INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN PROGRESSIVE EDUCATION & DEVELOPMENT

OPEN ACCESS JOURNAL

Vol 15, Issue 1, (2026) E-ISSN: 2226-6348

Preliminary Study on Recycling Practices Applied in the Malaysian Construction Industry

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DOI Link: http://dx.doi.org/10.6007/IJARPED/v15-i1/27783

Published Online: 31 March 2026

Abstract

Construction waste generation has been perceived as a crucial issue that has critical consequences on the project effectiveness and ecological effect of the construction industry. The key objective of the current research is to identify the most common recycling practices applied in the Malaysian construction industry. A well-structured questionnaire was designed based on the 25 identified recycling practices. The developed questionnaire was distributed to 38 highly experienced Malaysian construction industry experts. The collected data were analysed using mean score analysis. The top identified metals are sold to the recycling centres, concrete is used for paving temporary site access, concrete is used as filling for road/road base, timber is used for temporary works and metals are sent to other construction projects. The novelty of this study lies in the systematic identification and empirical ranking of construction waste recycling practices within the Malaysian construction context based on expert perspectives. The study contributes to the social sciences by providing insights into industry stakeholders' waste management behaviour and decision-making practices related to sustainable resource management in construction projects. The findings will aid construction practitioners in focusing on recycling practices to reduce material construction and demolition waste generation at construction sites.

Keywords: Recycling Practices, Mean Score, Construction, Waste, Malaysia

Introduction

The construction industry plays a vital role in the socioeconomic development of any nation by supporting infrastructure growth and economic expansion. However, despite its significant contributions, the industry is often associated with considerable environmental impacts. Construction activities consume large amounts of natural resources and can lead to environmental degradation, including the depletion of raw materials, irreversible alteration of natural landscapes and increased levels of atmospheric pollution. In addition, construction waste is generated at various stages of the construction process such as site clearance, inefficient material utilization, excessive procurement of materials and human errors during

onsite operations. Previous studies indicated that approximately 10 – 30 % of total construction materials may become waste during construction activities. Given the increasing environmental concerns associated with construction waste, it is essential to identify and implement effective recycling practices at construction sites in order to minimize material waste generation and promote more sustainable construction practices. Therefore, this study aims to identify the most common recycling practices implemented in the Malaysian construction industry. The novelty of this study lies in the systematic identification and empirical ranking of recycling practices based on the perspectives of experienced construction practitioners. Furthermore, this study contributes to the field of social sciences by providing insights into stakeholder behaviour and decision making related to sustainable construction waste management within the construction sector.

Construction Waste Management

In Malaysia, the construction industry's impact on the environment is significantly high due to the great demand for major projects that have resulted in the generation of high volumes of construction waste. Proper construction waste management implementation can improve the construction industry in terms of economics, quality, sustainable benefits, and environmental friendliness. The waste management hierarchy was proposed by Peng et al. (1997). This hierarchy consists of four steps, namely, 'Reduce, Reuse, Recycle and Disposal'. In this hierarchy, the most favorable option begins at reduction and concludes with disposal as the least favorable option. In general, the waste management hierarchy provides an order of urgency for managing waste that involves reduction, reuse, recovery, and disposal.

Various researchers have suggested different hierarchies to classify waste. One such hierarchy was proposed by Nizar et al. (2018). In this method, one of the sustainable strategies for handling construction waste is to apply a waste management hierarchy from the step that has the highest desirability to the step that has the lowest priority (Nizar et al., 2018). In this hierarchy, recovery is ranked as the fourth step. Recovery is defined as the exclusion of materials or components from waste output that are retained in their original form for reuse. Figure 1 depicts the hierarchy proposed by Nizar et al. (2018) with improvisations to the 'Waste hierarchy guide'.

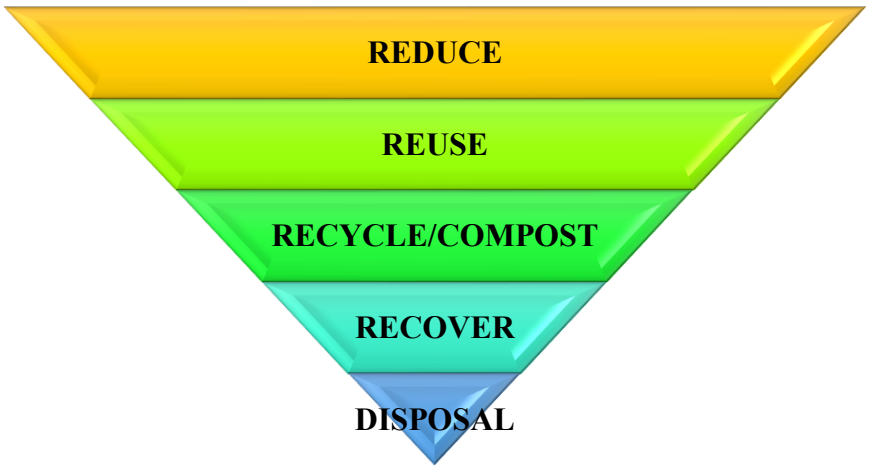

Figure 1. Improvisation of waste management hierarchy (Nizar *et al*., 2018).

In the construction waste management hierarchy, the recycling approach is employed as the third-most preferred waste disposal option (Nadarason, 2018). Recycling refers to minimizing waste by recovering and processing usable products that might otherwise become waste (EPA, 1997). According to Tonini et al (2022), the recycling process is defined as processing new products. Recycling is known as the process of collecting used, reused, and also unused things that are already considered waste but turn into usable (Hasmori et al., 2020).

When recycled, C&D waste is converted into new products and reduces the demand for new resources. For example, the timber used as formwork can be recycled into workers' quarters and temporary pavements at construction sites. Hence, the demand for timber production will be reduced. Reducing the demand for new resources indirectly preserves land for future urban development such as developing a city. By practicing recycling, transportation, and production costs can be reduced. In addition, there is less C&D waste delivered to landfills; thus, recycling reduces the space required for landfills.

Timber is usually burnt by open burning. This burning causes air pollution and affects workers' health. By recycling, pollution can be reduced and health improved. Recycling also helps to improve the general state of the environment. Figure 2 describes the benefits of recycling as determined by past researchers.

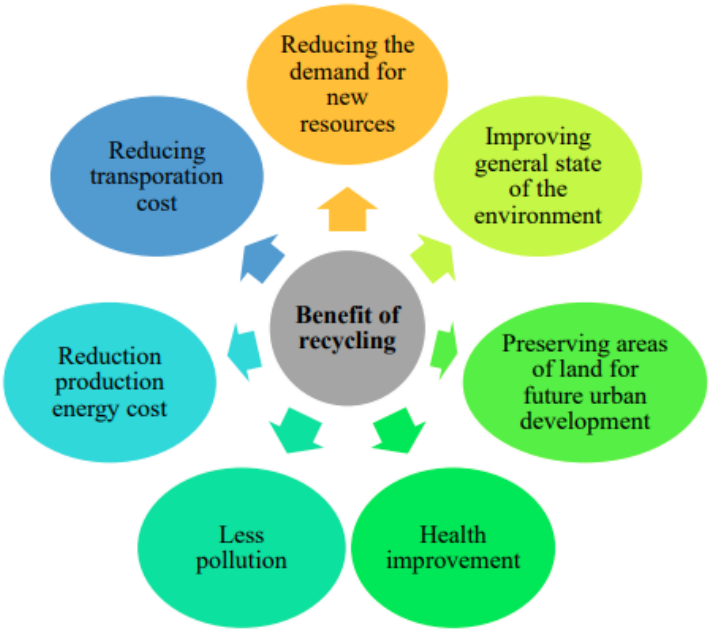

Figure 2. Benefits of recycling stated by past researchers.

Research Methodology

This study adopts a quantitative technique to comprehend the viewpoint of construction experts towards the recycling practices applied in the Malaysian construction industry. The exploration of this research is divided into 2 phases. The first phase includes an extensive literature review after which 25 recycling practices were identified. In the second phase, a questionnaire was developed. The questionnaire comprises two parts, the demography of the respondents and recycling practices in the Malaysian construction industry. Each respondent

was asked to verify the most common recycling practices applied in the Malaysian construction industry.

Data Collection and Analysis

The questionnaire was designed based on a five-point Likert scale ranging from 1 for less practice to 5 for common practice. The developed questionnaire was distributed to 38 experts in the Malaysian construction industry. The received questionnaires were analyzed and a reliability test was conducted. The Cronbach's alpha value was 0.958. According to Kaliannan, 2021, if Cronbach's alpha value is higher than 0.7, the inner consistency of the data is highly acceptable. Figure 3 indicates the number of respondents and their corresponding working experience. The majority (13 out of 38, 34%) of the respondents have 16-20 years of experience in the construction industry. The total percentage of respondents with more than 10 years of experience in the industry is about 89%. This shows that the majority of the respondents are eminently experienced and vastly knowledgeable regarding the Malaysian construction industry.

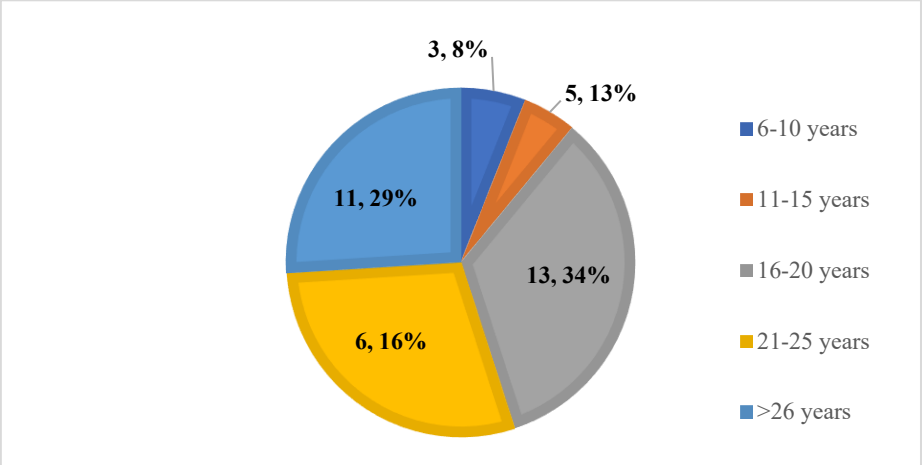

Figure 3. Respondents' working experience.

Figure 4 exhibits the respondents' organization. Most of the respondents are contractors with 77% (29 out of 38). The opinion of contractors is considered important as they are the ones who are present at the site and have better understanding of the recycling practices practiced in the construction sites. Clients' and consultants' inputs are crucial as well because they also have good involvement in construction industry.

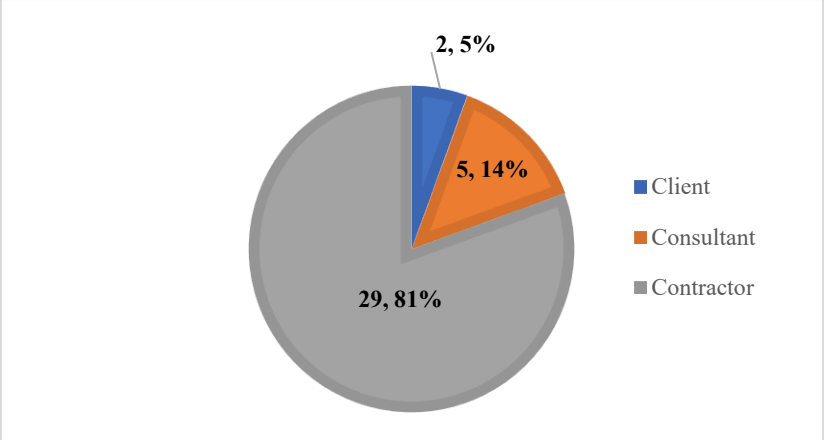

Figure 4. Respondents' organization.

The mean value of each recycling practices that applied in sites is presented in Table 1. Result analysis showed that the recycling practices with higher mean values are metals are sold to the recycling centres, concrete is used for paving temporary site access, concrete used as filling for road/road base, timber used for temporary works and metals are sent to other construction projects. The ranking of the recycling practices is shown in Table 2. There are 25 recycling practices which scored more than 4.00, however this paper only elaborates on the common recycling practices.

Table 1
Mean value of recycling practices

Code	Recycling Practices	Mean
M19	Sold to recycling practices	4.89
C28	Used for paving temporary site access	4.89
C26	Used as filling for road base	4.89
T13	Used as temporary works	4.79
M20	Send to next construction project	4.76
P33	Excess packaging materials are sold to recycling practices	4.66
C29	Replaced as aggregates	4.63
T1	Recycled in next projects	4.55
T5	Used as hoardings	4.47
T6	Used as energy for power generation	4.42
T7	Used as decorative products	4.29
P35	Sack bags used as pots to grow small plants	4.18
C27	Used to build kicker blocks	4.18
T15	Used for erosion control and ground cover	4.05
T14	Used as landscaping mulch	4.05
T16	Chipboard production	4.03
T9	Used for furniture	4.00
M24	Used for roof cladding	3.95
T8	Used as piles	3.39
M23	Cut steel corners for shelves	3.34
T4	Used as aggregate	3.24
T12	Used to improve soil texture	3.18
T18	Ground timber used as a sewage sludge bulking medium	3.13
T10	Used as special lightweight concrete	3.12
T2	Used as a bulking medium	3.08

Table 2
Ranking of recycling practices

Code	Recycling Practices	Mean	Rank
M19	Sold to recycling practices	4.89	1
C28	Used for paving temporary site access	4.89	1
C26	Used as filling for road base	4.89	1
T13	Used as temporary works	4.79	2
M20	Send to other construction sites	4.76	3
P33	Excess packaging materials are sold to recycling practices	4.66	4
C29	Replaced as aggregates	4.63	5
T1	Recycled in next projects	4.55	6
T5	Used as hoardings	4.47	7
T6	Used as energy for power generation	4.42	8

Sold to Recycling Practices

Metals are recycled throughout construction sites (Hamid et al., 2020). A common recycling practice for metal is to resell the metal to scrap dealers (Nascimento et al., 2022). According to Balasbaneh et al. (2025), reinforcement bars are extracted from unwanted concrete after demolition and sent to the steel yard for recycling. The rate for metal recycling depends on the types of metals. The rate is between RM500 to RM800 per tonne. The price of metal increases when the quality of metal increases. The construction community sells the metal from recycling and uses the money for other purposes (Nadarason et al., 2018).

Used for Paving Temporary Site Access

The excess concrete waste is spread at the construction sites to construct temporary pavements for workers. It is a common recycling practice applied at construction sites. This practice makes it possible to reduce significantly the overall labor intensity of work and the energy intensity of production operations and to increase the level of labor mechanization (Kazaryan et al., 2022).

Used as Filling for Road Base

Broken concrete is used as an aggregate in Vietnam (Nguyen et al., 2022). A similar recycling practice is being applied in our country, Malaysia. The characteristics of broken concrete are almost the same as the characteristics of aggregates in road construction (Lockery et al., 2018). Laboratory tests showed that recycled aggregates had similar performance characteristics with crushed gravels as chippings used in rigid pavement construction (Mihai, 2019).

Used as Temporary Works

The timber used for temporary works credit focused on eliminating the use of virgin forest products. This credit is related to temporary works such as scaffoldings and formwork (Illankoon et al., 2020). In Klang, the contractors transformed the formwork timber into temporary quarters for the site workers (Hamid et al., 2020).

Send to other Construction Sites

According to Nadarason et al (2018), the metal formworks are used in other projects by the contractors. The metal formwork can be used several times. What makes metal waste eligible and legit to be recycled and encouraged to do so because recycling metal waste of the same material can be done over and over again without degradation of the material itself (Hamid et al., 2020).

Excess Packaging Materials are Sold to Recycling Practices

Packaging materials consist of paper, cardboard, and plastic. Paper and cardboard are reprocessed into recycled paper. In recent years, construction practitioners have sold packaging materials to recycling centers (Kabirifar et al., 2020).

Replaces as Aggregates

The ratio for the concrete-making process is 1:2:4, the ratio 1 represents cement, the ratio 2 represents sand and 4 represents the aggregates. The previous researcher stated that semi-crushed or recycled aggregates are used in concrete (Nadarason et al., 2018). The recycled aggregates are used as sub-base material. The construction community usually uses gravels as sub-base materials for road construction. The aggregates are used to fill the space between the gravels (Nadarason et al., 2018).

Recycled in Next Projects

The formwork made from timber can used as formwork several times (Pronk et al., 2022). According to Nadarason (2018), the used formwork is recycled in another or the next project of the contractor.

Used as Hoardings

Timber is mostly recycled in the initial stage of construction (Sun et al., 2022). Timber is recycled as hoardings around construction sites in Malaysia. Many contractors in the Klang Valley transformed timber waste from the formwork into timber/wood hoarding at the site (Hamid et al., 2020).

Used as Energy for Power Generation

The timber is used as energy for power generation. Based on Nadarason et al (2018), the timber is chopped and burnt to produce energy such as heat energy and light energy. Timber is recycled into energy sources such as fuel and charcoal for power generation and combustion processes in Japan and the Netherlands. In the Netherlands, most of the timber is landfilled or incinerated as a by-product in either coal-fired power plants or cement kilns. Before incineration, the wood is reduced in size drastically. Blast furnace deoxidization is also adopted in recycling timber (Sun et al., 2022).

Conclusion

This research found that construction waste generation is a major issue in the Malaysian construction industry, thus it is crucial to identify the recycling practices to minimize the generated waste. After analysis, 25 recycling practices with a mean value of more than 4.00 were considered the most applied recycling practices at construction sites. The recycling practices will aid construction practitioners to curb construction waste generation from the initial stages of construction. The outcome of this research will not only be valuable in

minimizing material waste generation, but it will also support cultivating environmental awareness in the construction industry of Malaysia.

Acknowledgement

We express our gratitude to the Universiti Tun Hussein Onn Malaysia and BP Renalcare Sdn Bhd for financing this work under the Vot M085 and Vot H689.

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