PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 22 ISSUE 3 (2024), Page 470 – 485

DEVELOPMENT OF PROCEDURAL FRAMEWORK FOR 6R IMPLEMENTATION IN CONSTRUCTION WASTE MANAGEMENT

Joshua Chua Shu Min[1], Hong Wan Thing[2], Chai Yoon Jing[3], Abba Tahir Mahmud[4], Mohd Ashraf Mohd Fateh[5]

[1,2,3] *School of Energy, Geoscience, Infrastructure and Society,*
HERIOT-WATT UNIVERSITY MALAYSIA
[4]*School of Civil Engineering and Surveying,*
UNIVERSITY OF PORTSMOUTH, UK.
[5]*School of Construction & Quantity Surveying, College of Built Environment,*
UNIVERSITI TEKNOLOGI MARA (UITM), MALAYSIA

Abstract

Sustainable construction has become a top priority in most developing countries including Malaysia. With the rapid development progress in Malaysia, construction waste continues to rise and putting pressure on the social, economy, and environmental sustainability of the nation. Effective construction waste management (CWM) is crucial for achieving the sustainability goals. A well-designed waste management strategy is essential to minimise the environmental impact of waste generation for a more resilient built environment. Past researchers have identified a lack of systematic procedures for CWM and implementation by contractors. This research aims to address this gap by developing a procedural framework for implementing the 6R approach - refuse, reduce, reuse, recycle, recovery, and reflect in the local construction waste management. An extensive literature review on the CWM practices was conducted followed by a preliminary focused-group interview with the Solid Waste Management and Public Cleansing Corporation (SWCorp). A draft procedural framework focusing on 6R waste management was developed following the pilot group studies. To improve the developed framework, semi-structured interviews with the main contractors were conducted for their insights on the current practices and challenges faced in construction waste management, and the feasibility of the proposed procedural framework. The interview findings showed great support to the developed procedural framework with little recommendations incorporated. A final procedural framework was then concluded for implementation. This study presents a significant opportunity for the main contractor in practising sustainable construction waste management (SCWM) through the recommended procedural model.

Keywords: Construction Waste Management, Main Contractors, Procedural Framework, Reduce, Reuse, 6R Implementation

[3] Correspondence Email: Y.chai@hw.ac.uk

INTRODUCTION

The rapid growth of the Malaysian construction industry has led to a challenge in dealing with the upsurge of construction waste. Despite efforts being made to manage construction waste, disposal in landfills still seems to be Malaysia's preferred solid waste management option (Iacovidou and Ng, 2020). Although the Construction Industry Development Board (CIDB) and Construction Research Institute of Malaysia (CREAM) have introduced training modules to promote SCWM, these initiatives remain insignificant (Kathiravale et al., 2020) and therefore impeded the efforts of Malaysia progressing towards the United Nation (UN) 17 Sustainable Development Goals (SDGs). It is also worth noting that solid waste management in Malaysia is not fully under the authority of the Federal government. In this context, the effective management of construction waste must be highlighted to realise the national sustainability objectives. As the development in Malaysia accelerates, construction waste generation escalates in parallel, placing substantial strain on the nation's SDGs (Nagapan et al., 2012). The rise in waste output has not just triggered the depletion of natural resources but also upscaling issues related to illegal dumping. Perhaps this could be attributable to the absence of robust enforcement measures in the construction sector and limited access to waste-sorting facilities. While it is evident that Malaysia has listed the types of waste that should be managed holistically in the 11th Malaysia Plan, this research has a parallel mission in construction waste management. Past research by Cheen et al. (2018) mentioned the most practical waste management approach should embrace *reduce, reuse, recycle, and* then dispose in a proper dumpsite. To complement a holistic CWM approach, *refuse*, *recover* and *reflect* shall also be incorporated into the practice. This research aims to develop a procedural framework embracing the 6R principles, which cover "*refuse*, *reduce*, *reuse*, *recycle*, *recover*, and *reflect*" for full implementation.

CHALLENGES OF IMPLEMENTING EFFECTIVE CONSTRUCTION WASTE MANAGEMENT WITH 6R APPROACH

In 2022, there was a significant increase in illegal dumping hotspots in Malaysia, with 29 out of 42 reported hotspots being associated with construction waste. Kuala Lumpur alone accounted for 326.0 tonnes of construction waste out of a total of 344.3 tonnes of illegal waste (TheStar, 2023). Studies by Lin et al. (2021) and Ngapan et al. (2012) mentioned research conducted by Faridah et al. (2004) identified six types of waste on 30 construction sites in the following composition: wood (69.10%), concrete (12.32%), metal (9.62%), bricks (6.54%), plastics (0.43%), and other waste (2%). Currently, Malaysian contractors are facing several challenges in implementing effective CWM, which include time constraints, limited resources, lack of enforcement of legislation and guidelines, lack of knowledge about construction waste, and limited space on construction sites. It was highlighted that CWM often takes a backseat to the primary

objectives of completing projects on time and within budget, which are considered more critical in the construction industry (Chidiobi et al., 2023). Studies conducted by Ng et al. (2017) and Salleh et al. (2022) highlighted inefficient implementation of 3R practices by contractors resulting in unsustainable CWM and an increase in waste being sent to landfills or illegal dumping, which is a major concern in areas with limited land available for waste disposal. In addition. the National Solid Waste Management Department (JPSPN) and SWCorp are responsible for policies and regulations implementation and enforcement for solid waste management of the country. However, solid waste management in Malaysia is not fully under the authority of the Federal government. Out of thirteen (13) states and three (3) federal territories, only six (6) states and two (2) federal territories have accepted and committed to it (SWCrop,2018; Iacovidou and Ng, 2020). This situation emphasises the need for a more structured and systematic approach to CWM that aligns with the UN SDGs. However, there is a lack of readily available frameworks or guidance for contractors in Malaysia. Previous research has discussed topics such as a procedural framework for assessing construction and demolition waste management performance by Wu et al. (2019), a waste management process modelling for construction and demolition waste by Esguícero et al. (2021), or a sustainability framework for waste management by Taelman et al. (2018), all of which emphasise the importance of waste management. Still, their findings are not sufficient for direct application in the Malaysian context.

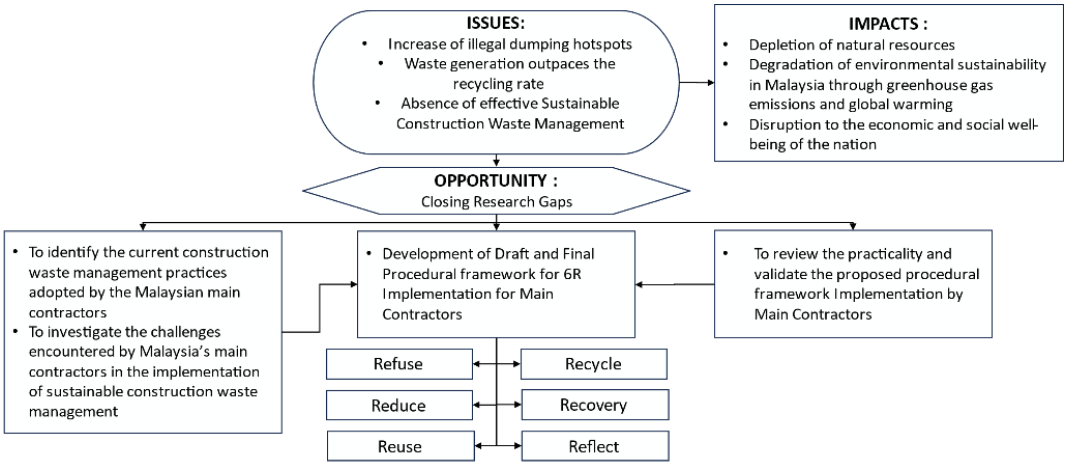

Figure 1: Current CWM issue, Potential Research opportunity and Objectives

Figure 1 demonstrates the issues, factors and impacts in relation to subpar practices in managing construction waste, as well as the research

opportunities for proposing a systematic and holistic approach to implement effective CWM. Zainon et al. (2022) claimed that understanding evidence-based trends in common CWM practices is crucial in developing a solid waste management framework. To address the research gaps, the development of a procedural framework for 6R implementation in construction waste management is recommended. The 6R principles of refuse, reduce, reuse, recycle, recovery, and reflect are complete reflections of SCWM which can be considered in practice. The proposed framework will comply with Act 672 requisites published under the Solid Waste and Public Cleaning Management Act (revised 2017). The first principle that shall be incorporated into the framework begins with *refuse* wasteful or non-recyclable products. Next, the recommended procedures include: - *reduce* project waste generation by decreasing construction mistakes, ordering the right quality/ right quantity of materials, *recycle reusable* materials, improving CWM planning, appointing on-site waste management officers, and providing secure site storage. Nagapan et al. (2011) supported that additional ordering has significant impacts on construction waste generation. The appointment of a licensed waste collection service provider, and establishment of site storage, collection points, and receptacles, are mandated in Part VIII of Act 672. Apart from this, Eusuf et al. (2012) further supported that the ordered materials must be securely stored and appropriately packaged. Then, the option to *recover* waste resources to produce other valuable products could optimise the values created from waste. This forms a part of a circular economy, in which the waste is minimised thereby reducing the need for landfill space. The option for landfill disposal must always be the last resort. The last recommended procedure is to rethink and *reflect* on the overall CWM practices and recommend further improvements that benefit the entire project life cycle for the subsequent projects. A systematic and holistic procedural framework for 6R implementation as proposed above is significant to ensure an effective SCWM practice among the local main contractors.

RESEARCH METHODOLOGY

This research utilised the qualitative research method, which is well-suited for the research context requiring more in-depth thoughts and insights of the targeted respondents. Figure 2 illustrates the research methodology applied. Prior to the scheduling of the preliminary group interview, an extensive literature review about the local CWM practices and issues was conducted to identify the gaps in the research opportunity. Then, an unstructured pilot group interview with the SWCorp personnel was conducted for the development of a draft procedural framework focusing on 6R waste management. SWCorp is a government agency established under the Ministry of Housing and Local Government and the Solid Waste Management and Public Cleaning Corporation Act (Act 673), which aims to create a comprehensive, integrated, cost-effective and sustainable solid waste

management system. The pilot group interview with SWCorp benefits the feasibility of the 6R approach as well as enhances and improves Malaysia CWM. Five (5) personnel including the director, assistant director, and three executive engineers were involved in the face-to-face group interview. All their responses and recommendations were recorded for developing a draft 6R procedural framework for the contractor's implementation. Suggestions from the interview were also taken into consideration for refining the semi-structured interview questions prepared for main contractors in the next agenda.

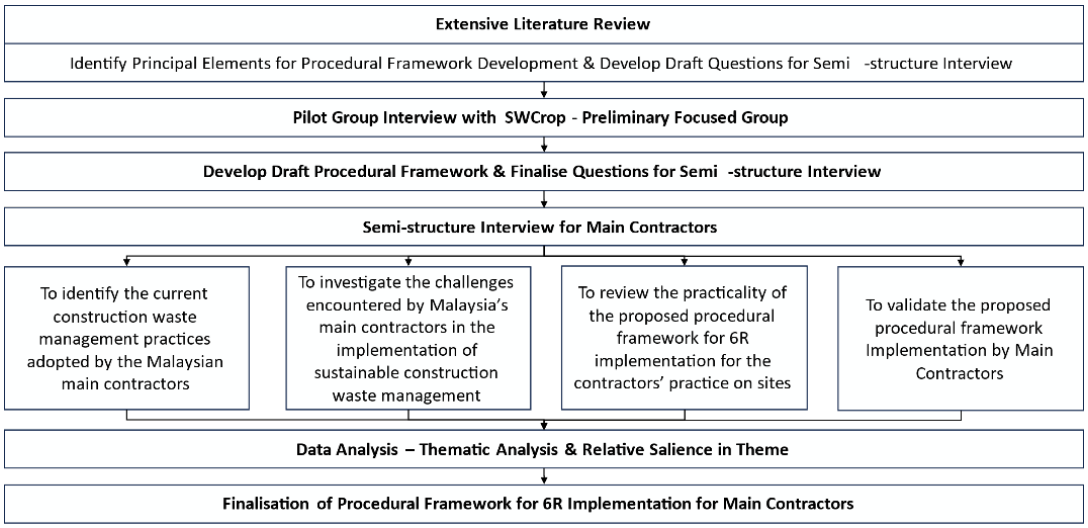

Figure 2: Research Approaches for Data Collection.

Thereafter the draft procedural framework was developed, and the semi-structured interview questions were refined, targeted interview participants were identified through purposive sampling method. Grade 7 (G7) main contractors registered under the Construction Industry Development Board (CIDB) within Klang Valley, Malaysia, who have direct exposure and experience in construction waste management were contacted for interviews. Given that the targeted audience was somewhat hard to reach, the snowball sampling technique was utilised. The semi-structured interviews were conducted with the G7 main contractors in face-to-face mode, which included the organisation executives and managerial personnel. The interviews explored the participants' current practices in construction waste management, the challenges they encountered in implementing SCWM, the feasibility of the draft procedural framework and the proposal for improving the procedural framework for 6R implementation. Qualitative studies often yield limited data results, relative salience in themes was integrated into the thematic analysis for data analysis. Data collected from these interviews are thematically analysed, wherein the findings are systematically

organised and categorised. The data are organised into themes by identifying key concepts, grouping them into categories, refining through iterative review, and finally defining and naming each theme. Relative salience in theme was integrated to further enhance the data analysis based on the frequency of the points/topics discussed and its alignment with the research objectives. The key findings from this holistic approach were then used to enhance the procedural framework, facilitating the effective adoption of the main contractor's implementation in 6R waste management.

RESEARCH FINDINGS AND DISCUSSION

Preliminary Focused Group Interview

The findings of expert group interview with SWCorp Malaysia are presented in this section. From the group discussion, all participants strongly agreed that main contractors play a crucial role in reducing construction waste. While main contractors must follow the client's and designers' instructions, the main contractor also plays an important role in reducing construction waste through proper storage and ordering the necessary quantity of construction materials. Two prominent challenges to implement SCWM were identified i.e. lack of legislation enforcement and outdated waste management guidelines. They urged that these CWM guidelines should be eliminated and replaced accordingly. These statements were supported by Ng et al. (2015) who emphasised the significance of policy and legislation in reducing waste during the construction stage. The lack of strict enforcement in CWM can be observed as the reason for the lack of awareness among contractors. Perhaps, the existing guided procedures should be more comprehensive in this context.

During the group discussion, principal elements required for the procedural framework development were outlined and presented to the expert group. Five suggestions were conveyed for consideration in commencing the procedural framework for 6R implementation. Firstly, SWCorp suggested the appointment of waste management officer on-site and identification of waste disposal facilities in advance to facilitate waste management. Second, more information should be provided for non-recyclable, lead-free and asbestos-free materials in developing the framework. Next, the framework should consider the appointment of waste collection service providers during the pre-construction stage, as waste is inevitably generated during site preparation. Besides, certain contracts under the Jabatan Kerja Raya (JKR) require contractors to order 20% of construction materials upfront to receive their first payment. Hence, the term "required quantity" is subjective in the outline. This serves as a reminder to contractors, that the practice of excessive ordering often leads to on-site waste. The last suggestion was about the international recognition of the 6R practices which is essential for continuous improvement and introducing new habits to construction practices. The inputs by SWCorp are valuable, insightful and have

comprehensively captured the essential elements for the development of the procedural framework. Figure 3 illustrates the proposed procedural framework as a result of the group discussion.

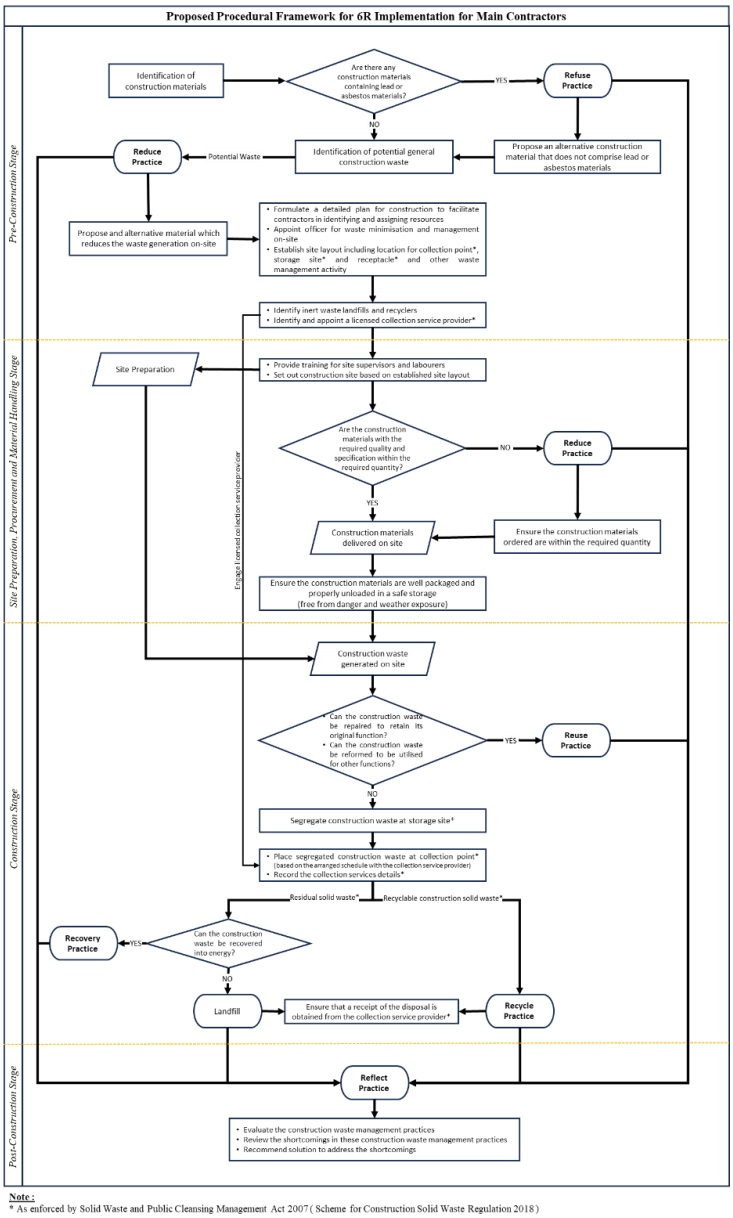

Figure 3: Proposed Procedural Framework for 6R Implementation for Main Contractors

Interviews with Main Contractors

The interviewees are made up of professionals of different position levels in the construction industry, ranging from Chief Operating Officer to Managing Director and Senior Manager, with an average of 22.8 years of working experience. A set of open-ended semi-structured questions and the proposal of the procedural framework for 6R implementation were prepared for the interviews. The collected data was then analysed thematically, ensuing four main themes that captured the results and findings from these interviews.

Main Contractor's Construction Waste Management Plan

All interviewees correspondingly agreed that contractors play a crucial role in reducing construction and demolition waste on site. This includes substituting potential waste materials for more sustainable alternatives, ordering materials in the specified quantities, and ensuring proper handling and storage. Based on the collected data, it was observed that most of the main contractors adopt three primary approaches to reduce waste in construction: i) Industrialised Building System (IBS), ii) Prefabricated Components, and iii) Adoption of metal formwork. Among the different types of construction waste, timber is a significant contributor. This finding is supported by Lin et al. (2021) and Faridah et al. (2004) that timber waste usually occupies at least two-thirds of the overall construction waste, due to massive use of timber formwork. While alternative formwork methods could help reduce waste and eliminate the need for timber formwork, challenges arise when dealing with complex curved structures that cannot accommodate these alternative methods. Albeit to completely eliminate timber formworks from the waste stream remains a challenge, all interviewees reassured that they make efforts to reuse timber formworks for multiple cycles. When the timber can no longer serve its original purpose, two interviewees shared their experience in repurposing the timber for site offices or as temporary sheds.

Complexities in Implementing Sustainable Construction Waste Management (SCWM)

The implementation of Sustainable Construction Waste Management (SCWM) in Malaysia faces significant challenges, as pointed out by the respondents. The main challenge conveyed is about cost limitation, with half of the interviewees noting that competitive project awarding based on price often compels contractors to reduce their profit margins during tendering, leading to a focus on cost reduction throughout the construction stage. Sustainable materials like metal formworks, although beneficial, can be more expensive than conventional timber formwork, making them financially prohibitive for some projects. Insufficient space on construction sites, both large and small, can impede proper waste segregation and management. Even when space is available, all interviewees have

concerns about coordination issues that may arise as construction progresses, requiring constant adjustments to storage and segregation areas.

All interviewees experienced appointing licensed service providers for construction waste disposal. However, there are doubts on where the waste will be disposed after it leaves the sites. It is believed that most of waste collection service providers have inadequate waste management facilities, especially the problems of landfill shortage. This may have impacts on the construction disposal processes and end up illegal dumping may happen. Such results will further complicate the efforts of the main contractors. Inadequate CWM facilities in Malaysia, including a shortage of landfills and a lack of plants of waste-to-energy (WtE) incineration, hinder sustainable practices. Moreover, all interviewees have also mentioned time constraints issues for implementing proper waste disposal process, particularly in fast-tracked projects. Fast-tracked projects may discourage the implementation of waste segregation processes due to the additional time and cost required for coordination. Interestingly, most interviewees do not consider the lack of knowledge among construction workers as a major challenge, as training programs are in place to promote awareness and understanding. However, language barriers may pose difficulties when foreign labourers are involved. The poor attitudes of construction workers, influenced by cultural practices, can be an obstacle, but organisations can foster a culture of sustainability to shape behaviours.

Lastly, all interviewees have highlighted that the lack of precise legislation enforcement and detailed guidelines for construction solid waste management is a notable challenge. Interviewees suggest the need for improved communication and engagement to ensure compliance with sustainable practices in the industry. Yadav et al. (2022) supported this statement in their research on the challenges in implementing SCWM, which emphasised the lack of proper regulations for waste sorting, the lack of coordination among government bodies, and the absence of an effective waste tracking system.

Overall, all interviewees highlighted the difficulty in implementing sustainable construction waste management in Malaysia, identifying various challenges such as cost limitations, insufficient space for waste segregation on construction sites, doubts about the disposal destinations of waste collected by service providers, inadequate waste management facilities, time constraints, language barriers with foreign labourers, cultural influences, and the lack of precise legislation enforcement and detailed guidelines for construction solid waste management.

The Practicality of the Procedural Framework for 6R Implementation

Over 65% of the interviewees revealed that their companies are implementing a systematic procedure for CWM in compliance to the 3R practices in Malaysia. The suggestion to incorporate the additional CWM practices i.e. *refuse*, *recover*,

and *reflect* has gained positive response among the interviewees, as the additional 3R practices supplement the current. Two interviewees expressed consensus that these practices include the refusal of asbestos and lead mineral materials, but it was suggested that contractors should inform designers and propose alternative materials. Nevertheless, there are differing opinions on whether contractors can suggest alternative materials while declining those with such minerals. Notably, all interviewees agreed on the practicality of *recovery* and *reflect* practices. Overall, the concept of *reflect* practice received unanimous approval as it promises continuous improvement in project performance by incorporating sustainability and waste management practices.

In summary, the main contractors collectively believe that the proposed 6R procedural framework holds significant promise in facilitating the effective implementation of SCWM practices throughout their projects. However, interviewees acknowledge that successful adoption depends on the availability of additional funds, the engagement of suitable personnel and legislation enforcement.

Validation of Procedural Framework for 6R Implementation

The draft procedural framework for 6R Implementation (see Figure 3) was presented to the interviewees for their valuable comments to enhance the effectiveness of the procedural framework for Main Contractors. One suggestion is to create of a platform for knowledge sharing on SCWM practices, which allow contractors to exchange insights on challenges and best practices. Another proposal is to include appropriate materials handling, storage, disposal, and 6R practices in project kick-off meetings. These meetings are deemed essential by all project stakeholders, emphasising the importance of early engagement and effective communication. Active participation from the client and consultant teams during the pre-construction stage is encouraged to implement this recommendation. The goal is to promote brainstorming and collaboration among stakeholders for a comprehensive and successful implementation of 6R practices, distributing responsibility and accountability across the entire project team. Additionally, all interviewees unanimously agree on the need for a reward and penalty system to motivate and enforce SCWM practices. While back charges currently serve as penalties for material damage, it is suggested that a balanced reward and penalty system be implemented. This approach would create accountability and provide incentives for exemplary practices. Besides, using visual reminders on construction sites has been proposed to reinforce SCWM practices among workers. Similar to safety signage, these visual reminders would help workers remember proper waste disposal and handling procedures, indirectly reducing construction waste. Incorporating the term "unloading" into the procedure is also recommended. Proper unloading practices are important for fragile components like glass and masonry, as improper handling can lead to

waste. By emphasizing careful unloading, the aim is to minimise material damage and waste during construction. Moreover, it was recommended to prepare CWM evaluation reports to be submitted to government bodies such as the Ministry of Housing and Local Government (KPKT) and the Solid Waste Management and Public Cleansing Corporation (SWCorp). This reporting process should document the effectiveness of SCWM practices of a project, and facilitates collaboration with regulatory bodies for improvements. It creates a feedback loop for ongoing refinement and innovation in SCWM practices. Finally, one interviewee suggests that government bodies should offer incentives to encourage contractors in Malaysia to adopt 6R practices, aligning with national sustainability goals.

In summary, these recommendations reflect the collective wisdom and insights drawn from extensive experience in the construction industry. All interviewees emphasised the need of knowledge sharing, good communication, balanced reward & penalty systems, visual reinforcement, attention to unloading procedures, regulatory collaboration, and incentivization. These factors are essential for implementing successful SCWM practices within the proposed procedural framework for main contractors. These valuable suggestions provide a roadmap for refining and enhancing SCWM practices in the construction sector, aligning with Malaysia sustainability objectives.

Development of Procedural Framework for Main Contractor's Implementation

The proposed procedural framework for 6R implementation demonstrates the roles and waste management processes that main contractors should comply with during the pre and post construction stages. Following the pilot group interview with SWCorp, a draft framework is developed as shown in Figure 3. The framework firstly begins with the rejection of wasteful or non-recyclable products by main contractors. Next, the process to reduce potential construction waste on-site via substitution of sustainable materials is a vital move. Then, the contractors should minimise waste generation through appropriate site planning and management in relation to the construction process, and material arrangement. It is also important that the contractor is aware of the appointment of a licensed collection service provider and the location of the landfills and recyclers. Moving on, all construction materials should be ordered in the required quantities and the specification of the materials should be within the required quality. As mentioned in the previous section, these materials must be securely stored and appropriately packaged. For any unavoidable waste generation, main contractors should first evaluate whether the waste can be reused by repurposing it for other applications. If these options are not feasible, the waste should be segregated into residual solid waste and recyclable construction solid waste at the storage site, as required by supplementary legislation under Act 672. Once the receptacle is full, it should be

placed at the designated collection point. Furthermore, recording the details of the collection services is mandatory. The sorted recyclable construction solid waste should be sent to recycling facilities, while the residual solid waste should be delivered to recovery facilities. Landfilling should only be considered when the construction waste is no longer reusable, recyclable, or recoverable. Finally, main contractors should reflect on the implemented CWM practices by evaluating them and recommending further improvements for future projects. Although the supplementary legislation under Act 672 does not apply nationwide, it is still advisable to adopt these good practices to facilitate sustainable construction waste management. The drat procedural framework aims to support main contractors in implementing successful SCWM through the incorporation of 6R practices throughout their entire project. However, the draft framework requires criticism on its practicality and validation from the users i.e. the main contractors.

The interviews with main contractors revealed all respondents collectively acknowledged the proposed 6R procedural framework holds significant promise in facilitating the effective implementation of SCWM. Additional recommendations were derived from the interview data to finalise the procedural framework. These recommendations are in reference to the section *Validation of Procedural Framework for 6R Implementation* and are summarised as: establishing a knowledge-sharing platform, proper materials handling, storage & disposal, including 6R practices in the kick-off meeting agenda, involvement of top management in SCWM, balanced reward and penalty system, visual reinforcement of SCWM practices, documentation of SCWM practices for KPKT and SWCorp approval, and government incentives and rewards. The finalised procedural framework is illustrated in Figure 4.

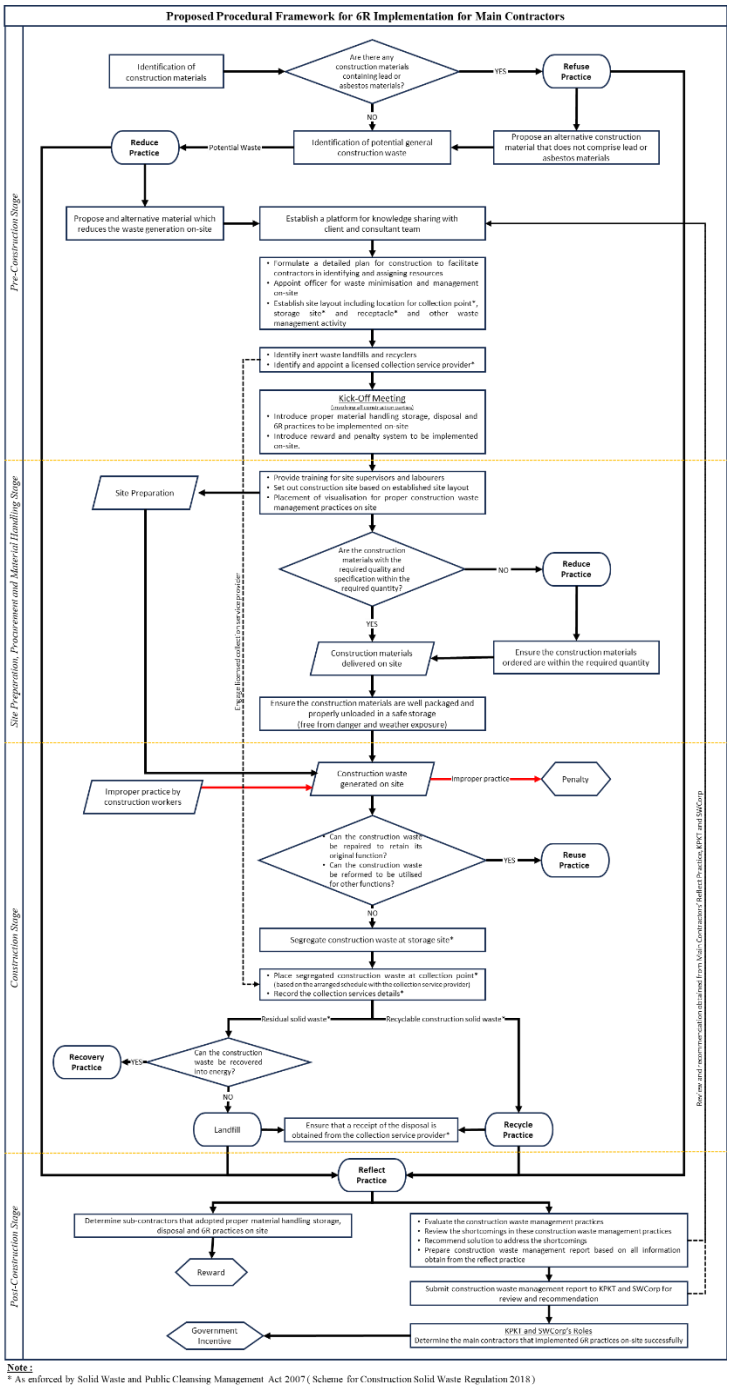

Figure 4: Finalised Procedural Framework for 6R Implementation for Main Contractors

CONCLUSION AND FUTURE RESEARCH

The research aims to improve the SCWM practice of the contractors in Malaysia by developing a procedural framework for 6R implementation. Pilot group interviews were conducted with SWCorp and semi-structured interviews were carried out with main contractors to gain insights into current CWM practices, challenges faced, how the issues can be solved via a procedural framework and the viability of the developed framework. The research findings revealed that the most commonly adopted CWM practices are *Reduce* and *Reuse*, with the remaining waste being collected by licensed waste collectors. However, these practices do not align seamlessly with the comprehensive CWM guidelines outlined by SWCorp (2018). From the perspective of contractors, cost limitations pose a significant obstacle to the adoption of SCWM practices, particularly for large to small-scale construction firms. This issue has become more prominent when considering advanced construction methods (usually higher cost) such as metal framework and prefabricated components, making contractors hesitant to spend for SCWM. The additional practices on *refuse*, *recovery*, and *reflect* were suggested to complement the current 3R practices in Malaysia. The results notably indicated that contractors were majorly receptive to the *recovery* and *reflect* practices. The *reflect* practice was considered essential for a project to improve its sustainability aspect. All recommendations received to improve the procedural framework were evaluated and wisely incorporated into the finalized procedural framework for 6R implementation as shown in Figure 4.

The procedural framework was developed in mind to improve the current practices and resolve the challenges faced by local contractors. The study concluded the final product is well-accepted by contractors and deemed feasible for implementation. It is important to note that the final procedural framework can be suitably applied into the federal territories and certain states in Malaysia. The research contributes a systematic procedure for main contractors' application in managing construction waste throughout the project phases. The study is particularly significant in the area of sustainable construction, promising a healthier and more resilient built environment by supporting the UN SDG 12: Responsible Consumption and Production and SDG 13: Climate Action. There is a suggestion that future research can focus into evaluating the effectiveness and impacts of implementing the developed procedural framework in real construction projects. Exploration into the barriers to adopting the procedural framework for successful SCWM practices, incentives to main contractors, as well as the economic implications of applying the framework are also within the future research directions.

REFERENCES

Cheen, K. S., Yieh, L. C., Ashola, O. A., Yahya, N. N. H. N., Han, W. S., & Yusof, M. N. (2018). A study of construction waste practice in selangor. *Planning Malaysia*, 16.

Chidiobi, C. C., Booth, C. A., & Lamond, J. E. (2023). Prioritising Materials Procurement and Construction Waste Management attributes. Proceedings of the Institution of Civil Engineers - *Waste and Resource Management*, 1–15. https://doi.org/10.1680/jwarm.22.00013

Esguícero, F. J., Deus, R. M., Battistelle, R., Martins, B. L., & Bezerra, B. S. (2021). Construction and demolition waste management process modeling: A framework for the Brazilian context. *Journal of Material Cycles and Waste Management, 23*(5), 2037–2050. https://doi.org/10.1007/s10163-021-01247-y

Eusuf, M. A., Ibrahim, M., & Islam, R. (2012). The construction and demolition wastes in Klang Valley, Malaysia. *Journal of the Malaysian Institute of Planner*, 99-124.

Faridah, A., H., A., Hasmanie, A., H., Hasnain, M., I., (2004), A study on construction and demolition waste from buildings in Seberang Perai, Proceeding of 3rd National Conference in Civil Engineering, Copthorne Orchid, Tanjung Bungah, Malaysia

Iacovidou, E., & Ng, K. S. (2020, July 29). Malaysia Versus Waste. Retrieved from https://www.brunel.ac.uk/news-and-events/news/articles/Malaysia-Versus-Waste

International Trade Administration, ITA. (2023). Malaysia Waste Management Solutions. Retrieved from https://www.trade.gov/market-intelligence/malaysia-waste-management-solutions

Kathiravale, S., Kittappa, S., Ismail, N. M. S., Ghani, Hj. M. K., Bashah, K. N. A., Abd Hamid, Z., & Haji Ibrahim, H. R. (2020, April). Sustainable waste management practices for the construction industry. *The Ingenieur*, 82(April-June), 36–46.

LAWS OF MALAYSIA, Act 672, SOLID WASTE AND PUBLIC CLEANSING MANAGEMENT ACT 2007 (2017).

Lee, J. C., Thedy, W. H., Ng, J. L., & Lee, S. (2023). Recycled waste of construction industry in Malaysia: A Review. *IOP Conference Series: Earth and Environmental Science, 1205*(1), 012030

Lin, N. Y., Hassan, Z. F. A., & Halim, I. A. (2021). RECYCLING OF CONSTRUCTION TIMBER WASTE TO ENERGY: A CASE STUDY IN SWCORP. *Journal of Surveying, Construction and Property, 12*(1), 1-16.

Master Builders Association Malaysia. (2019). Retrieved from http://mbam.org.my/solid-waste-and-public-cleansing-management/

Nagapan, S., Rahman, I. A., & Asmi, A. (2011, October). A review of construction waste cause factors. In Asian Conference on Real Estate: Sustainable Growth Managing Challenges (ACRE) (pp. 967-987).

Nagapan, S., Rahman, I. A., & Asmi, A. (2012, April). Construction waste management: Malaysian perspective. In International Conference on Civil and Environmental Engineering Sustainability (IConCEES), Malaysia (Vol. 2, pp. 299-309).

Ng, L. S., Seow, T. W., & Goh, K. C. (2015). Implementation on solid waste reduction through 3R (NSWM policy) and elements to close gap between policy and contractors in construction industry in Penang. *International Journal of*

Environmental Science and Development, 6(9), 668–675. https://doi.org/10.7763/ijesd.2015.v6.678

Ng, L. S., Tan, L. W., & Seow, T. W. (2017). Current practices of construction waste reduction through 3R practice among contractors in Malaysia: Case study in Penang. IOP Conference Series: *Materials Science and Engineering*, 271, 012039. https://doi.org/10.1088/1757-899x/271/1/012039

Salleh, H., Ying, C. K., Hanid, M., Samad, Z. A., Sabli, N. A. M., & Khuzzan, S. M. S. (2022). Development of Guidance for the Adoption of Circular Economy in Construction and Demolition Waste Management. *Planning Malaysia, 20* (5), 415–427.

SWCorp Malaysia (2018) Sustainable Waste Management in Construction Industry. [PowerPoint presentation]. Bangi-Putrajaya Hotel, 27 September 2018.

Taelman, S., Tonini, D., Wandl, A., & Dewulf, J. (2018). A holistic sustainability framework for waste management in European cities: Concept development. *Sustainability, 10*(7), 2184. https://doi.org/10.3390/su10072184

The Star. (2023, January 12). SWCorp stepping up enforcement against illegal dumping of construction waste. https://www.thestar.com.my/news/nation/2023/01/12/swcorp-stepping-up-enforcement-against-illegal-dumping-of-construction-waste

Wu, H., Zuo, J., Yuan, H., Zillante, G., & Wang, J. (2019). A review of Performance Assessment Methods for construction and Demolition Waste Management. Resources, *Conservation and Recycling*, 150. https://doi.org/10.1016/j.resconrec.2019.104407

Yadav, B. P., Chandran, H., Ajithkumar, S., Mondal, P., Singh, V. K., & Sharma, V. (2022). Review on Construction Waste Management: India Versus Malaysia. In Advances in Construction Safety: Proceedings of HSFEA 2020 (pp. 207-219). Singapore: Springer Nature Singapore.

Zainon, N., Myeda, N. E., Bakar, A. A., Chuing, L. S., Rahim, F. A. M., Zyed, Z. A. S., ... & Lim, M. Z. (2022). The Assessment of Waste Segregation Exercise Among Malaysian Contractors: A Descriptive Analysis. *Journal of Design and Built Environment, 22*(1), 72-87.

Received: 18th Mar 2024. Accepted: 6th July 2024