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Sustainable Waste Management Practices for Construction Waste Prevention

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Abstract

The construction industry generates a whole variety of waste, depending on the amount and form of waste, such as the construction phase, type of work and on-site practice. Therefore, effective sustainable construction waste management practices must be done. It is important to observe sustainability in this aspect so that every bit of waste can be managed in an efficient manner rather than just dumping it all in landfills. Hence, sustainable waste management can be one of the prevention methods to prevent construction waste from becoming a contributor to pollution and, indirectly, environmental sustainability can be achieved. The aim of this study is to evaluate the implementation of sustainable construction waste management practices in the design and construction phase at the construction site in Pulau Pinang. The data collected from the 68 respondents and the questionnaire was analysed by SPSS version 25.0 and the results found that the effective sustainable construction waste management practice is 3R, followed by good, estimated materials and provides space due to cost-effective practices. Thus, the ranking analyses can be used as a guideline for contractors and consultants to implement waste management practices for their projects, such as construction waste prevention. Moreover, this study also found that the image of a company can be improved and raised by implementing sustainable construction waste management.

Keywords: Waste Management, Waste Prevention, Construction Waste, Sustainable waste Construction

Introduction

The waste generated during construction, reconstruction, or demolition of structures (C&D) can be described as waste material (Statistics Canada, 2013). C&D is often a large part of the total urban solid waste, comprising 20 to 30% and sometimes more than 50%. C&D waste is mainly made up of wood products, gravel, drywall, concrete, and masonry (Yeheyis et al., 2013). Other components often present in significant quantities include metals, plastics, earth, shingles, insulation and paper and cardboard (Yeheyis et al., 2013). The construction

industry generates a whole variety of waste, depending on the amount and form of waste, such as the construction phase, type of work and on-site practice (Begum et al., 2007b). The main reasons for construction waste are design defects, inadequate procurement and planning, improper material handling, raw material residues and unforeseen modifications to building design. Improving site practice and building design, on the other hand, would contribute to waste disposal (Bossink & Brouwers, 1996). Several previous studies have shown that focus should be put on increasing the recycling rates of waste generated by construction activities in developed countries (Carpenter et al, 2013). The waste reduction activities began in the design phase. The early development of waste provides the greatest possible potential for waste minimisation in the construction process. The best way of handling waste is to manage the system, especially hazardous waste, so that no waste is handled (Yeheyis et al., 2013). Building in Malaysia produces a lot of building waste, causing significant environmental impacts, and increasing public concern in the local community. Minimising construction waste has thus become an important problem (Begum et al., 2006).

Malaysia is facing an increase in the generation of waste and accompanying problems related to its disposal (Begum et al., 2007a). In the last 20 years, the production of construction waste products has increased over substantial project building and infrastructure development (Begum et al., 2007a). Extra construction materials are usually planned, because waste reduction is not considered during the planning and design phase to minimise waste generation. Local construction sites are often affected by unnecessary waste use, inadequate waste management, and a low consciousness of the need to reduce waste (Begum et al., 2007b). There is a need for the minimization of construction waste by proper construction waste management. A site waste management (SWMP) developed during construction planning is one among the examples of waste management practices. Another example is 3R, consisting of a recycling and reducing process, which refers to a reduction in source or resource optimization. Resuse refers to returning part of the waste stream from a product for recycling repeatedly and a means of separating, collecting, processing, marketing and ultimately using material which otherwise would be discarded (Yeheyis et al., 2013). Therefore, this study was conducted to evaluate sustainable construction waste management, to guide contractors and consultants through this analysis in determining the ranking of sustainable construction waste management.

Methodology

Questionnaire Survey

The questionnaire form is structured in three sections, which are section A consists of demographic data of the respondents and section B determining the effectiveness of the current waste management practices and C is to determine the most benefit in implementing sustainable construction waste management. Table 1.0 shows the example of Likert scale data that is used in the questionnaires for section A and B. Pilot Study is done before being distributed to respondents, then the quality of the questionnaire can be achieved and the question produced is more understandable and comprehensive.

Table 1
Likert Scale for Questionnaire

Scale	Level of agreement
1	Strongly disagree
2	Disagree
3	Moderate
4	Agree
5	Strongly Agree

Sampling
The distribution of the questionnaire was directed towards consultants and contractors around Pulau Pinang grade G4 and above, which are registered under CIDB. The survey was sent via WhatsApp and Telegram platforms with a link to the Google form. There were altogether 68 survey respondents.

Data Analysis and Discussion
The data collection is processed using SPSS software version 25.0. SPSS is a widely used program for statistical analysis in social science. The data was analysed based on the survey using a mean value and a standard deviation formula.

Results and discussion
The data analysis for the results was divided into three main parts, which are demographic profile, the benefits of the implementation of sustainable construction waste management practices in the design phase construction site in Pulau pinang and the benefits of implementing construction waste management practices in Pulau Pinang.

Demographic Profile
The demographic profile for this questionnaire surveys the type of organisation of respondents, their experience of being involved in the construction industry and knowledge of construction waste management. Figure 1 shows the type of organisation of respondents. There are only two types of organisation involved in this survey, which are consultants and contractors. From the chart, most of the respondents come from contractors, which is 55%, and followed by consultants, which is 45% from the total number of respondents. Data from consultants is important for analysing the method used in waste reduction at an early stage. While a data contractor is used to analyse the implementation of waste management during construction site.

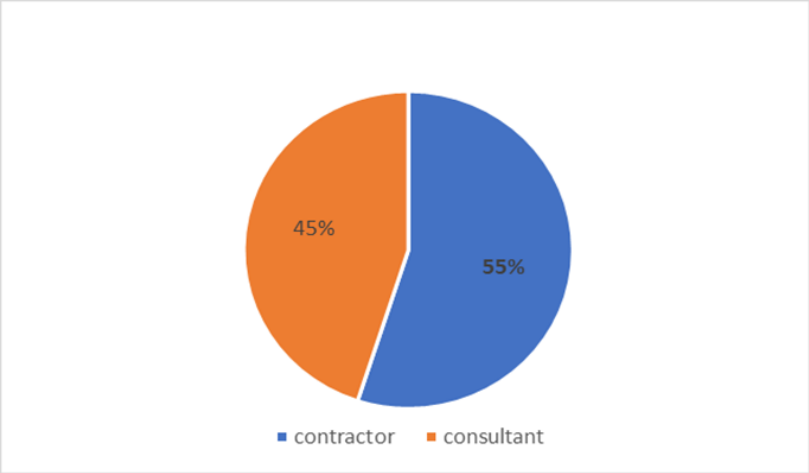

Figure 1. Type of the Organisation of Respondents

The following demographic profile of the respondents is the respondents' experience of being involved in the construction industry as shown in Figure 2. The data showed about 55% majority of respondents had 6-10 years' experience in waste management and about 12% and 18% of respondents had implemented waste management for more than ten years. Hence, from the data, it can be concluded that most of the respondents have vast experience in the construction industry, which would not affect the viable findings.

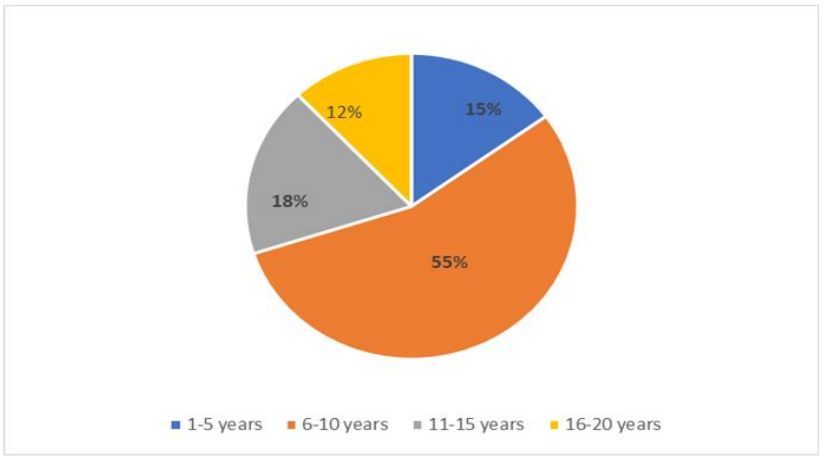

Figure 2 The Experience of the Respondents Involved in The Construction Works

The last demographic profile data collected is the knowledge rating of the respondent's knowledge of construction waste management. The data collected for this section used the Likert Scale as the rating, with 1 as the lowest and 5 as the highest. Figure 3 shows the history of knowledge of construction waste management. From the figure below, most of the respondents answered 3, which is moderate, followed by 4 which is quite well, 5 which is very well and only 1 respondent answered 2, which is low. The standard deviation of the data is 0.653 and the mean of the data is 3.36, which is quite high considering the maximum value is 5, which indicates the average knowledge about construction waste management of the respondents is quite good. It can be concluded that most of the respondents have good knowledge about construction waste management, so the data from the respondents is viable for this survey.

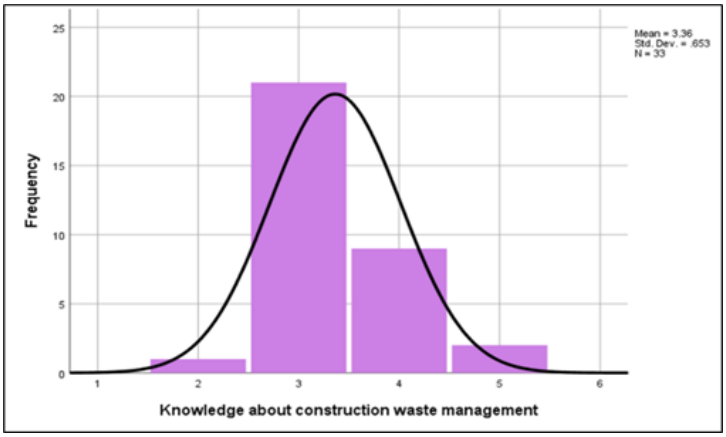

Figure 3 Knowledge Rating About Construction Waste Management.

The effectiveness of Sustainable Construction Waste Management Practices in Design Phase at Site

There are 12 lists of sustainable construction waste management practices. Contractors and consultants are required to choose effective sustainable construction waste management practices. Figure 4 shows the common effectiveness methods of construction waste management practice in Pulau Pinang. The first ranking construction waste management practice in Pulau Pinang is 3R (Reuse, Reduce and Recycle), which has 81.8%. This is not surprising considering 3R is one of the most common waste management practices in the world. There are some challenges to implementing 3R as a construction waste management tool. The main problems are pollution, waste quality, collection and transport challenges and difficulty in sorting, processing, and disposal of waste (Umar et al., 2020). However, implementation of 3R is much less costly compared to IBS and BIM, which are the best waste management practices. 3R is also easy to implement, as everyone has basic knowledge about recycling, so there will be less training that workers need to implement 3R at site. Then, the next effective construction waste management practice in Pulau Pinang is to produce good estimates of materials and provide space at the work site with both having 57.6% of the votes followed by minimizing the need for stockholding with 45.5% votes. The result indicates the practices are chosen because they generally do not cost much compared to the other practices. These practices may also save cost by managing the materials properly, which will benefit the contractor. Environmental criteria in design, which are 36.4% are followed by designating a waste management plan (WMP) coordinator who is responsible for ensuring that the plan adheres on site, to has 30.3%. Then, the result stated that correct foundation depths with 27.3% votes, followed by flexible and adaptive design with 21.2% votes. This shows that flexible and adaptive designs are not very popular to be adopted in the construction industry in Pulau Pinang. The second top of the effectiveness ranking is Building Information Modelling (BIM) with 15.2% votes, followed by the last ranking, which is modular design implementation with only 3% of the votes. BIM is surprisingly low in the rank, considering BIM is one of the most useful construction waste management practices. A study by Othman et al, shows that most contractors are not clear about the execution procedure of using BIM software and they argued that the Malaysian government would provide a comprehensive framework for recognizing BIM's strategy for implementation and the management of BIM programs by various organizations.

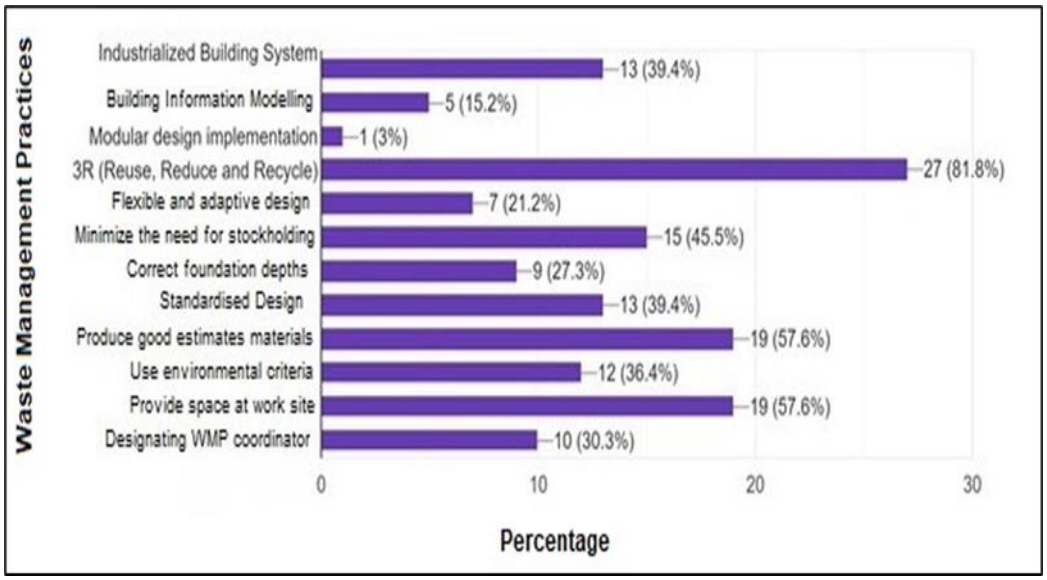

Figure 4. The Rank of Construction Waste Management Practice in Pulau Pinang

Benefits of Implementing Construction in Waste Management Practices

As illustrated from figure 5, the most benefit of implementing construction waste management practices in Pulau Pinang is the improvement of the image of the company with the mean value of 4.48. Through implementing the construction waste management at the site, the image of the company will be greatly improved. It will show that the company has a good performance of management practice by managing the construction waste properly. The selection of a contractor should not only relate to its profit-making capacity, but also to its effectiveness in managing practices (Rashvand et al.,2015). The clients and authorities will acknowledge the reputation of the company when the image of the company improves. The company also can advertise the usage of construction waste management in their company to improve more of their image in public.

The next benefit of implementing construction waste management practices in Pulau Pinang is improvement of onsite construction waste management with mean value of 4.45. As a result of implementing waste management practices, the onsite construction waste management also greatly improves. The waste management practices make the onsite construction waste management more systematic and easier to manage. The waste management practices will guide the workers and staff to manage the construction wastes and make the waste management much smoother. This will drastically improve onsite construction waste management. Then, for the ranking no 3, with mean value 4.44, raw material saving is chosen as construction waste management benefit among respondents because with a good estimate of materials from a good waste management practice, the material ordered also will be reduced thus saving the raw material. Next, ranking no 4 is raising staff awareness with a mean value of 4.21. By implementing construction waste management practice, the staffs will follow the progress of the waste management practice and then after a while, the staffs will automatically aware the benefits of the waste management practice and they will manage their own waste thus saving the environment. Lastly on the rank, greater advantages in bidding a tender with mean value of 4.00 were chooses. Some of the respondents do not agree with greater advantages in bidding a tender because bidding a tender requires much more criteria from the contractor and not from implementing construction waste management practices alone. These included management

capacity, financial wellbeing, technical staff, and capacity to achieve or support the intended job, past success, experience, financial status, project management organization and ability (Watt et al., 2009). However, implementing construction waste management practices does slightly have greater advantages in bidding a tender.

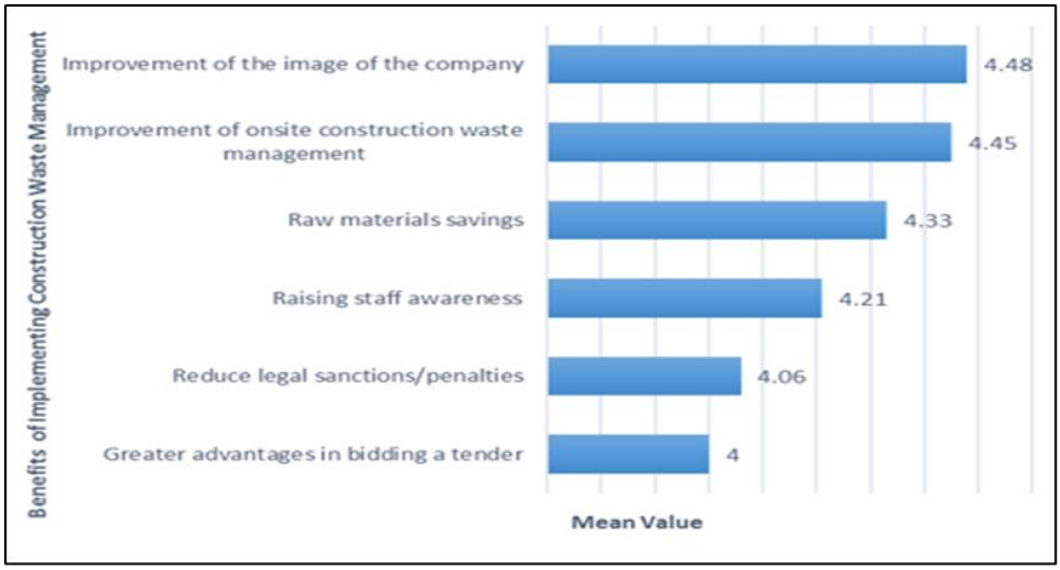

Figure 5. The Rank of Benefits of Implementing Construction Waste Management

Conclusion

From the data collected, most of the respondents indicate the most effective sustainable construction waste management practices in Pulau Pinang with 81.8%, are 3R, followed by 57.6% producing good estimates of materials and providing space at work sites. The three best sustainable waste management choices from construction site expertise will be the best solution to prevent waste generation from harm to environmental pollution and to grant a healthy environment. The reason for most construction players was choosing 3R because it is more cost-saving than IBM and IBS methods. 3R is also easy to understand and conduct with everyone that has basic knowledge about recycling. In addition, many types of construction waste are valuable and 3R is the best method for implementing sustainable waste management because it's based on the idea of fully utilising the resources before disposal.

Apart from that, the result also indicates that improvement of the image of the company is most benefited by implementing sustainable construction waste management. This indicated that the image of the company can be raised through implementing sustainable waste management effectively and properly. This is a good sign for the construction industry to start implementing waste management at construction site. The result from this study can be a guideline and reference for all key players in the construction industry, in managing and planning future construction waste management. The minimization of waste generation will contribute towards a sustainable green environment.

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