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CONSTRUCTION WASTE MANAGEMENT IN CONSTRUCTION PROJECT BY USING 3R PRINCIPLE: G7 CONTRACTORS' PERSPECTIVE

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ABSTRACT

Waste management in the construction industry is essential for achieving sustainable development, but many professional players in the industry are unaware of the significant waste reduction measures, which hinders the implementation of waste management practices efficiently. This study aims to propose the 3R practices for dealing with construction waste in construction projects. This study objective (1) to determine the current practices of construction waste management at site and (2) to suggest the 3R practices for dealing with construction waste. Regarding this research, the population size of this study obtained approximately 532 companies, and its sample size is 226 companies for CIDB-registered G7 contractors in Johor Bahru, Johor. A quantitative methodology employed by sending questionnaires to Johor Bahru, Johor, G7-class contractors. It has been demonstrated that the use of recyclable materials in construction, such as glass, plastic, or bitumen, has a positive effect on the environment by reducing the demand for resources and diverting waste away from landfills, which contributes to an eco-friendly economy. The research could be conducted in multiple Malaysian states to gain a more precise understanding of the contractor's perspective.

Keywords: *waste management, 3r principle, sustainable, eco-friendly, professional players.*

INTRODUCTION

The term "construction waste" encompasses not only the waste generated during building construction but also waste throughout the entire construction process, including planning, acquisition, excavation, site clearing, demolition, and building rehabilitation (Kanimoli et al., 2020). As sustainable development gains prominence, traditional waste management systems have evolved into a new approach known as the 3R concept, which emphasizes waste reduction, recycling, and resource reuse (Huang et al., 2018). Implementing effective construction waste management practices is essential for achieving sustainable development goals and avoiding negative environmental impacts. Lu & Tam, (2013) highlighted the need to prioritize construction waste management to achieve mutually beneficial outcomes for the environment, community, and economy. To effectively deal with construction waste in construction projects, 3R practices need to be proposed. By reducing waste, recycling materials, and promoting resource reuse, construction waste management can contribute to a more sustainable and eco-friendly construction industry.

The Solid Waste and Public Cleansing Management Corporation of Malaysia has confirmed that construction projects annually generate approximately 8 million tonnes of waste. Ineffective waste management procedures and poor construction practices are the primary cause of the increase in construction waste. According to Ingrao et. al. (2019), all construction waste generated as a by-product of construction activities will negatively impact the environment, costs, productivity, time, society, and economy. When viewed from the perspective of the contractor in construction project, this issue will result in a decrease in construction productivity and overall project performance.

The limited space available on construction sites provides significant obstacles for waste management and storage, which is preventing the implementation of efficient waste management practices (Zou et. al., 2021). Moreover, Yuan et. al., (2019) stated that the construction industry generates massive amounts of waste, making it a significant contributor to environmental problems and resource depletion. Inadequate recycling facilities and processing and recycling systems for various categories of waste materials further hinder effective waste management (Ismaeel & Kassim, 2023). Lack of education and awareness about the benefits and methods of waste reduction, reuse, and recycling among industry professionals which obstructs the implementation of effective waste management practices based on the 3R principle (Ruan et. al., 2020). Furthermore, there is a crucial need to address these challenges and cover the existing gap by conducting a study proposing effective waste management 3R practises for the construction industry. By resolving these issues, the study seeks to contribute to the development of more eco-friendly and sustainable building practices.

LITERATURE REVIEW

To Determine the Current Practices of Construction Waste Management Practice at Site

Construction waste management is crucial for sustainable growth. Construction and demolition waste pollute the environment, and waste management practices for construction activities were established to protect the environment. According to Fauziah and Agamuthu (2012), waste management considers economical, aesthetic, and public considerations when creating, storing, collecting, transporting, processing, and disposing of construction waste. This term covers all aspects of construction waste management. Waste management includes monitoring, collecting, transporting, processing, and disposing.

Ensure the Site Clean and Neat to Minimize Losing Material and Generate More Construction Waste

Effective construction waste management requires the maintenance of a clean and organised construction site. A dirty and disorganised construction site not only increases the likelihood of material loss but also increases construction waste production. The significance of systematic material storage in construction projects and its capacity to reduce material loss and waste generation Ling et al., 2019). The process of storing items in designated areas or storage facilities serves to protect them from loss, damage, or larceny.

Implementing distinct labelling and efficient inventory management systems can enhance material accessibility and reduce the need for inconsequential reordering or disposal (Shazwan et al., 2017). Yeo et al. (2017) emphasise the significance of consistent cleaning and waste removal in construction waste management. They underscore the benefits of these practices in terms of site sanitation and waste reduction. These practices reduce the danger of material loss, prevent waste accumulation, and create a safer and more productive work environment (Baxter and Srisaeng, 2022).

Prepare Safe Storage to Minimize the Damaged on The Material

Reducing waste and promoting sustainable building practices require proper storage of construction materials. Inadequate storage practices may result in material deterioration, leading to an increase in waste generation and additional costs (Kabirifar et al., 2020). Damaged materials frequently become ineffective or necessitate repair, resulting in an increase in waste. Not only does this impact project timelines, but it also contributes to resource depletion and environmental degradation.

The importance of designated and organised storage areas in reducing material damage and waste generation in construction projects (Rahayu et al., 2019) On construction sites, different types of materials should be stored in designated areas while being maintained in appropriate conditions. Organisation and labelling of storage areas facilitate the identification and retrieval of materials, thus decreasing the risk of damage caused by carelessness or misplacement (Ajayi et al., 2017).

Set-Up Effective Communication to Prevent Miscommunication on Waste Management

Effective communication will be required for the implementation of common construction waste management practices. Miscommunication can result in inefficient waste management processes, increased waste production, and disorientation. The research by Lu et al. (2019) highlights the significance of establishing effective communication channels to improve waste management practices and reduce communication errors in construction projects. Effective channels of communication facilitate the distribution of waste management guidelines, policies, and procedures, ensuring that all stakeholders are aware of their respective roles and responsibilities.

Jarkas et al. (2019) emphasise the significance of frequent meetings and updates for enhancing construction project communication and waste management efficiency. It is suggested that project administrators and supervisors hold regular meetings to discuss the progress of waste management, address any concerns, and discuss any modifications to waste management procedures (Won and Cheng, 2017). These meetings promote openness, encourage the exchange of best practices, and afford the opportunity to rectify any instances of miscommunication or misunderstanding.

To Suggest the 3R Practices for Dealing with Construction Waste

According to Aadal et al. (2013), the construction industry can reduce, reuse, and recycle waste by employing the "3R" approach. This is due to the fact that all phases of construction, including design, production, and even manufacturing, are directly related to waste generation. Therefore, it appears imperative for a sustainable economy that construction initiatives comply with the "3R" principles. There are "3R" concepts that apply to construction management activities because they relate to the people involved, society, and the environment (Jin et al., 2017). Various personnel in control of construction operations are typically responsible for achieving a balance between sustainable and environmental. Using concepts such as "reuse, recycle, and reduce" makes it possible to build environmentally beneficial structures.

Use Materials Which Can Be Recyclable for The Future Benefit

According to Ling et al. (2021), utilising recyclable materials has a few potential benefits. First, it aids in the preservation of natural ecosystems by conserving resources and decreasing the demand for the extraction of new materials. Second, it decreases the amount of waste sent to landfills, thereby preventing environmental pollution and promoting a greener and healthier environment. Recycling construction waste materials creates economic opportunities by creating a market for recycled materials and fostering the growth of sustainable industries (Turkyilmaz et al., 2019).

Although there are obvious benefits to using recycled materials, such as eliminating the need for riverbed aggregates and reducing the number of landfills, the application of these materials is contingent on the presence of additional criteria and indicators used to evaluate the quality of the final product (Popescu & Berlacu, 2017). Concerns regarding the impact of the use of these recycled materials on the environment pertain to the possibility that certain elements may permeate the soil and groundwater and become detrimental to both the environment and human health (Ma et al., 2023).

Reuse Construction Materials to Cut Cost from Ordering More Construction Material

Reuse of construction waste refers to the practice of reprocessing the same construction material multiple times, even in different capacities. The most important benefit of construction waste management is the protection of the natural environment from pollution and deterioration. Other benefits include economic advantages, reduced energy consumption, and fewer emissions (Kabirifar et al., 2020). Examples of such operations include determining the building activities that can accommodate reused construction materials, preventing the overordering of supplies, and removing any residual grime from reusable materials.

The study by Bocken et al. (2016) demonstrates the potential for cost savings through the implementation of circular economy strategies involving the reuse of construction materials. By utilising on-site materials or obtaining them from completed projects, a construction company can reduce procurement and transportation costs, which decreases the need to purchase new materials. The practice of repurposing materials can result in significant cost reductions relative to raw material expenditures, allowing construction projects to remain within budgetary constraints and allocate resources more efficiently (Bao et al., 2020).

Detect The Construction Activities That Can Contribute on Reusable Materials from The Construction

The generation of waste from construction operations not only has monetary consequences for the processes that are engaged in its management, but it also involves the use of valuable land for activities that are connected to the disposal of waste. According to Ajayi et al. (2017), resources from construction waste such as soil, concrete, steel, and timber, as well as mixed site clearing materials, have the potential to be reused on site. As a direct result of the different construction activities that are carried out, such as land excavation or formation, civil and building construction, site clearing, demolition operations, roadworks, and building rehabilitation (Udawatta et al., 2015).

RESEARCH METHODOLOGY

The study's data was collected using a quantitative method, which included a questionnaire with multiple sets of questions regarding the 3R principle of construction waste management. The survey was distributed to the chosen contractors' class G7 in Johor Bahru, Johor by several methods such as through email and WhatsApp. Several suggested 3R practices for construction waste management in construction projects were included in the questionnaire, which will be delivered throughout the survey.

For the population size, 532 contractors' class G7 in Johor Bahru, Johor are registered with the CIDB. The sample size for this research is 226 out of a population of approximately 532 companies. This sample size was determined using the table developed by Krejcie and Morgan (1970). For the purposes of this study, a survey was distributed to the registered contractors of class G7 in Johor Bahru, Johor, to collect reasonable and accurate data.

Using a set of questionnaires, data were collected. Class G7 contractors in Johor Bahru, Johor, were issued 226 surveys. However, only 147 respondents can be contacted through the questionnaire due to the limited scope of the study. Consequently, the response rate to these questionnaires is 67%, which is greater than 20% of the population. According to Medway, and Fulton, (2012), web-based and mail-based survey response rates range between 10 and 20 percentage points.

Version 29.0 of Statistical Package for the Social Sciences (SPSS) will be used as the instrumentation. For quantitative research methods, descriptive data analysis is used to analyse them. This aims to provide the researcher with a summary of the available sample. This type of analysis is required on its own for a specific case. In other words, descriptive data analysis is the process of transforming raw data into a form that is readily understood and interpreted by rearranging, organising, and manipulating the data to produce descriptive information.

RESEARCH FINDINGS

Based on the Likert scale, respondents were asked to rate their level of agreement. There are Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree for the respondents to rate it. From the collected data, there two 2 types of Likert scales were used in the same section which are 3-point scale (neutral, agree, and strongly agree) and 4-point scale (disagree, neutral, agree, and strongly agree). This is due to the fact that some of the questionnaires in the survey will not rate all scales in the Likert scale because the respondents are only allowed to tick only one box among the 5-scale provided. Thus, the respondents rate the right scale that reflects their opinions as accurately as possible and to answer factual questions to the best of their knowledge.

The Current Practices of Construction Waste Management at Site

Table 1: Ranking of The Current Practices of Construction Waste Management at Site

Waste management practices	Mean score	Agreement level	Rank
Ensure the site clean and neat	4.68	Strongly Agree	1
Prepare Safe Storage	4.61	Strongly Agree	2
Set-Up Effective Communication	4.61	Strongly Agree	3
Providing Education	4.58	Strongly Agree	4
Providing Suitable Space	4.54	Strongly Agree	5
Storing Waste at an Accessible Site	4.27	Strongly Agree	6
Prevent of Double Handling Material	4.24	Strongly Agree	7
Providing Bins or Ro-Ro Bins	3.99	Agree	8
Adequate Supervision	3.90	Agree	9

Based on data collected on The Current Practices of Construction Waste Management at Site as shown in Table 1.

The first current practice of construction waste management at a site that has the highest mean is ensuring the site is clean and neat, with a score of 4.68. Meanwhile, the next most current practice with the second highest mean is preparing safe storage and setting up effective communication, with 4.61 each. Next, the third current practice is providing education, with a mean of 4.58. Next, the fourth current practice is providing suitable space, with a mean of 4.54. Furthermore, the fifth current practice is storing waste at an accessible site, with a mean of 4.27. In addition, the sixth current practice, with a mean of 4.24, is to prevent double handling of material. Moreover, the seventh current practice with a mean of 3.99 is providing bins, or roro bins. Lastly, the least current practice, with a mean of 3.90, is adequate supervision.

The first rank for current practice of construction waste management at site was keeping the site clean and tidy. It was separated into three (3) responses: neutral, agree, and strongly agree. 105 respondents (71.4%) indicated that they strongly agreed, 37 respondents (25.2%) said they agreed, and five respondents (3.4%) said they were neutral. The second rank in the current practice of construction waste management at site was to prepare safe storage. It was separated into four (4) responses: disagree, neutral, agree, and strongly agree. 100 respondents (68.0%) agreed, 38 respondents (25.9%) agreed, eight respondents (5.4%) were neutral, and only one respondent (0.7%) disagreed. The third ranking in current practice of construction waste management at site was set-up effective communication. It was separated into three (3) responses: neutral, agree, and strongly agree. Strongly agreed was acknowledged by 98 respondents (66.7%), agreed by 40 respondents (27.2%), and neutral by nine (9) respondents (6.1%).

Suggestions of 3R Practices for Dealing with Construction Waste

Table 2: Ranking of The Suggestions of 3R Practices for Dealing with Construction Waste

3R practices	Mean score	Agreement level	Rank
Using Recyclable Material	4.78	Strongly Agree	1
Reuse Material	4.73	Strongly Agree	2
Detect Reusable Construction Activities	4.62	Strongly Agree	3
Supervise Workers	4.41	Strongly Agree	4
Enhance Construction Period	3.99	Agree	5
Waste Auditing	3.79	Agree	6
Setting-up Temporary Bins	3.72	Agree	7

Based on data collected on Suggestions Practices for Construction Waste Management Using 3R Principle as shown in the table 2.

First Suggestions for Practices for Construction Waste Management Using the 3R Principle, which has the highest mean, is using recyclable material with a 4.78. Meanwhile, the next suggestion practice with the second highest mean is reuse material with 4.73. Next, third suggestion practice is reusable activities with a mean of 4.62. Next, the fourth suggested practice is supervising workers, with a mean of 4.41. Furthermore, the fifth suggestion practice is enhancing the construction period with a mean of 3.99. In addition, sixth suggestion practice with a mean of 3.79 which is waste auditing. Lastly, the least suggested practice, with a mean of 3.72, is setting up temporary bins.

The first rank was suggested by using recyclable material in construction waste management, which was based on 3R practise. It was separated into three (3) responses: neutral, agree, and strongly agree. Strong agreement was acknowledged by 115 respondents (78.2%), followed by 31 respondents (21.1%), and neutral by one (1) respondent only (0.7%). The second rank was suggested by reusing material as a 3R practice for construction waste management. It was separated into three (3) responses: neutral, agree, and strongly agree. Strongly agreed was admitted by 110 respondents (74.8%), followed by 35 respondents (23.8%), and neutral by two (2) respondents (1.4%). Lastly, the third rank for 3R practice was suggested by detecting reusable construction activities. It was separated into three (3) responses: neutral, agree, and strongly agree. Most frequency is strongly agreed with by 95 respondents (64.6%), agreed with by 48 respondents (32.7%), and neutral by 4 respondents (2.7%).

DISCUSSION

Objective 1 – To determine the current practices of construction waste management at site.

According to the study's findings, keeping the construction site clean and tidy ranked first among the most current practices of construction waste management at site. With a mean score of 4.68, respondents agreed with this study, ranking keeping the site clean and tidy as the most important factor in the current practice of construction waste management at site. This analysis aligns with Baxter and Srisaeng's (2022) finding that a cleaning and waste collection schedule ensures the timely removal of waste, debris, and other waste materials from working areas. These practices reduce the risk of material loss, prevent the accumulation of waste, and create a secure and more productive work environment (Yeo et al., 2017). In addition, it is supported by Ling et al. (2019), who state that efficient organisation and storage of materials on the construction site can significantly reduce material loss and construction waste.

Respondents believed, with a mean score of 4.61, that secure storage preparation also contributes to the current practice of construction waste management at site, placing it in second rank. This current practice of construction waste management at site reflects the findings of Kabirifar et al., (2020), who highlighted that secure storage is required for waste reduction and promoting sustainable building practices. On construction sites, different types of materials should be stored in designated areas while being maintained in appropriate conditions. Organisation and labelling of storage areas facilitate the identification and retrieval of materials, which minimises the risk of damage caused by carelessness or misplacement. (Rahayu et. al., 2019).

Finally, the third-ranked current practice of construction waste management at site is setting up effective communication, with a mean score of 4.61, indicating that all respondents agree that it is a current practice of construction waste management. This is supported by a study by Lu et al. (2019), which highlights the significance of establishing effective communication channels to improve waste management practices and reduce communication errors in construction projects.

Objective 2 - To Suggest the 3R Practices for Dealing with Construction Waste

According to the study's findings, one of the 3R practices for managing construction waste was the utilisation of recyclable materials. Respondents acknowledged this study, ranking the use of recyclable materials as the most important contribution to 3R practices for managing construction waste with a mean score of 4.78. This analysis relates to Turkyilmaz et al.'s (2019) findings that the recycling of construction waste materials generates economic opportunities by creating a market for recycled materials and fostering the development of sustainable industries. According to Ling et al. (2021), utilising recyclable materials has a number of potential benefits. First, it contributes to the preservation of natural ecosystems by conserving resources and decreasing the demand for new material extraction. Second, it decreases the amount of waste sent to landfills, therefore preventing environmental pollution, and promoting a greener and healthier environment.

Respondents believed, with a mean score of 4.73, that material reuse also contributes to 3R practices for managing construction waste, placing it in second rank. This 3R practice for dealing with construction waste reflects the findings of Bao et al. (2020), who underlined that material reuse can result in significant cost savings with respect to raw material expenditures, allowing construction attempts to remain within budgetary constraints and allocate resources more effectively. This was supported by a study by Bocken et al. (2016) that demonstrates the potential for cost savings through the implementation of circular economy strategies involving the reuse of construction materials.

Finally, the third-ranked 3R practice for managing construction waste was detecting reusable construction activities, with a mean score of 4.62, indicating that all respondents agree that it is a 3R practice. Construction activities such as land excavation or formation, civil and building construction, site clearance, demolition activities, roadworks, and building renovation are reusable, according to research conducted by Ajayi et al. (2017).

CONCLUSION

This study investigated all variables to determine site construction waste management practices and recommended 3R practices. These findings indicate that this research achieved its aims. The present study has been conducted in accordance with the literature review carried out in the initial phase, focusing on construction waste management in construction projects by using the 3R principle.

First, determine current practices of construction waste management at site. To obtain data, Johor Bahru's G7 contractor class was given questionnaires. This survey determines the current practices of waste management at site construction. Based on the findings and analysis in Chapter 4, respondents agreed that construction waste management helps keep sites clean. It improves productivity, security, and construction waste. Clean building sites reduce waste. Construction workers may reduce waste by organising supplies, tools, and equipment.

Second, suggest 3R practices for construction waste management. The variables of the literature review are examined using survey data. Distributing questionnaires to class G7 contractors to suggest 3R practises for managing construction waste on site This study uses the 3R concept to propose 3R practises for dealing with construction. Based on the results, respondents agreed that employing recyclable materials in construction, such as recycled glass, plastic, or bitumen, helps to create an eco-friendly economy by diverting waste from landfills and lowering solid material demand. Recyclability and sustainability as material selection criteria help create an industry for recycled items and encourage their usage in construction projects.

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Perkara di atas adalah dirujuk.

2. Adalah dimaklumkan bahawa pihak kami ingin memohon kelulusan tuan untuk mengimbas (*digitize*) dan memuat naik semua jenis penerbitan di bawah UiTM Cawangan Perak melalui Repositori Institusi UiTM, PTAR.

3. Tujuan permohonan ini adalah bagi membolehkan akses yang lebih meluas oleh pengguna perpustakaan terhadap semua maklumat yang terkandung di dalam penerbitan melalui laman Web PTAR UiTM Cawangan Perak.

Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

Setuju.

27.1.2023

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Timbalan Ketua Pustakawan

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