

Construction Project Sustainability: The Role of Contractor Practices in Waste Management

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Abstract

The construction industry is a sector that contributes significantly to the economy in Malaysia. However, this rapid development brought in a large amount of construction waste and the contractor needs knowledge on how the construction waste should be managed strategically while the sustainability of the construction project could be maintained. A quantitative approach using survey design is adopted in this study. The questionnaire as a study instrument and software used to make descriptive and inferential analysis is the Statistical Package for Social Science (SPSS) version 29. The findings showed that under the Solid Waste Management and Cleansing Regulations, the majority of respondents ensure that construction waste is handled by a competent or licensed party. On the part of construction waste management methods, the majority of respondents ensure that construction waste is disposed of only in gazetted areas. Furthermore, the majority of respondents believe that recycling construction trash can enhance cost-effective advantages to a project, and that there is a strong correlation between knowledge, the sustainability of construction projects and construction waste management techniques. Consequently, there is a difference between construction waste management practices on the sustainability of construction projects based on the G1, G4 and G7 contractor classes. Therefore, this study is important in assisting Johor State contractors in managing construction waste more effectively and consistently in the future so that the sustainability element can be applied in construction projects in Malaysia.

1. Introduction

One of the most significant sectors in any developing nation is the construction industry because it provides services for residential and other purposes that affect every part of human life (Olanrewaju, 2018). The development of the construction sector is a part of the living environment that affects living conditions, social well-being, and health. This industry also creates job opportunities and contributes to the country's economy (Wibowo, 2019). However, despite all these contributions, the rapid development of the construction industry has unwittingly led to an increase in construction waste and this situation has become one of the serious issues in Malaysia. The National Construction Policy 2030 is a specific policy for the construction sector in Malaysia covering six (6) core and focus areas on strategic, initiatives and empowerment to drive the construction industry in Malaysia towards sustainable construction (Rahim, 2022).

The second thrust focuses on sustainability in the construction sector including effective construction waste management by referring to the established acts. The effort undertaken by the Ministry of Works Malaysia is to ensure that Malaysia is in line with the 11th Sustainable Development Goals (SDGs), sustainability in cities and communities. The development of strategies in waste management is crucial to raise awareness of its impact on the environment. Effective construction waste management is essential to protect the environment from being polluted (Jain, 2020). Construction waste management includes the development, storage, collection, processing, and disposal of solid waste taking into account social and economic considerations. The Malaysian government has also made various efforts to reduce the amount of waste produced through monitoring, collection, transportation, processing, and effective waste disposal strategies (Solid Waste Management and Public Cleansing Corporation, 2020).

According to the Building and Construction Global Status Report (2019) the construction sector accounts for 36% of final energy consumption and 39% of energy and carbon dioxide gas (CO₂) emissions, 11% is generated from the manufacture of building materials and products such as steel, cement and glass. This phenomenon can be overcome by applying the concept of sustainability in the construction industry during the phase before and during the implementation of the project (Ismail, 2020). Sustainability in construction is a construction concept that promotes the preservation of natural habitats, promotes the social well-being of residents and reduces negative impacts on the environment (Oke, 2021).

The contractor is one of the parties responsible for the project carried out to control and manage the construction waste generated from the construction project sites (Almaliki, 2020). The rules and guidelines set by the superiors must also be complied with by the contractor so that the waste produced at the construction site can be managed efficiently. If the waste generated from the construction site is not handled systematically, this situation will cause problems for the environment, the public and the workers at the construction site. The appointment of a certified subcontractor registered under the Construction Industry Development Board (CIDB) as the party that manages construction waste can control the production of solid waste produced at construction sites more effectively (Sukri, 2022). Therefore, to ensure that the construction waste is strategically managed, a study is carried out on the contractor's practice in managing construction waste towards the sustainability of construction projects. This study is also necessary so that contractors especially those undertaking projects in the State of Johor, could be guided to apply strategic management methods in their construction projects. Johor, a State that is expanding in construction projects and creating solid waste, is the focus of this study (Sobian, 2013).

2. Literature Review

According to Creswell (2003) literature review is a crucial aspect that researchers need to focus on in order to gather information and references. This involves the process of reading articles and journals to help researchers acquire additional knowledge and ideas relevant to their study.

2.1 Construction Waste Management in Malaysia and its Impact on Project Sustainability

According to the Japan International Cooperation Agency (2021), solid waste management, following the hierarchical concept, has been widely implemented globally, emphasizing methods such as reduction, reuse, recycling, waste treatment, and disposal methods.

2.1.1 Reduction of construction waste

According to Samsudin et al. (2021), waste reduction can be achieved by contractors, architects, and developers in two phases: during the pre-construction phase and during the design phase.

2.1.2 Reuse of construction waste

The reuse of construction waste such as wood, iron and bricks can provide benefits such as saving time, reducing greenhouse gas emissions and helping to preserve the environment for future generations (Tam, 2017).

2.1.3 Recycling of construction waste

The process of breaking down used materials in construction work to produce new material is a form of recycling (Wang et al., 2018).

2.1.4 Construction Waste Treatment

Waste to energy is a technology used to recycle waste produced from construction activities and convert it into electricity, heat, or steam (Malinauskaitet al., 2017)

2.1.5 Disposal Methods

The sanitary landfill disposal method is one of the best methods to reduce the negative impact on the environment (Jeyasundar et al., 2020). It's clear that Johor State's status as an economic development State with rising living standards has contributed to an increase in the volume and complexity of waste produced. Most nations favor sanitary landfilling because to its inexpensive cost and little technical requirements. The system includes yard waste incineration, recycling, composting, and landfills created for a particular type of waste. Generally speaking, landfills are built on properties in locations where there may be a considerable demand for garbage disposal, and they are done in compliance with accepted industry standards. (Islam, 2021; Vijay Kumar, 2021)

2.2 Knowledge of Construction Project Sustainability

Construction industry players should be sensitive to knowledge in environmental preservation (Choi, 2009). This is crucial because without sufficient knowledge, the effective implementation of green elements becomes challenging.

2.2.1 Environment

Construction waste can be burned under controlled conditions to lower health concerns for workers and nearby residents, including allergies, breathing difficulties, congestion, and coughing (Bisschop, 2012). Other than that, recycling construction waste contributes to resource conservation and reduce the overall environmental impact of construction activities (Lu & Tam, 2013). An orderly layout of the site allows for efficient storage and handling of materials, reducing the risk of mishandling and, at the same time, minimizing potential damage (Nagapan & Asmi, 2011).

2.2.2 Materials

The selection of environmentally friendly materials such as recycled materials has the potential of reducing the project's carbon footprint and reducing demand on resources that is increasingly endangered (Raihan & Tuspekova, 2022). Furthermore, the use of materials that are easy to recycle such as wood, bricks, tiles that have been used on previous projects in order to reduce the waste that will be brought to the site for disposal, will also help in reducing carbon footprints. (Cai & Waldmann, 2019).

2.2.3 Cost of Construction Projects

According to Laovisutthichai (2022) systematic construction waste management save costs for a project because the waste generated can be controlled through a certain method. Then, according to Sarkodie and Owusu (2020) the reuse of building waste generated at construction sites can minimize waste treatment costs and reduce the demand for land for the disposal of construction waste. Traditional waste disposal methods such as landfilling will cause large expenses in terms of tip payments and transportation costs (Li et al., 2019). Lastly, an organized site layout such as providing an area for sort and store construction waste to promote recycling practices and minimize the cost of waste treatment that will be taken to the landfill (Bao et al., 2020). According to Samsudin & Mat Don (2013), the problem of site selection is the most challenging part of the municipal solid waste disposal process. The researchers noted that a crucial first stage in the entire waste disposal process is choosing landfill locations. In keeping with the foregoing, Samsudin & Mat Don (2013) found that, for a variety of reasons, landfilling is Malaysia's most popular form of disposal. Furthermore, Sabeen and Zainura (2016) contended that landfills are less expensive given their significant contributions to the disposal of waste.

2.3 Construction Waste Management Factors Affecting Sustainability

In general, several factors that affect the sustainability of construction caused by construction waste management can be identified based on previous studies. The following are among the factors that affect construction waste management. The dwindling construction waste landfills are the cause of non-compliance among contractors in managing construction waste (Almaliki, 2020). The landfill method is commonly employed in construction waste management. However, the effectiveness of this method is highly dependent on-site availability if one wishes to implement it.

According to the study by Avilova et al. (2020), the main factor influencing successful construction waste management is the management cost. The cost of managing construction waste directly impacts compliance with the regulations that serve as guidelines for waste management. The charges imposed on contractors also emerge as a primary reason for their reluctance to comply. According to Manzoor et al. (2021) the contractor's attitude is the main driver of non-compliance with construction waste management. The intended meaning of the contractor's attitude is a lack of responsibility and trust in managing the construction waste produced on the construction site.

According to Norihan (2016), construction material waste exists in various forms, including solid and liquid forms. The separation of building materials poses a challenge to contractors and subcontractors due to the various necessary processes involved, such as separation, storage, and processing at the available facility. The lack of knowledge in handling modern and more efficient technology is a constraint faced in the construction waste management sector in Malaysia (Janari et al., 2020). Therefore, the party responsible, such as Local Authorities and especially the government of Malaysia, should provide information to contractors through organized programs or seminars on modern technologies in construction waste management.

3. Methodology

The researcher determined the design of the study was to use the survey design because the data obtained from this random sample would be analyzed using statistical techniques and inference tests (Prakash et al., 2023). A quantitative approach using survey design was used in this study. The survey design is more suitable for use for descriptive studies (Robinson, 2020). The researcher have determined that the population for this study are contractors consisting of three classes, namely G1, G4 and G7.). The researchers selected a simple random sample by referencing the Krejcie and Morgan tables (1970). The total population is 4684 contractors registered on CIDB's website and the total sample for each district is selected using the Krejcie and Morgan table (1970) which gives the total number of respondents to 357. The researcher have determined four districts involved in this study, namely Kluang, Batu Pahat, Muar and Johor Bahru.

Researchers use questionnaires as an instrument to obtain and collect data. Questionnaire instruments also provide structured and analyzed data using statistical techniques. This allows data to be analyzed such as calculating mean, standard deviation, correlation and inference testing. The questionnaire developed is adapted from a journal entitled Contractor Perspective Study on Compliance with Construction Waste Management Regulations developed by Bahri et al (2022). The research instrument used by the researchers consists of two sections, namely Part A is a set of questions related to Solid Waste Management and Public Cleansing Regulations for the 2018 Construction Solid Waste Scheme. Meanwhile Part B includes the the methods used on construction waste management. The number of items in Part A is 14 items, and in Part B, there are 24 items, making the total number of items developed in this study 38 items.

In this study, the adapted questionnaire was evaluated for validity with three expert and a pilot study was conducted to ensure the reliability of the instruments used. In the data analysis section, the researchers compared mean values using Statistical Package for Social Science (SPSS) version 29 software.

4. Result and discussion

The data collection process is based on the research instrument, which is a questionnaire distributed to 357 respondents in four districts in the state of Johor. In the section on Contractor Practices in Construction Waste Management, two type of practices are discussed: Solid Waste Management and Public Cleansing Regulations for the 2018 Construction Solid Waste Scheme and construction waste management methods. In the Solid Waste Management and Public Cleansing Regulations section of the 2018 Construction Solid Waste Scheme, the majority of respondents ensure that construction waste is handled by competent or licensed parties. This is because

contractors managing construction waste must be officially registered. The findings of this study align with Koh et al. (2023) research, which emphasizes that contractors must be legally registered under the Construction Industry Development Board to ensure proper waste management and preserve the sustainability of construction projects. In addition, the majority of respondents agreed to ensure that construction waste is disposed of only in gazetted areas. This is because the disposal of construction waste in non-gazetted places is influenced by the irresponsible behavior of contractors and can have a negative impact on the environment and surrounding residents. Che Ad's (2017) study has established guidelines from the Solid Waste Management and Public Cleansing Corporation (SWCorp) for all contractors, ensuring that construction waste is disposed of only in gazetted areas. Therefore, all construction industry players need to be attentive and identify areas that have been gazetted by authorities, ensuring that sustainability is maintained and, at the same time, reducing the occurrence of illegal landfills. The findings for Section A - Solid Waste Management and Public Cleansing Regulations for the 2018 Construction Solid Waste Scheme are presented in Table 1.

Table 1: Solid Waste Management and Public Cleansing Regulations for the 2018 Construction Solid Waste Scheme

Bil	Statements	Mean Score	Standard Deviation	Level
1	The contractor appoints the construction waste collection service.	3.48	0.51	High
2	The contractor uses the services of a competent and legally registered sub-contractor for the collection of construction waste	3.31	0.47	High
3	Contractor keeps records / documents related to the appointment of licensed waste collection services	3.57	0.56	High
4	The contractor isolates construction solid waste according to the specified category.	3.46	0.51	High
5	Contractor provides suitable storage site for storing/collecting construction waste	3.49	0.51	High
6	Contractor prepares suitable containers/barrels to place construction waste	3.52	0.53	High
7	Contractors ensure that construction waste collection sites do not obstruct public vehicle traffic	3.54	0.52	High
8	The contractor complies with the notice issued by the enforcement officer by taking steps as contained in the notice	3.51	0.52	High
9	The contractor complies with the notice that has been given by acting according to the time period contained in the notice	3.49	0.51	High
10	The contractor keeps records/documents of construction waste collection activities for a period of seven (7) years from the date the records are issued	3.54	0.53	High
11	The contractor provides records of construction waste collection activities to enforcement officers for inspection purposes	3.48	0.52	High
12	The contractor ensures that construction waste is disposed of only in gazetted areas	3.61	0.51	High

13	The contractor ensures the rigor of waste management at the construction site according to established guidelines	3.55	0.52	High
14	The contractor ensures that the remaining construction work is handled by a competent or licensed party	3.62	0.49	High
	Overall mean average		3.51 (High)	

In the section B, on construction waste management methods, the majority of contractors were found to implement the land reclamation method in gazetted landfill areas. This indicates that the land reclamation method is the preferred choice among contractors due to its economic efficiency and safety. The results of this study align with the findings of Jeyasundar et al. (2020) which state that the recurrent disposal of construction waste in sanitary landfills is a widely adopted method by most contractors. This method is considered safe to practice without disturbing the environment and the health of the local population. In addition, the majority of respondents were found to reuse board waste as formwork for their subsequent projects. Wood or board waste is a significant contributor to construction waste. It can be easily modified into various shapes and sizes required as molds in construction (Estrada & Lee, 2023). It is a versatile material that is to be cut, shaped and assembled to meet specific project requirements. Therefore, it is suitable for reuse as long as it can function properly to control the production of construction waste. Next, the contractor also recycles building materials such as steel and concrete, isolating materials with the potential for reuse in future projects. The findings of this study align with a study by Maghool et al. (2017), which stated that recycling steel waste from construction sites, including steel and aluminum, is a sustainable practice in the recycled metal construction industry. This approach aims to reduce the environmental impact of raw material extraction and processing, save energy, and promote the preservation of natural resources

Lastly, the practice of burning construction waste on the construction site, utilizing the waste-to-energy concept, is less implemented by contractors due to financial constraints. This happens because the use of the waste to energy system requires high costs to be implemented by the contractor. The results of this study are also influenced by the class of contractors where the majority of respondents involved in this study are class G1 which is 273 people out of 357 people. In general, the tender value for G1 class contractors is limited to RM 200,000 only. Therefore, the implementation of the waste-to-energy system clearly requires a high cost, and G1 class contractors face major constraints, namely financial problems and so on. The findings for Section B- Construction Waste Management Methods are presented in Table 2.

Table 2: Construction Waste Management Methods

No	Statements	Mean score	Standard Deviation	Level
1	Contractors control the production of construction waste to reduce the negative impact on the environment	3.35	0.48	High
2	Contractors use standard measurements to avoid excessive wastage of materials	3.22	0.42	High
3	Contractors use pre-fabrication methods such as IBS to minimize construction waste	2.59	0.86	Moderate
4	The contractor segregates construction waste that has the potential to be reused on the next project	3.15	0.38	High

5	Contractors use high durability materials such as roof steel to reduce the replacement process for maintenance work	3.38	0.50	High
6	The contractor reuses construction waste to save on the overall cost of the project	3.27	0.51	High
7	Contractors resell construction waste to establish recycling practices	2.72	0.75	High
8	The contractor separates toxic substances such as paint, varnish to reduce the risk of environmental pollution.	3.16	0.43	High
9	The contractor recycles scrap metal to a recycling center to produce new metal products	2.34	0.62	Moderate
10	Contractors reuse construction waste to reduce demand for new raw materials	3.12	0.42	High
11	The contractor reuses the leftover boards to be used as formwork on the next project.	3.40	0.51	High
12	The contractor recycles bitumen waste for use in road maintenance work	2.93	0.77	Moderate
13	The contractor crushes the concrete waste to be used as recycled aggregate in the next project	2.63	0.73	Moderate
14	Contractors reuse excess raw materials to reduce demand for new raw materials	3.16	0.40	High
15	The contractor separates the steel material that has the potential to be reused on the next project	3.24	0.45	High
16	The contractor uses the concept of waste to energy by burning construction waste at the construction site	2.31	0.63	Moderate
17	Contractors handle contaminated building materials such as asbestos by following established guidelines	3.18	0.38	High
18	Contractors use sanitary landfill methods to save the environment from being polluted	3.39	0.51	High
19	The contractor implements the land clearing method in the gazetted landfill area	3.44	0.51	High

20	Contractors control the production of construction waste to reduce costs disposal and transportation	3.29	0.48	High
21	The contractor records construction waste information to be notified to the appointed disposal contractor	3.23	0.44	High
22	Contractors carry out disposal activities in stages to prevent soil erosion	3.09	0.55	High
23	The contractor prepares a landfill management plan throughout the disposal activities	3.18	0.51	High
24	The contractor implements erosion control before disposal works are carried out	2.95	0.69	Moderate
Overall mean average		3.07	(High)	

5. Conclusion

It can be concluded that the increasing number of unauthorized dumping sites needs to be addressed seriously by all parties. Construction waste generated as a result of activities at construction sites needs to be managed strategically to maintain the sustainability of construction projects. Contractors should also possess knowledge of the Solid Waste Management and Public Cleaning Regulations set by the Solid Waste and Cleaning Corporation (SWCorp) to achieve the sustainability of construction projects. This study has assisted G1, G4, and G7 class contractors in the districts of Kluang, Batu Pahat, Muar, and Johor Bahru in understanding the practices of managing construction waste, referencing the waste management hierarchy established by the Japan International Cooperation Agency. Additionally, the study has informed contractors of all classes about the regulations in the Solid Waste Management and Public Cleaning Regulations, aiming to control the issue of illegal dumping of construction waste in the state of Johor

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

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