, the construction output in the first three quarters of 2022 rose to RM89.9 billion, reflecting a 6.6% increase compared to 2021.

However, rapid construction activities associated with urban growth have led to a substantial increase in C&D waste generation. C&D waste refers to solid waste produced during building construction, renovation, demolition, land excavation, and site preparation (Shen et al., 2004). Globally, the construction sector is a major contributor to waste generation, accounting for approximately 30% of total waste (Papargyropoulou et al., 2011). The growing volume of such waste highlights the urgent need for effective management strategies to mitigate environmental and societal impacts.

2.0 LITERATURE REVIEW

The generation of C&D waste has increased significantly over recent decades due to expanding construction activities (Jaillon et al., 2009). Globally, large quantities of C&D waste are produced each year. For instance, the United States generated approximately 600 million tonnes of C&D waste in 2018, which exceeded the amount of municipal solid waste produced (EPA, 2018). Similarly, Australia generated around 27 million tonnes of C&D waste in 2018–2019, accounting for 44% of total waste and representing a 61% increase since 2006–2007 (Milton, 2022). In the European Union (EU-27), C&D waste constitutes over 36% of total waste generated (European Commission, 2022), while global projections estimate that such waste may exceed 4 billion tonnes by 2026 (Zheng, 2022).

In Malaysia, rapid infrastructure development has similarly contributed to increased waste generation. The country was projected to generate over 15 million tonnes of waste by 2022, with a compound annual growth rate exceeding 2% over nine years (The Star, 2022). The Malaysian construction sector alone produces approximately 25,600 tonnes of C&D waste daily (Saadi et al., 2016). This trend has raised environmental concerns, as construction activities consume large amounts of natural resources and generate substantial waste (Umar et al., 2018). Poor waste management practices further exacerbate environmental degradation and community concerns (Begum et al., 2009).

C&D waste poses serious environmental and health risks, particularly when hazardous materials are involved (Chang & Kumar, 2021). Effective waste management strategies, including reuse and recycling, can generate economic, environmental, and social benefits when properly implemented. Despite this, waste accumulation remains a challenge, indicating inefficiencies in current waste management practices (Hasmori et al., 2020). In many countries, landfill disposal remains the dominant method, contributing up to 30% of global landfill waste (Lu et al., 2017; Zhang et al., 2022). In Malaysia, C&D waste accounts for approximately 20% to 30% of landfill waste (Kupusamy et al., 2019), with significant quantities disposed of annually due to the perception that such waste has low economic value (Hasmori et al., 2020).

The increasing reliance on landfills has intensified challenges related to limited disposal space and environmental sustainability (Alemayehu et al., 2021; Mbadugha et al., 2021). Furthermore, illegal dumping has emerged as a critical issue, often driven by the high costs of transportation and landfill disposal (Turkyilmaz et al., 2019). Contractors may resort to illegal waste disposal to reduce operational costs, leading to severe environmental and social consequences (Chen et al., 2017; Wu et al., 2017).

To address these challenges, sustainable waste management strategies focusing on the 3R principles (reduce, reuse, recycle) have been widely recommended. Improved recycling and reuse practices can significantly reduce environmental impacts, with estimates suggesting that achieving 50% recycling could reduce impacts by 33.2%, while full recycling and reuse could reduce impacts by up to 46% (Aleksanin, 2019). In developed countries, recycling rates have exceeded 90% due to strong regulatory frameworks and environmental policies (Umar et al., 2021). However, in Malaysia, the adoption of 3R practices in the construction sector remains limited, with only about 5% of waste being recycled or reused (Mohammed et al., 2020, 2022; Ilmi et al., 2024).

Several barriers hinder effective C&D waste management in Malaysia, including limited awareness, insufficient training, and lack of economic incentives (Hamid et al., 2020; Omer et al., 2022). Additionally, inadequate policies and regulatory enforcement contribute to inefficient waste management and increased illegal dumping (Bao & Lu, 2021; Rangga et al., 2023; Victar & Waidyasekara, 2023). Although the Solid Waste and Public Cleansing Management Act 2007 (Act 672) has been implemented, recycling rates remain low at approximately 5% (Chang & Kumar, 2021). Furthermore, the lack of reliable data and comprehensive studies on C&D waste management presents a significant research gap (Kupusamy et al., 2019; Lim & Norazman, 2024; Min et al., 2024; Wen et al., 2025).

Given these challenges, this study aims to provide a comprehensive assessment of C&D waste management practices in Malaysia by examining practitioners' awareness, identifying key implementation barriers, evaluating the impacts of inadequate waste management, and proposing targeted strategies for improvement.

3.0 METHODOLOGY

This study adopted a quantitative research approach using a questionnaire survey to gather relevant and reliable data. Quantitative methods emphasize systematic and controlled data collection through structured instruments that allow numerical analysis (Boncz, 2015; Fellows & Liu, 2015). The questionnaire served as the primary data collection tool, distributed to a targeted population of construction professionals to gather insights on C&D waste management practices. This approach was chosen for its effectiveness in collecting data from a large population, its cost-efficiency, and its ability to provide measurable results. Respondents received structured Likert-scale items, allowing analysis using descriptive and inferential statistics, such as mean, standard deviation, and ANOVA, which are appropriate for Likert-type data (Carifio & Perla, 2008). The sampling strategy was stratified sampling, targeting experienced contractors from G1 to G7 CIDB-registered firms in the Klang Valley. As every construction project generates C&D waste, this demographic was considered suitable for achieving the study's objectives. According to CIDB (2021), there are 38,757 such firms in the area. Based on Krejcie and Morgan's sample size determination table, the required sample size was 380 (Kumar, 2018). To optimize cost and response time, the survey was distributed via email. This method proved efficient compared to traditional postal methods, aligning with current digital communication trends. Descriptive statistics were used to present the findings, including dichotomous data (e.g., gender) and ranked responses (e.g., agreement levels on C&D practices), following the framework suggested by Creswell (2017).

3.1 Respondents' Background

Table 1 of the survey gathered demographic data from 187 respondents using frequency distribution, pie charts, and tables. In terms of contractor firm grade, most respondents (48.7%) worked in G7 firms, followed by G6 (21.4%), G4–G5 (16.6%), and G1–G3 (13.4%). Regarding job positions, the largest group were quantity surveyors (36.9%), followed by contract executives (23.5%), project managers (18.2%), directors (13.4%), site

supervisors (6.4%), and a small group (1.6%) with other roles such as HSE officers. In terms of working experience, 40.1% had less than 5 years of experience, 29.9% had 11–20 years, 26.7% had 6–10 years, and only 3.2% had 21–30 years of experience. The majority of respondents (67.9%) were involved in building construction projects, followed by industrial (15.5%), civil (15.0%), and others (3%), such as theme park projects.

Table 1. Summary of respondents' background.

Category	Sub-Category	Frequency	Percentage (%)
Contractor Firm Grade	G1 – G3	25	13.4
	G4 – G5	31	16.6
	G6	40	21.4
	G7	91	48.7
Job Position	Director	25	13.4
	Project Manager	34	18.2
	Quantity Surveyor	69	36.9
	Contract Executive	44	23.5
	Site Supervisor	12	6.4
	Other (e.g., HSE Officer)	3	1.6
Working Experience	Below 5 years	75	40.1
	6 to 10 years	50	26.7
	11 to 20 years	56	29.9
	21 to 30 years	6	3.2
Main Project Type	Building Construction	127	67.9
	Industrial	29	15.5
	Civil (Heavy/Highway)	28	15
	Other (e.g., Theme Park)	3	1.6

4.0 RESULT AND DISCUSSIONS

Based on the results obtained from the data analysis, this section discusses the findings in relation to the objectives of the study.

4.1 Awareness Level among Construction Practitioners Related to Construction and Demolition (C&D) Waste Management

As discussed before, C&D waste management is important as a key component of sustainable building is ethical waste management. In this sense, managing waste entails reusing items that may otherwise become waste, decreasing waste where it is practical, and eliminating waste wherever it is practicable (Napier, 2016). Having strategies to manage C&D waste is very crucial to the construction industry since having the contractors to manage C&D waste effectively bring a lot of benefits to some aspects. As a result, it is very important to introduce C&D waste management to all the construction practitioners in the construction industry. A questionnaire survey was done to survey the awareness of construction practitioners (ie contractors) related to this matter (refer Table 2). The survey from 187 respondents was collected and further analyzed. Based on the analysis, it indicates that the majority of respondents are heard of C&D waste management before and are aware of how crucial it is to implement in industry. However, out of 187 respondents, there are 12 respondents are not heard of C&D waste management before which 8 respondents are from G1 – G3 contractor firm and 4 respondents are from Grade G4 – G5. It can conclude that although most of the respondents are heard of C&D waste management, the minority group who did not heard of it are from the medium scale of contractor firm, summarizing the C&D waste management is not promote enough to the medium scale of contractor firm. Based on the analyzed, although most of the respondents have heard of C&D waste management, the adoption rate of C&D waste management in the projects which they involved in are

considered low as only 11.8% of respondents are implementing C&D waste management in more than 6 projects. As a result, it shows that it is very important to promote and raise the awareness and understanding level of implementation of C&D waste management among all the contractors from G1 to G7.

Table 2. Summary of awareness level towards C&D waste management

			Count	Column N %
Heard of Construction and Demolition Waste Management	G1 - G3	Yes	17	68.00%
		No	8	32.00%
	G4 - G5	Yes	27	87.10%
		No	4	12.90%
	G6	Yes	40	100.00%
		No	0	0.00%
G7	Yes	91	100.00%	
	No	0	0.00%	
Number of Projects Implemented Construction and Demolition (C&D) Waste Management	G1 - G3	None	25	100.00%
		1 to 3	0	0.00%
		4 to 6	0	0.00%
		More than 6	0	0.00%
	G4 - G5	None	8	25.80%
		1 to 3	23	74.20%
		4 to 6	0	0.00%
		More than 6	0	0.00%
	G6	None	3	7.50%
		1 to 3	37	92.50%
		4 to 6	0	0.00%
		More than 6	0	0.00%
	G7	None	1	1.10%
		1 to 3	30	33.00%
		4 to 6	38	41.80%
		More than 6	22	24.20%

4.2 Barriers in Implementing C&D Waste Management

Positive results show that most of the respondents are aware of C&D waste management, however, there are some barriers in implementing it. The barrier, inadequate knowledge of C&D waste management ranks highest among all the challenges, with a mean score of 4.3476 (see Table 3).

Table 3. Descriptive statistics on barriers in implementing C&D waste management

Barriers	Mean	Std. Deviation	Rank
Inadequate Legislature	3.5615	0.96175	5
Inadequate Funding and Government Support	4.2086	0.96405	4
Inadequate Awareness	4.2834	0.80981	2
Inadequate Technology	4.2299	0.77290	3
Inadequate Knowledge	4.3476	0.76343	1

The present result aligns with the results of Saad et al. (2022) who highlighted that inadequate knowledge and awareness are the major cause of low-rate implementation of C&D waste management. Result results of Saad et al. (2022) also tally with this research’s results as inadequate awareness in implementing C&D waste management is ranked number two with mean score of 4.2834, where can conclude that lack of knowledge and awareness is one of the major barriers in implementing C&D waste management.

Followed by inadequate technology and inadequate funding and government support, with the mean score of 4.2299 and 4.2086 respectively. Rahim et al. (2017) mentioned in their research that when there is no proper technology be used to manage C&D waste, waste are normally being dumped and landfill, as it is the easiest way to manage C&D waste, would lead to the improper management of C&D waste such as illegal dumping. The professionals in the construction industry are hesitant to adopt C&D waste management measures due to increased costs. Therefore, one of the C&D waste management ways to inspire them is to employ proper money and incentives by government (Ghafourian et al., 2017). The finding of Ghafourian et al. (2017) supports the finding that inadequate funding and government support is one of the barrier in implementing C&D waste management. Last but not least, although lack of legal enforcement has the least mean score with 3.5615, it is also one of the major barrier in adopting C&D waste management as it exceed the average mean score of 3.00. As mentioned by Saad et al. (2022) in their paper, lack of law enforcement and regulations is a significant barrier in implementing C&D waste management.

4.3 Impact of Inadequate Implementation of C&D Waste Management

The most significant effect agreed by respondents is illegal dumping with the highest mean score of 4.4706 which is consistent with findings of Zain et al. (2018). In addition to illegal dumping, poor management of C&D waste can cause issues with the environment, society and economy. Therefore, it is essential that the construction industry have an effective C&D waste management plan. The second-ranked consequence, the potential impact of inadequate C&D waste management on ecosystem, is recognized by respondents with 4.3957 mean score. This study confirms that concerns raised by Minelgaitè and Liobikienè (2019). The environment may be gravely harmed by pollution. The struggle for survival of both plants and animals is resulting in the loss of biodiversity and instability of the food chain. Moreover, aquatic species and any animal that consumes them are harmed by the poisons if they find their way into rivers. Therefore, C&D waste poses a risk to both human health and the environment (See Table 4).

Table 4. Inadequate C&D waste management

Impacts	Mean	Std. Deviation	Rank
Illegal Dumping	4.4706	0.72062	1
Damage to Ecosystem	4.3957	0.69837	3
Water and Soil Contamination	4.3850	0.73425	4
Threaten Human Health	4.3690	0.67815	5
Air Pollution	4.0695	0.93353	6
Economic Loss	4.4171	0.67786	2

Furthermore, most of the respondents are aware of the potential effects of poor C&D waste management on soil and water contamination, with a mean score of 4.3850 and supported by Minelgaitè and Liobikienè (2019). Pollutants from construction and demolition activities such as paints, cement and other dangerous substances can contaminate the groundwater and water systems through soil seepage, surface runoff and drains. Although groundwater is a source of drinking water, once contaminated, it is challenging to clean up. Ingestion of the chemicals by humans may result in serious health risks. Animals and plants may suffer from solutions as well. Having ranked fourth overall with a mean score of 4.3690, the respondents are aware of the detrimental effects that inadequate C&D waste management has on human health. The results showed that respondents ranked economic loss in number five with mean score of 4.4171. This observation validates findings of Nagapan et al. (2013). Landfill, labour and disposal fees are additional expenses related to C&D waste

treatment and upkeep. As a result, a more cost-effective way to address this issue should be carried out since it might result in savings on waste disposal.

Poor air quality and water pollution are caused by pollution which puts human health at risk by creating symptoms including asthma, cancer and shortness of breath (Wang et al., 2022). Although the effect to air pollution has the least mean score with 4.0695, the construction sector should be aware of the consequences air pollution has on society and the environment since it may have an adverse effect on human health and contribute to global warming. Therefore, in order to lessen the negative effects of the emissions generated by construction and demolition activities, construction experts should be aware of them and take appropriate precautions. To conclude, the above listed effects all are significant, and it is important to reduce or eliminate them in order to make sure the environmental, social and economic is getting better and better with the cooperation of all parties in construction industry by managing C&D waste effectively.

4.4 Strategies for Managing C&D Waste Management in Malaysia

Since there are some barriers in implementing C&D waste management, it is important to eliminate the barrier by adopting some effective strategies. There are six strategies being rated by respondents to conclude the most agreed effective measures in implementing C&D waste management (See Table 5). According to the findings, which are consistent with results mentioned on the paper of Zain et al. (2018), most of the respondents think that putting the waste management hierarchy into practice is a good way to deal with the C&D waste issue.

Table 5. Descriptive statistics on effective strategies in implementing C&D waste management

Strategies	Mean	Std. Deviation	Rank
Waste Management Hierarchy (3R Practice)	4.6738	0.56369	1
Cooperation of Construction Industry Players	4.4492	0.61464	2
Raising Awareness of Construction Industry Participants	4.4439	0.70391	3
Develop Site Waste Management Plan (SWMP)	4.2727	0.72990	5
Waste Reduction during Design Stage	4.1711	0.70530	6
Using Building Information Modelling (BIM) Technology	4.2941	0.87012	4

This approach was recognized as the most effective means of managing C&D waste with a mean score of 4.6738. Because it is the most widely used approach in many countries with the most effective way and result. Source reduction, reuse and recycling are ranked highest in the waste management hierarchy with disposal coming in last and with the lowest criteria (Kabirifar et al., 2021). Reduction entails using less material by making more accurate estimates, which may significantly cut down on waste. Reuse and recycling may also boost the country's economy and reduce environmental issues. Moreover, the bulk of respondents, based on the answers gathered, firmly concur that every stakeholder has a duty and plays a significant role in the administration of C&D waste with the second highest mean score of 4.4492. This is due to the fact that employee behavior may significantly affect waste levels. The willingness of participants in the construction industry to alter their attitudes and behaviors is necessary for the management of C&D waste. In order to manage garbage effectively, all stakeholders must work together.

According to the findings, which concurred with Abkar et al. (2023), most of the respondents believed that increasing knowledge among those involved in the construction business would help to reduce C&D waste in Malaysia. This technique is regarded as the third effective C&D waste management strategy with a mean score of 4.4439. These days, contractors are less concerned with cutting waste and more focused on meeting contract requirements for quality, time, and money. Consequently, it is critical to foster a positive mindset among those involved in the building sector. In order to enhance knowledge and increase awareness, relevant parties may provide training courses on waste management and environmental protection to professionals in the construction sector. In addition, Building Information Modelling (BIM) technology is one of the strategies that

can be adopted in implementing C&D waste management as the respondents ranked it number four with the mean score of 4.2941. According to the paper of Jin et al. (2019), they highlighted the application of BIM in the building design stage to estimate the amount of C&D waste is believed to be have a large potential for more efficient C&D waste management based on its functions.

According to the literature evaluation, Site Waste Management Plan (SWMP) is classified as the fifth most effective C&D waste management with a mean score of 4.2727. This tactic, which was covered in the literature study, controls the waste disposal process to prevent illicit dumping activities and promotes the adoption of reuse, recycling, and recycling solutions. In addition, the development of a SWMP at the design stage may promote the evaluation of existing waste reduction strategies and identify the most effective waste minimization strategies that can be put into action (Shooshtarian et al., 2021). The approach is acknowledged as an efficient way to cut down on C&D waste since it was created effectively in western nations. Since respondents support this method, the Malaysian construction industry may attempt to put it into practice.

Last but not least, the waste reduction during design stage has the lowest mean score of 4.1711 in strategy of implementation C&D waste management. However, since it exceeds the average mean score of 3.00, this strategy is considered important to be implemented. According to Mbadugha et al. (2021), the focuses on waste reduction during design stage is to target the improvement of the constructability, deconstruction and reusability of structures. Measures such as waste efficient design strategies and designing-out-waste strategies can be used by considering design for reuse and recovery, reduce design complexity, design accuracy and design coordination. This is one of the strategies that can be implemented to manage C&D waste better. To conclude, all the abovementioned strategies can be implemented to manage C&D waste and at the same time solve the barriers on implementing it in the construction industry.

4.5 Social Aspect

According to Table 6, different kinds of responses are received and rated regarding the benefits of implementing green façade in the social aspect. The frequency, relative importance index, and ranking of social benefits are concluded to display the data of respondents that include improving human health and well-being (RII = 0.830), providing a better environment (RII = 0.883), aesthetically pleasing (RII = 0.826), city branding (RII = 0.835), and educational effect (RII = 0.817). The highest rank among all social benefits falls to provide a better environment factor which was mentioned by Aung et al., (2023). The ranking is followed by city branding, improved human health and well-being, aesthetically pleasing, and educational effect ascendingly which is in line with Radić, Dodig, and Auer (2019). All social benefits are relatively essential by having an RII value in the range between 0.817 and 0.883.

Table 1. Frequency, RII, and rank on social benefits

Social aspect	Frequency of Scale					RII	Rank
	Not Agree	Less Agree	Average	Agree	Most Agree		
	1	2	3	4	5		
Improve human health and well-being	0	1	6	24	15	0.830	3
Provide better environment	0	0	1	25	20	0.883	1
Aesthetically pleasing	0	0	11	18	17	0.826	4
City branding	0	1	13	9	23	0.835	2
Educational effect	0	3	9	15	19	0.817	5

Referring to the analysis made above along with Table 6, the top three social benefits specifically providing a better environment, city branding along improved human health and well-being have been suggested by respondents due to their significant contribution to the community. The quality of life and experience can be enhanced by adopting green concepts such as green façades. It makes urban areas to be more visually appealing

due to city branding impact. Respondents indicated that enhancing human health and well-being has a significant positive impact on individuals living in urban areas, where both mental and physical health can be improved. The other two social benefits namely aesthetically pleasing and educational effect which rankings are at fourth and fifth are also important due to their RII scores being above 0.80. This suggests that the respondents appreciate the appearance of green façades and recognize the potential for green façades to serve as educational tools to demonstrate sustainable practices.

4.6 Challenges in Implementing Green Facades

According to Table 7, the main challenges in implementing green facades can be classified into several areas namely (i) Green façades construction cost (ii) Lack of technical knowledge, (iii) Possible growth in insects and pollen (iv) Damage to building façades, Competition with alternative solution (v) Lack of policy and standard and Plant selection and local climate consideration.

Table 2. Frequency, RII, and rank on challenges

Challenges	Frequency of Scale					RII	Rank
	Not Agree	Less Agree	Average	Agree	Most Agree		
	1	2	3	4	5		
Green façades construction cost	0	1	3	14	28	0.900	2
Lack of technical knowledge	3	5	5	14	19	0.778	4
Possible growth in insect and pollen	2	6	12	14	12	0.722	7
Damage to building façades	2	6	9	17	12	0.735	6
Competition with an alternative solution	1	6	22	11	6	0.665	8
Lack of policy and standard	0	3	13	14	16	0.787	3
Plant selection and local climate consideration	2	3	10	15	16	0.774	5
Maintenance	0	2	0	12	32	0.922	1

The data of respondents has been summarised in frequency, relative importance index and rank based on given challenges such as green façades construction cost (RII = 0.900), lack of technical knowledge (RII = 0.778), possible growth in insect and pollen (RII = 0.722), damage to building façades (RII = 0.735), competition with alternative solution (RII = 0.665), lack of policy and standard (RII = 0.787), plant selection and local climate consideration (RII = 0.774), and maintenance (RII = 0.922). The highest rank among all challenges falls to the maintenance factor. Ranks 2 and 3 are attributed to the construction cost of green façades and the lack of policy and standardisation. Rankings from 4 onwards include lack of technical knowledge, challenges in plant selection and local climate considerations, potential damage to building façades, possible growth of insects and pollen, and increasing competition from alternative solutions.

The main challenges to implementing green façades in Selangor within high-rise buildings are in terms of maintenance and green façades construction cost with RII scores of 0.922 and 0.900 respectively. Among all the challenges provided, these two challenges are the ones to have RII values above 0.90 while others are below 0.80 RII values. Maintenance was identified as the most significant challenge by the respondents to suggest that ongoing work and updates are challenging. Ranked as the second-highest challenge based on the RII score, the construction cost of green façades is a key concern among respondents, highlighting the financial constraints associated with their implementation. This cost factor may influence the willingness of developers and building owners to adopt green façade solutions.

The lack of policy and standardisation is identified as another significant challenge, ranking third with an RII value of 0.787. This indicates the need for clearer regulatory frameworks and guidance to support the adoption of green façade practices. In addition, challenges such as limited technical knowledge, difficulties in plant selection and local climate considerations, potential damage to building façades, the possible growth of insects and pollen, and competition from alternative solutions are also noted, although their RII values are comparatively lower than the top-ranked challenges.

5.0 CONCLUSION

This study has implications not only for policymakers, industry stakeholders, and academia, but also for the wider public. For regulators, the findings highlight the urgent need to establish clearer compliance guidelines and effective incentive structures to accelerate the adoption of sustainable construction and demolition (C&D) waste practices across all contractor grades. Strengthening regulatory enforcement in line with the Solid Waste and Public Cleansing Management Act 2007 could help reduce illegal disposal while promoting recycling activities. Within the construction sector, enabling measures such as the implementation of Site Waste Management Plans and the adoption of digital tools like Building Information Modelling (BIM) can equip duty-bearers with practical mechanisms to minimise waste generation and improve compliance with sustainability standards.

From an academic perspective, this research provides a foundation for future longitudinal studies aimed at assessing the long-term economic, social, and environmental impacts of waste management strategies. By linking C&D waste management to Malaysia's commitment to the United Nations Sustainable Development Goals (SDGs), particularly Goal 11 on sustainable cities and communities, the study underscores the need for a systemic transition toward circular economy practices within the construction industry. Overall, these insights demonstrate that effective C&D waste management is not merely a technical requirement but also a strategic approach to building a more resilient and resource-efficient construction sector.

For future research, scholars may explore the level of familiarity and practical experience among Malaysian practitioners in waste management, including sustainable waste management approaches, as sustainability continues to gain increasing attention. Researchers could also adopt real-world approaches, such as case studies, to observe how contractors and site workers manage construction and demolition (C&D) waste in practice. Such investigations would enable a more accurate assessment of which strategies are most effective for implementing C&D waste management. In addition, it is recommended that future studies be conducted across the entire country, encompassing both Peninsular West Malaysia and East Malaysia. This broader scope is important, as contractors operating in different regions may face distinct challenges and possess varying perspectives regarding the implementation of C&D waste management practices.

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7.0 AUTHOR CONTRIBUTIONS

Low Yee Peng is a Master of Project Management candidate who works on this topic, Mohd Suhami Mohd-Danuri is the candidate's supervisor; Mazura Mahdzir is a co-researcher and the corresponding author; and Mohammed Ali Berawi is a research collaborator and visiting professor at Universiti Malaya.

8.0 CONFLICT OF INTEREST

The authors declare no conflicts of interest.

9.0 REFERENCES

- Abkar, M. M. A., Yunus, R., Al-Shameri, A. S. A. S., Harouache, A., & Gamil, Y. (2023). An empirical investigation of automation technology as material waste mitigation measure at Johor construction sites. *Frontiers in Built Environment*, 9. <https://doi.org/10.3389/fbuil.2023.1232195>
- Aleksanin, A. (2019). Development of construction waste management. *E3S Web of Conferences*, 97, 06040. <https://doi.org/10.1051/e3sconf/20199706040>
- Alemayehu, T., Osman, A., & Goitom, H. (2021). Assessment of Construction Waste Management Practice in Mekelle, northern Ethiopia: Challenges and Opportunities. *Momona Ethiopian Journal of Science*, 13(1), 177–190. <https://doi.org/10.4314/mejs.v13i1.10>
- Bao, Z., & Lu, W. (2021). A decision-support framework for planning construction waste recycling: A case study of Shenzhen, China. *Journal of Cleaner Production*, 309, 127449. <https://doi.org/10.1016/j.jclepro.2021.127449>
- Begum, R. A., Siwar, C., Pereira, J. J., & Jaafar, A. H. (2009). Attitude and behavioral factors in waste management in the construction industry of Malaysia. *Resources, Conservation and Recycling*, 53(6), 321–328. <https://doi.org/10.1016/j.resconrec.2009.01.005>
- Boncz, I. (2015). *Introduction to research methodology*. University of Pécs, Faculty of Health Sciences.
- Carifio, J., & Perla, R. (2008). Resolving the 50-year debate around using and misusing Likert scales. *Medical Education*, 42(12), 1150–1152. <https://doi.org/10.1111/j.1365-2923.2008.03172.x>
- Chang, T. W., & Kumar, D. (2021). Overview of Environmental Management Practice for Construction in Malaysia. *Civil and Sustainable Urban Engineering*, 1(1), 15–25. <https://doi.org/10.53623/csue.v1i1.33>
- Chen, H., Chen, F., Huang, X., Long, R., & Li, W. (2017). Are individuals' environmental behavior always consistent? —An analysis based on spatial difference. *Resources Conservation and Recycling*, 125, 25–36. <https://doi.org/10.1016/j.resconrec.2017.05.013>
- CIDB (2021). *Annual Report 2021*. https://www.cidb.gov.my/wp-content/uploads/2022/07/CIDB-Laporan-Tahunan-2021_compressed.pdf
- Creswell, J. W. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.
- DOSM (2022). Current Population Estimates, Malaysia, 2022. *Department of Statistics Malaysia Official Portal*. <https://www.dosm.gov.my/portal-main/release-content/current-population-estimates-malaysia-2022>
- EPA (2018). Sustainable Management of Construction and Demolition Materials. *Sustainable Materials Management*. <https://www.epa.gov/smm/sustainable-management-construction-and-demolition-materials>
- European Commission (2022). Construction and demolition waste. *Environment*. Retrieved January 1, 2022, from https://environment.ec.europa.eu/topics/waste-and-recycling/construction-and-demolition-waste_en
- Fellows, R. F., & Liu, A. M. (2015). *Research Methods for Construction John Wiley and Sons*. Sussex.
- Ghafourian, K., Mohamed, Z., Ismail, S., Abolghasemi, M., & Bavafa, A. (2019). Sustainable Construction and Demolition Waste Management in Malaysia: Current Issues. *Jurnal Kemanusiaan*, 17(1). Retrieved from <https://jurnalkemanusiaan.utm.my/index.php/kemanusiaan/article/view/111>
- Hamid, S., Mat Isa, C. M., N Felix, S., & Mustaffa, N. K. (2020). Sustainable management using recycle and reuse of construction waste materials in Malaysia. *ESTEEM Academic Journal*, 16, 47–58.
- Hasmori, M. F., Zin, A. F. M., Nagapan, S., Deraman, R., Abas, N., Yunus, R., & Klufallah, M. (2020). The on-site waste minimization practices for construction waste. *IOP Conference Series: Materials Science and Engineering*, 713(1), 012038.

- Ilmi, H. S., Yee, J. W., Kam, K. J., Lim, T. S., & Soon, L. T. (2024). Implementation Of Zero Waste Concept In Malaysia: From Contractors' Perspective. *Planning Malaysia*, 22. <https://doi.org/10.21837/pm.v22i32.1521>
- Jaillon, L., Poon, C.-S., & Chiang, Y. H. (2009). Quantifying the waste reduction potential of using prefabrication in building construction in Hong Kong. *Waste Management*, 29(1), 309–320.
- Jin, R., Yuan, H., & Chen, Q. (2019). Science mapping approach to assisting the review of construction and demolition waste management research published between 2009 and 2018. *Resources, Conservation and Recycling*, 140, 175–188. <https://doi.org/10.1016/j.resconrec.2018.09.029>
- Kabirifar, K., Mojtahedi, M., Wang, C., & Tam, V. W. Y. (2021). Effective construction and demolition waste management assessment through waste management hierarchy; a case of Australian large construction companies. *Journal of Cleaner Production*, 312, 127790. <https://doi.org/10.1016/j.jclepro.2021.127790>
- Kumar, R. (2018). *Research methodology: A step-by-step guide for beginners*. Sage.
- Kupusamy, K., Nagapan, S., Abdullah, A. H., Kaliannan, S., Sohu, S., Subramaniam, S., & Maniam, H. (2019). Construction Waste Estimation Analysis in Residential Projects of Malaysia. *Engineering Technology & Applied Science Research*, 9(5), 4842–4845. <https://doi.org/10.48084/etasr.2986>
- Lim, C. H., & Norazman, N. (2024). Construction Waste Management Strategies Towards Sustainable Practices in Malaysia. *Journal of Advanced Research Design*, 121(1), 22–32. <https://doi.org/10.37934/ard.121.1.2232>
- Lu, J., Zhang, S., Hai, J., & Lei, M. (2017). Status and perspectives of municipal solid waste incineration in China: A comparison with developed regions. *Waste Management*, 69, 170–186. <https://doi.org/10.1016/j.wasman.2017.04.014>
- Mbadugha, L. C., Ozumba, A. O. U., & Shakantu, W. M. (2021). The need to improve current waste management practices in the area of construction waste reduction. *IOP Conference Series Earth and Environmental Science*, 654(1), 012008. <https://doi.org/10.1088/1755-1315/654/1/012008>
- Milton, L. (2022). Australian Waste, Recycling and Reuse Statistics for 2022. *The Junk Map*. <https://www.thejunkmap.com.au/australian-waste-recycling-reuse-statistics/>
- Min, J. C. S., Hong, W. T., Jing, C. Y., Mahmud, A. T., & Fateh, M. A. M. (2024). Development Of Procedural Framework For 6r Implementation In Construction Waste Management. *Planning Malaysia*, 22. <https://doi.org/10.21837/pm.v22i32.1520>
- Minelgaitė, A., & Liobikienė, G. (2019). Waste problem in European Union and its influence on waste management behaviours. *The Science of the Total Environment*, 667, 86–93. <https://doi.org/10.1016/j.scitotenv.2019.02.313>
- Mohammed, M., Shafiq, N., Al-Mekhlafi, A. A., Rashed, E. F., Khalil, M. H., Zawawi, N. A. W. A., Muhammad, A., & Sadis, A. M. (2022). The Mediating Role of Policy-Related Factors in the Relationship between Practice of Waste Generation and Sustainable Construction Waste Minimisation: PLS-SEM. *Sustainability*, 14(2), 656. <https://doi.org/10.3390/su14020656>
- Mohammed, M., Shafiq, N., Abdallah, N., Ayoub, M., & Haruna, A. (2020). A review on achieving sustainable construction waste management through application of 3R (reduction, reuse, recycling): A lifecycle approach. *IOP Conference Series Earth and Environmental Science*, 476(1), 012010. <https://doi.org/10.1088/1755-1315/476/1/012010>
- Nagapan, S., Rahman, I. A., Asmi, A., & Adnan, N. F. (2013). Study of Site's Construction Waste in Batu Pahat, Johor. *Procedia Engineering*, 53, 99–103. <https://doi.org/10.1016/j.proeng.2013.02.015>
- Napier, T. (2016). Construction Waste Management. *WBDG - Whole Building Design Guide*. <https://www.wbdg.org/resources/construction-waste-management>

- Omer, M. M., Rahman, R. A., & Almutairi, S. (2022). Strategies for Enhancing Construction Waste Recycling: A Usability Analysis. *Sustainability*, 14(10), 5907. <https://doi.org/10.3390/su14105907>
- Papargyropoulou, E., Preece, C., Padfield, R., & Abdullah, A. A. (2011). Sustainable construction waste management in Malaysia: A contractor's perspective. *Management and Innovation for a Sustainable Built Environment MISBE 2011*, Amsterdam, The Netherlands, June 20-23, 2011.
- Rahim, M. H. I. A., Kasim, N., Mohamed, I., Zainal, R., Sarpin, N., & Saikah, M. (2017). Construction waste generation in Malaysia construction industry: Illegal dumping activities. *IOP Conference Series: Materials Science and Engineering*, 271(1), 012040. <https://doi.org/10.1088/1757-899X/271/1/012040>
- Rangga, J. U., Ismail, S. N. S., Rasdi, I., & Karuppiah, K. (2023). Estimation of Leachate Volume and Treatment Cost Avoidance Through Waste Segregation Programme in Malaysia. *Pertanika Journal of Science and Technology*, 32(1), 339–364. <https://doi.org/10.47836/pjst.32.1.19>
- Saad, A., Bal, M., & Khatib, J. (2022). The Need for a Proper Waste Management Plan for the Construction Industry: A Case Study in Lebanon. *Sustainability*, 14(19), 12783. <https://doi.org/10.3390/su141912783>
- Saadi, N., Ismail, Z., & Alias, Z. (2016). A review of construction waste management and initiatives in Malaysia. *Journal of Sustainability Science and Management*, 11(2), 101–114.
- Shen, L., Tam, V. W. Y., Tam, C. M., & Drew, D. (2004). Mapping Approach for Examining Waste Management on Construction Sites. *Journal of Construction Engineering and Management*, 130(4), 472–481. [https://doi.org/10.1061/\(asce\)0733-9364\(2004\)130:4\(472\)](https://doi.org/10.1061/(asce)0733-9364(2004)130:4(472))
- Shooshtarian, S., Maqsood, T., Yang, J., Khalfan, M., & Wong, S. P. P. (2021). The impact of new international waste policies on the Australian construction and demolition waste stream. AUBEA 2021: Construction Education: Live the Future. *Proceedings of the 44th Australasian Universities Building Education Association Conference (AUBEA 2021)*, Deakin University, Australia.
- The Star (2022). Nation: *Advancing waste management solutions*. <https://www.thestar.com.my/news/nation/2022/07/20/advancing-waste-management-solutions>
- Turkyilmaz, A., Guney, M., Karaca, F., Bagdatkyzy, Z., Sandybayeva, A., & Sirenova, G. (2019). A Comprehensive Construction and Demolition Waste Management Model using PESTEL and 3R for Construction Companies Operating in Central Asia. *Sustainability*, 11(6). <https://doi.org/10.3390/su11061593>
- Umar, U. A., Shafiq, N., & Isa, M. H. (2018). Investigation of construction wastes generated in the Malaysian residential sector. *Waste Management & Research*, 36(12), 1157–1165. <https://doi.org/10.1177/0734242X18790359>
- Umar, U. A., Shafiq, N., & Ahmad, F. A. (2021). A case study on the effective implementation of the reuse and recycling of construction & demolition waste management practices in Malaysia. *Ain Shams Engineering Journal*, 12(1), 283–291. <https://doi.org/10.1016/j.asej.2020.07.005>
- Victar, H. C., & Waidyasekara, K. G. A. S. (2023). Circular economy strategies for waste management in Sri Lanka: A focus on demolitions and repurpose and material recovery and production stages. *Waste Management & Research: Journal for a Sustainable Circular Economy*, 42(11), 953–976. <https://doi.org/10.1177/0734242x231206988>
- Wang, C., Sheng, Y., Wang, J., Wang, Y., Wang, P., & Huang, L. (2022). Air Pollution and Human Health: Investigating the Moderating Effect of the Built Environment. *Remote Sensing*, 14(15), 3703. <https://doi.org/10.3390/rs14153703>
- Wen, V. C. W., Najib, N. 'Ulyani M., & Manoharan, E. (2025). Construction Waste Generation and Minimisation Strategies in Setapak, Kuala Lumpur: A Case Study. *IOP Conference Series Earth and Environmental Science*, 1577(1), 012009. <https://doi.org/10.1088/1755-1315/1577/1/012009>

- Wu, J., Chang, I., Yilihamu, Q., & Zhou, Y. (2017). Study on the practice of public participation in environmental impact assessment by environmental non-governmental organizations in China. *Renewable and Sustainable Energy Reviews*, 74, 186–200. <https://doi.org/10.1016/j.rser.2017.01.178>
- Zain, A. F. M., Hasmori, M., Nagapan, S., Abdullah, A. H., & Yunus, R. (2018). A review of construction management practices in minimizing on-site construction waste. *Jour of Adv Research in Dynamical & Control Systems*, 10(6), 9-14.
- Zhang, T., Zhang, D., Zheng, D., Guo, X., & Zhao, W. (2022). Construction waste landfill volume estimation using ground penetrating radar. *Waste Management & Research the Journal for a Sustainable Circular Economy*, 40(8), 1167–1175. <https://doi.org/10.1177/0734242x221074114>
- Zheng, Y. (2022). China Construction and Demolition Waste Industry Market Report. *EnvGuide*. <https://us.envguide.com/china-construction-and-demolition-waste-industry-market-report/>