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Investigation of the Recycling Practices on Construction Waste in Green Building Index (GBI) Projects

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Abstract: Construction sector is growing rapidly in constructing projects in urban and rural area. The sector using high volume of building materials. Due to the rate of construction waste increasing day by day, construction waste becoming a crucial issues in construction industry. The research conducted to investigate the recycling practices on construction waste in Green Building Index (GBI) Projects. The objective of this study are to determine the recycling practices on construction waste and to identify the benefits of the recycling practices on construction waste in GBI Projects. An online questionnaire survey through Google Form was used to collect data for this study. The questionnaire distributed to all construction professionals who are experienced in construction field. A total of 110 questionnaires were received from the construction professionals. The collected data was analysed by using mean score and ranking method. The three most suitable methods determined from the analysed are 'Recycling should be carefully planned before starting and follows local regulations' (mean score = 4.16), 'Segregating metal waste on site' (mean score = 4.15) and 'Uses multiple container for each type of waste on site' (mean score = 4.01). The top three of benefits are 'Save large amounts of energy and decreases the consumption of natural resources to produce new materials' (mean score = 4.17), 'Enhance the company's public images' (mean score = 4.13) and 'Reduction of negative environmental effects' (mean score = 4.12). The findings of this study useful for construction professionals in practicing recycling construction waste in GBI Projects.

Keywords: Construction, Construction Waste, Recycling, Green Building Index (GBI)

1. Introduction

Construction sector is currently growth due to high demand in developing an urban or rural area. The increasing of this sector affected high consumption of building materials. Due to high demand, the rate of construction waste increasing day by day [1]. Over the last few years, most of the construction

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waste were disposed at site landfill such as timber and paper based were burned [2]. In addition, conventional disposal practices eventually contribute to saturation of landfill that cause ecological and health problems [3]. Managing waste from construction does not only conserves landfill space and decrease the impacts of waste, but it also reduces the project expenditures by avoiding high order and costs. In Malaysia, various efforts have been implemented by reusing construction waste as a building materials. Waste management is an important component in construction industry which the purpose is to reduce the waste generated.

Nowadays, the construction industry is quickly expanding, particularly in emerging countries. Construction waste becoming a crucial environmental issue in Malaysia, and it is clear that construction trash accounts for a significant amount of the waste stream. Most of construction waste is discarded in landfills, which may build the weight on landfill stacking and activity. New landfills can be hard to find, and existing ones are topping off and shutting as the year progressed [4]. Higher measure of waste created by construction industry could give a bad effect to the environment. Soil and water contamination may happen because of waste from sources like solvents or artificially treated lumber. Most of construction sector are focused on making as much money as possible, and as a result, they unable to manage construction waste [5]. It is critical that construction firms be taught in effective waste management, which includes recycling procedures and awareness of environmental degradation. The aim of this study are to determine the recycling practices and the benefits on construction waste in Green Building Index Projects. This study also help them to know the impact of construction waste to the environment and also human health. Sustainable growth is very necessary for savings to ensure that future generations are able to get benefit from the same benefits on the current generation.

2. Literature Review

Any product of material by human and industrial activity with no residual value known as waste [6]. With the demands for major infrastructure projects in Malaysia, along with several commercial buildings, the higher amount of construction waste is being generated by the construction industry and housing development programmes. Construction waste may give an impact towards the environment. It is the responsibility of the construction industry to develop a whole spectrum of waste, the quantity and form of which depends on variables, such as the stage of construction, method of construction work and onsite activities. Therefore, waste minimization is important to ensure the construction waste management successfully implemented in Malaysia or worldwide.

2.1 Green Building Index (GBI)

Malaysia government has fostered a framework that will be alluded as the "Green Building Index" to evaluate the biological plan and effectiveness of Malaysian structures. The Malaysian Institute of Architects and the Association of Consulting Engineers Malaysia (ACEM) have mutually set up the GBI rating [7].

In 2009, the Malaysian construction sector made a significant contribution to the Green Movement by launching its own 'Green Building Index' (GBI). GBI is made especially for Malaysia's heat and humidity, recalling the social, infrastructural and monetary improvement in Malaysian association and meanwhile solidifying high need overall troubles. A green structure focused on growing the efficiency of resource use of energy, water, and materials and likewise reducing structure impact on human prosperity and the earth in the midst of the structure's life cycle, through better siting, design, improvement, activity, upkeep and clearing.

2.2 Construction Waste Recycling

Construction waste recycling is no longer a new phenomenon in the construction sector. Concrete and pavement debris have traditionally been repurposed as patching materials or roadbed. Concrete resources, including recycled aggregates from existing stone constructions, have been utilized since Roman times [8]. Contractors may save money on disposal by recycling construction waste. This

strategy can also help to save the environment by reducing the amount of building trash that is delivered to the next landfill.

2.3 Treatment Process of Different Properties of Construction Waste [9]

i. Primary Classification

The architectural engineering and civil engineering should be executed before entering the trommel screening equipment. The machine can separate the huge trash out of the machine.

ii. Filtered Classification

The large gravel materials included various types of brick and concrete block. The air classification machine could be used to collect the lightweight materials to avoid the air pollution and store the materials according to the industrial waste standards.

iii. Manual Separation

The magnetic separation machine was used for the separation of the ferrous metals. It was set before the air classification machine and the trammel screener.

2.4 Benefits of the Recycling Practices on Construction Waste

Recycling methods uses waste materials that have already been used as raw materials. It saves energy while producing the same amount of output. Based on [10], there are some benefits of a building and demolition recycling techniques. Firstly, reduction in disposal costs and landfill charges. It may assists with reducing the general development costs through keeping away from the removal charges and recycling and also make upper hand thusly. Construction professional can likewise hope to make advertises by giving feedstock to the assembling of new materials. Next, by minimizing trash and utilizing fewer resources, firms and organizations that recycle in their communities and with their consumers may improve their public image. Recycling measures improve a company's public image significantly. It will be seen as a corporation that acts responsibly. What's even better is that it reduces expenditures while also assisting in profit generation.

Construction waste likewise can be recycled and prepared into new items. For instance, recycling metal can make new parts for vehicles and structures, just as holders for food. In US, the development and destruction squanders have been recuperated and handled into reused content items. Paper, the main strong side-effect in the US and it takes 40% less energy to make paper from reused paper than from new wood. Moreover, due to the efforts being exerted to develop the markets for construction and demolition debris, the number of facilities operating in the US has grown [11]. Numerous people group have set up construction waste reducing objectives, since development and destruction projects produce a lot of debris. Discovering new clients or recycling proposals materials can essentially help in these endeavors.

Besides, by recycling materials, it may save a lot of energy by eliminating the need to devour common assets. At the point when concrete and asphalt are reused, the quantity of machines needed to produce and acquire new materials is diminished, resulting in decreased energy use. Furthermore, the quantity of waste solids created in Peninsular Malaysia grew from 16,200 metric tonnes per day in 2001 to 19,100 metric tonnes per day in 2005, according to the Ninth Malaysia Plan 2006-2010 report. Sustainable landfill management should involve waste generation, waste resources, recycling and reuse, early treatment to minimize amount, trash disposal at landfills, and subsequent treatment for landfill recovery after closure [12]. Some waste created during the construction phase can be eliminate. For instance, sturdy measured metal structure frameworks for use in substantial development might be chosen based on being promptly demountable and reusable on different tasks, hence wiping out wood waste related with formwork manufactured of pressed wood and dimensional timber. Diversion of waste can be advantageous to decrease impacts on human wellbeing and the climate.

Next, recycling measures can also help to minimize generation of pollution by solid waste. This is due to the fact that solid waste collected at the landfill produces a hazardous liquid when combined with precipitation, causing groundwater contamination. Furthermore, solid waste generates a sort of gas that is detrimental to health and pollutes the air. Lastly, the recycling practices may evaluates commercial and residential properties based on six primary factors which are energy efficiency, indoor environment quality, materials and resources, sustainable site planning management, water efficiency and innovation.

2.5 Components of Construction Waste

Design, material purchasing, management of the materials and the operations will be the causes of construction that has been stated from [13]. Among the materials waste on construction site consists of glass, concrete, bricks, plastics, metals, wood and so on [14]. [15] Discovered that the total waste of building materials produced was 27,068.40 tonnes in their investigation. The biggest composition of building material waste created was 65.80 percent concrete and aggregates, followed by 27 percent soil and sand, 5 percent wood, 1.16 percent bricks, 1 percent metal, 0.2 percent roofing, and 0.05 percent packaging material.

3. Research Methods

The research methodology for this project highlights the steps required to achieve the aim of study.

3.1 Questionnaire Development

In this research, the questionnaire survey consists of 3 sections. The first section contains questions related to the respondent, job role, academic qualification, working experience and types of construction projects. The second section was conducted to determine the recycling practices on construction waste in Green Building Index (GBI) projects. The third section was conducted to identify the benefits of the recycling practices on construction waste in Green Building Index (GBI) projects. The respondents have been requested to state the agreeability of each recycling practices and the benefits by using five Likert scales.

3.2 Data Collection

This study was focused on random construction professionals who worked at construction projects in Malaysia such as Project Manager, Engineer, Site Supervisor and Safety Officer. The recycling practices to minimize the amount of construction waste generated on site. The online questionnaires were distributed to the targeted respondents through email, Facebook, Twitter and WhatsApp. There were about 110 questionnaires were obtained from respondents who are working in Malaysian construction industry.

3.3 Data Analysis

The mean score analysis and ranking method were used to determine the most suitable methods of the recycling practices on construction waste in GBI Projects. The collected data from the questionnaires were analyzed using these both methods. As a result, the most suitable methods and benefits of the recycling practices on construction waste in GBI Projects were evaluated and comprehended as follows.

3.3.1 Mean Score

Data that has been gathered from the survey were analyzed by using Mean Score method to obtain the most suitable methods and benefits of the recycling practices in GBI Projects. The Likert scale rating of the respondents was converted into mean scores. This can be illustrated mathematically as below:

$$\text{Mean Score (ms)} = \frac{\sum nW}{N} \quad (2.1)$$

Where;
$\sum$ = summation
n = the highest attainable rating
W = corresponding weight of rank category
N = total number of respondents

3.3.2 Likert Scale

Once the mean score obtained, the most suitable methods and benefits of the recycling practices on construction waste in GBI Projects was ranked. The score range falls between 0.00 – 1.49 is regarded as "not agree", 1.50 – 2.49 is slightly agree, 2.50 – 3.49 is moderately agree, 3.50 – 4.49 is very agree and 4.50 – 5.00 is regarded as most agree [16].

4. Results and Discussion

Result and analysis were obtained from online survey questionnaires. Data were obtained by conducting an online survey questionnaires to construction professional at several construction projects in Malaysia.

4.1 Respondents Demography

According to Table 1, it shows the statistics of respondent's profile based on job role, academic qualification, working experience and types of construction projects. From this table, the highest proportion of respondents for job role were engineers with 42.7% or 47 respondents. Next, based on the observation from the academic qualification among respondents, the highest number of respondents were degree holder with 65.5% or 72 respondents. Then, the table shows that the working experience with 5 to 7 years shows the largest number of respondents which was 37 respondents or 33.6%. Finally, for the types of construction projects, it shows that, most of the respondents were covered on the residential projects which was 68.2% or 75 respondents.

Table 1: Statistics of Respondent's Profile

Item		Frequency	Percentage (%)
Job Role	Project Manager	22	20
	Engineer	47	42.7
	Site Supervisor	20	18.2
	Safety Officer	17	15.5
	Others	4	3.6
Academic Qualification	Diploma	30	27.3
	Degree	72	65.5
	Master	8	7.3
	PhD	0	0
Working Experience	< 2 years	18	16.4
	2-4 years	22	20
	5-7 years	37	33.6
	8-10 years	13	11.8
	> 10 years	20	18.2
Types of Construction Projects	Residential	75	68.2
	Non-residential	10	9.1
	Social Amenities	7	6.4
	Infrastructure	17	15.5

	Others	1	0.9

4.2 Analysis and Ranking of the Recycling Practices on Construction Waste in GBI Projects

Based on Table 2, it shows the mean score of suitable methods for the recycling practices on construction waste in Green (GBI) Building Index Projects. The results concluded that, the highest mean score was method 1 which was recycling should be carefully planned before starting and follows local regulations with 4.16 mean score. Then, the method that has the second highest mean score of 4.15 was method 2 namely by segregating metal waste on site. Next, the third highest mean score of 4.01 was method 3 that was uses multiple container for each type of waste on site. Then, followed by method 4 with 3.97 mean score which was segregating paper and cardboard waste and bale on site prior to disposal. Besides, the fifth highest mean score of 3.94 was method 5 namely by analyze the distance involved for the recycling center and located near the waste. Lastly, another 4 methods which were method 7, 8, 9 and 10 categorized as moderately suitable in order to practice on recycling method on construction waste.

Table 2: Ranking of the Recycling Practices on Construction Waste in GBI Projects

No	Methods	Mean Score	Ranking
1	Recycling should be carefully planned before starting and follows local regulations.	4.16	1
2	Segregating metal waste on site.	4.15	2
3	Uses multiple container for each type of waste on site.	4.01	3
4	Segregating paper and cardboard waste and bale on site prior to disposal.	3.97	4
5	Analyze the distance involved for the recycling centre and located near the waste.	3.94	5
6	Segregating timber waste on site.	3.83	6
7	Storing reusable bricks and roof tiles from demolition phase, for use in later phases.	3.35	7
8	Break the concrete waste into small pieces to produce hardcore materials.	2.80	8
9	Uses the vegetation and trees for replanting or for biomass fuel.	2.70	9
10	Mix the plastic and glass waste and turn into concrete paver bricks.	2.67	10

4.3 Analysis and Ranking of Benefits of the Recycling Practices on Construction Waste in GBI Projects

Based on Table 3, the result concluded that respondents considered 6 out of 10 benefits as very agree and another 4 benefits as moderately agree. Therefore, 6 of the benefits represented very agree will be top 6 for the benefits of the recycling practices on construction waste. The highest mean score of 4.17 was benefit 1 namely by save large amounts of energy, and decreases the consumption of natural resources to produce new materials. Then, followed by benefit 2 which was allow companies to enhance

their public images. Next, followed by benefit 3 with 4.12 mean score that was namely reduction of negative environmental effects. Furthermore, it follows by benefit 4 with 4.10 mean score which was reduction in disposal costs and landfill charges. Lastly, followed by benefit 5 and benefit 6 with 4.04 mean score that was helps meet local and state waste reduction goals and increase landfill life.

Table 3: Ranking of Benefits of the Recycling Practices on Construction Waste in GBI Projects

No	Benefits	Mean Score	Ranking
1	Save large amounts of energy, and decreases the consumption of natural resources to produce new materials.	4.17	1
2	Enhance the companies public images.	4.13	2
3	Reduction of negative environmental effects.	4.12	3
4	Reduction in disposal costs and landfill charges.	4.10	4
5	Helps meet local and state waste reduction goals.	4.04	5
6	Increase landfill life.	4.04	5
7	Make new products from old materials.	3.43	6
8	A companies may earn points, which is the assessment under the GBI rating tool.	3.43	6
9	Improve the market for recycled content products.	3.39	7
10	Diversion of waste that would otherwise occupy landfill space.	3.38	8

5. Conclusion

The study concluded that from ten (10) methods that has been determined, six (6) methods was chosen as very suitable to be practiced. The six very suitable methods were 'Recycling should be carefully planned before starting and follows local regulations', 'Segregating metal waste on site', 'Uses multiple container for each type of waste on site', 'Segregating paper and cardboard waste and bale on site prior to disposal', 'Analyze the distance involved for the recycling centre and located near the waste and segregating timber waste on site'. This study also identifying the benefits of the recycling practices on construction waste in Green Building Index Projects. The study found top five benefits namely 'Save large amounts of energy and decreases the consumption of natural resources to produce new materials', 'Enhance the companies public images', 'Reduction of negative environmental effects', 'Reduction in disposal costs and landfill charges', 'Helps meet local and state waste reduction goals' and 'Increase landfill life'.

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