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Implementation of green building materials in construction industry in Johor Bahru, Malaysia

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Abstract. The research paper is to investigate the implementation of green building materials by construction industry stakeholders in Johor Bahru. Several features and the main types of green building material used in construction industry in Johor Bahru is determined. Barriers and solutions is identified in adopting the green building materials and questionaire is used to gauge response from targetted respondends. The design structure of the questionnaire is to achieve the three objectives of the research. The first objective of the study intends to investigate the importance level for features of green building and the types of green building materials. The second objective of the research is to investigate importance level of the core barriers for the usage of green building materials and the third objective is to investigate importance level of the solutions for the barriers in adopting green building materials.
The data collected is analysed using SPSS software, descrptive statistics eg. mean score and standard deviation interpretations. In conclusion, the GBM features preferred are energy efficiency, low carbon emission and raw material and waste is recyclable. Preferred GBM types are "sustainable brick", "lightweight reinforced concrete" and "wood flooring" are the top three ranked GBM in Johor Bahru. The research also found that, "Higher cost", "Lack of awareness" and "Lack of rules and regulations" are the top three ranked core barriers. Finally, the research concluded that, "Reduce green building material cost", "Education" and "Training campaign" are the top three ranked solutions importance level in adopting GBM in Johor Bahru.

1. Introduction

Green building index (GBI) assessment criteria is to enhance the environmental initiatives in the construction project in Malaysia. The following are critical review of journals, which is summarized and relevant to this paper research. Green building materials (GBM) is, defined as sustainable materials, qualified by the Life-Cycle Assessment (LCA) methodology during their full life cycle [1], which is supported by [2] who did comparison for the assessment tools. However, [3] analyzed the ways to enhance the implementation which is education and training should be provided, government initiatives and enhance the level of awareness. The challenges in assisting the green initiatives for policy makers and to overcome the challenges are identified to bring forward Malaysia to a sustainable environment [4]. The challenges in Malaysia to adopt the sustainable materials are such as lack and access of information on GBM, low awareness of the GBM, costly, regulation/code and GBM is limited. Therefore, the implementation of GBM in Malaysia is still low and better strategies should be adopted to encourage the uses [5]. The objective of this research is to address the gap in enhanced strategies by identifying the current preferred features and types of GBM. Furthermore, by addressing the main barriers and main solutions, this research will be able to assist policy makers, education industry and

government initiatives will be more apparent in implementation of GBM among construction industry stakeholders in Johor Bahru.

1.1 Importance of Green Building Materials (GBM)

According to [6], GBM are defined as materials, which can be reused, renewed or recycled and can be implemented in the construction without adversely polluting the atmosphere. The production of GBM will not increase the environmental impact, on the contrary GBM is a renewable material which can alternate the limitation of non-renewable materials. Green building materials have positive impacts to the environment to enhance the performance of the building and will improve the effectiveness of indoor air quality. According to [7], the GBM are free from contaminants especially from volatile organic compounds (VOC) which is a threat to the occupants' health and the risk of cancer due to the indoor air quality. While, in the study of [8], argues that the GBM can minimize the health hazard by not producing a huge amount of toxic chemicals for instance, the usage of PVC can be controlled. Indoor air quality is influenced by the finishes of the building which is elaborated by [9]. If building finishes which is low toxicity is used, Sick Building Syndrome (SBS) can be minimized. Environmental pollution is critical during the production of building materials in construction industry. Atmospheric pollution, which caused by the cement production whereby the cement factories produces approximately 10 billion tons per year, which is equal to $1/10^{th}$ global emission and it is considered as a main contributor to greenhouse gases. In a report by [10], state that the GBM will contribute to minimize the occupants' health and environmental pollution. Furthermore, [11] describe that GBM as environmental building material which consists of natural resources and energy is reduced. Clean production technology is used to produce GBM, for example, environmental paint which is produced by nano technology is used to reduce the pollution to the air. GBM is also economically profitable compared to the traditional building materials because of the elimination of waste of resources and the manufacturing cost is reduce.

While, [12] state that by implementing GBM in the building, it is a sustainable operation strategy and design. The GBM is environmental friendly because it is a rapid renewable material if compared with conventional material. While, 10 years is the maximum of the harvest cycles and the benefit of it is the trees are saved, it will reduce the production of greenhouse gases (GHG) because it will be absorbed by the trees. The diversity of habitat, plants and animals are also minimized. Besides, the GBM also provides the energy efficiency .This is because the producer can recycle the waste material which is produced during the construction rather than using new raw materials. Therefore, the GBM can reduce the energy and cost on transportation of materials. According to [13], states that the GBM which are selected must able to improve the energy efficiency of the construction. In the research carried by [14], it compares the features and production of GBM with the conventional materials in construction industries and concluded that the energy consumption of GBM is lesser compared to conventional materials. In the studies by [15], suggests that the GBM embodied energy consume lesser energy if compared with conventional materials and GBM is biodegradable and it can decompose naturally. In the research of [16], also state that the agricultural wastes can replace as GBM to achieve the objective of cost effective for construction. In the studies of [17], suggest that the sustainable materials in the construction industry such as lime, sand-lime brick, eco-friendly tiles and colored plaster, which are more effective than the conventional materials.

2. Method

2.1. Research Design

The data was obtain using close-ended questionnaire survey and analyzed using SPSS, descriptive analysis eg. mean and standard deviation. The questionnaire contains four sections, which are the background information and 3 different research objectives. For the background information section, the respondents are required to fill in their working experience (years) in construction industry to determine the experience level and validity of opinions. The first objective, which is to determine the importance level for features and the main types of GBM. The second research objective is investigated by seeking the importance level of the barriers and reason of low usage of GBM. The third objective of

the research is achieved by defining the solutions for the barriers and identify the importance level of the solutions. The questionnaire is set based on 5 option Likert Index scale which is 1-Very unimportant, 2-Unimportant, 3-Neutral, 4-Important and 5-Very important or 1- Strongly Disagree; 2-Inclined to Disagree; 3-Neither; 4-Inclined to Agree; 5-Strongly Agree. The sampling of the research is determined by using the random sampling. Information on construction industry stakeholders such as developers firm, architects and quantity surveyors were selected from Real Estate and Housing Developers' Association Malaysia (REHDA), Persatuan Arkitek Malaysia (PAM) and Board of Quantity Surveying Malaysia (BQSM). Approximately 125 of total number of developer, architect and quantity surveyor firms in Johor Bahru [18] who have some working experience in GBM. According to [19], suggested that with a population size of 125 with approximately 10% confidence level, sample size is 56. Therefore, the research questionnaire assumed 56 set of data obtained and analyzed.

3. Results

3.1. The Important Features of GBM

In Table 3.1, it indicates that "Energy efficiency" with (M = 4.16, SD = 0.91) is the most important feature when choosing the GBM. The mean value revealed that the features of GBM with the highest level of agreement is "Energy efficiency". Therefore, GBM which is energy efficiency will be chosen and be the main consideration if compares with conventional material. This is because the energy consumption and operating cost will be reduced in the long run. The second factor is "Low carbon emission" (M = 4.12, SD = 0.82). It is followed by "Raw material/waste is recyclable" (M = 4.00, SD = 0.69), "Low Volatile Organic Compound (VOC)" (M = 3.92, SD = 0.85), "Durable" (M = 3.88, SD = 0.96) 34 and lastly Low transportation (M = 3.00, SD = 1.00).

Table 3.1. The Important Features of GBM.

Features of Green Building Materials	Mean	Standard Deviation
Low carbon emission	4.12	0.82
Raw material/waste is recyclable	4.00	0.69
Energy efficiency	4.16	0.91
Durable	3.88	0.96
Low transportation	3.00	1.00
Low Volatile Organic Compound(VOC)	3.92	0.85

The respondents find that the "Energy efficiency", "Low carbon emission' and 'Raw material/waste is recyclable" are the top three highest mean score and the most important features in GBM in Johor Bahru. However, the respondents find the least important features, which is the low transportation cost for the GBM.

3.2. The Important Types of GBM

The respondents were to give the opinions on the importance level on the type of GBM. The purpose of asking the importance level of GBM is to determine the major type of GBM in Johor Bahru. In Table 3.2, the top-ranked GBM in Johor is "sustainable brick" which has the highest mean (M = 3.84, SD = 0.99). It is followed by "lightweight reinforced concrete" (M = 3.72, SD = 1.09), "Wood flooring" (M = 3.46, SD = 0.97), "Triple glazed window" (M = 3.32, SD = 1.06), "Natural stone" (M = 3.32, SD = 1.08), "Steel stud" (M = 3.20, SD = 1.03) and lastly "Paper Insulation" (M = 3.02, SD = 1.15). The respondents deemed that the "sustainable brick", "lightweight reinforced concrete" and "wood flooring" are the top three ranked GBM in Johor Bahru. However, the respondents find the least important types, is the "paper insulation" as the GBM.

Table 3.2. The Important Types of GBM.

Type of Green Building Material	Mean	Standard Deviation
Wood flooring	3.46	0.97
Lightweight reinforced concrete	3.72	1.09
Triple glazed window	3.32	1.06
Sustainable brick	3.84	0.99
Steel stud	3.20	1.03
Paper Insulation	3.02	1.15
Natural stone	3.32	1.08

3.3. The Important Barriers in Adopting GBM

In Table 3.3, the major barrier in implementing the GBM in Johor Bahru is "Higher cost" which has a (M = 4.04, SD = 0.95). The second-ranked barrier is "Lack of awareness" with (M = 4.00, SD = 0.93), it is followed by "Lack of Rules & regulation (M = 3.84, SD = 0.77)" and "Client's preference" (M = 3.82, SD = 0.77), "Lack of information" (M = 3.80, SD = 0.76) and "availability of green materials" (M =3.78, SD = 0.93).

Table 3.3. The Important Barriers in Adopting GBM.

Barriers of Green Building Materials	Mean	Standard Deviation
Lack of awareness	4.00	0.93
Higher cost	4.04	0.95
Lack of information	3.80	0.76
Lack of Rules & regulation	3.84	0.77
Client's preference	3.82	0.77
Availability of Green materials	3.78	0.93

The respondents find that, "Higher cost", "Lack of awareness" and "Lack of rules and regulations" with high mean score are the top three ranked core barriers importance level in adopting GBM in Johor Bahru. The respondents believe that the "Availability of Green Building Materials" is the least important barrier.

3.4 The Important Solutions in Adopting GBM

The respondents were investigated with their opinions on the importance level of the solutions should be provided to increase the usage of GBM in Johor Bahru. In Table 3.4, "Reduce green building materials cost" (M = 4.20, SD = 0.83) is the most importance solution in the construction industry in Johor Bahru. However, the second-ranked solutions is "education" (M = 3.98, SD = 0.98).), followed by "Training campaign" (M = 3.92, SD = 1.03), "Government Cooperate" (M = 3.86, SD = 0.99), "Supplier recommendation" (M = 3.44, SD = 1.20) and lastly "Government policy" (M = 3.06, SD =0.95).

Table 3.4. The Important Solutions in Adopting GBM.

Solutions of Green Building Materials	Mean	Standard Deviation
Government Cooperate (tax subsidies)	3.86	0.99
Government policy (eg:law…)	3.06	0.95
Education (eg: school, university…)	3.98	0.98
Reduce green building material cost	4.20	0.83
Supplier recommendation	3.44	1.20
Training campaign (eg: in office or site…)	3.92	1.03

The respondents find that, "Reduce green building material cost", "Education" and "Training campaign" with high mean score are the top three ranked solutions importance level in adopting GBM in Johor Bahru. The respondents believe that the "government policy" is the least important.

4. Findings and Discussions

. Fulfilling the first research objective, the research discovered three major features of GBM, which are energy efficiency, low carbon emission and raw material and waste is recyclable. This research conforms to research review by [14], which expressed that the GBM is more energy efficiency compared to conventional materials. The research find that energy cost would be the upmost concern to most construction industry stakeholders and complying to the international and Malaysian government requirement such as low carbon emission would be the second priority. The research also proved that GBM will eliminate the construction waste based on study by [11]. However, the research find the least important features, is the low transportation cost for the GBM probably due to fuel cost is still low in Malaysia.

The respondents deemed that the "sustainable brick", "lightweight reinforced concrete" and "wood flooring" are the top three ranked GBM in Johor Bahru. Contrary to findings in [20], top GBM are sustainable concrete, paper insulation and triple glazed windows. However, the respondents find the least important types, is the "paper insulation" as the GBM. Research in [21], shows the top GBM are wood flooring, thatch roof and sustainable bricks.

Achieving the second research objective respondents find that, "Higher cost", "Lack of awareness" and "Lack of rules and regulations" are the top three ranked core barriers. On the contrary to research review by [22], expressed that the barrier in Malaysia was lack of awareness. Research by [23], stated that few barriers to implement the GBM such as the availability of the building materials, the higher initial cost and the compliance of regulation and code. However, in this research, the most importance barrier in Johor Bahru is the higher cost of GBM. The respondents believe that the "Availability of Green Building Materials" is the least important barrier.

Attaining the third research objective , the research find that, "Reduce green building material cost", "Education" and "Training campaign" are the top three ranked solutions importance level in adopting GBM in Johor Bahru. Conforming to research by [3], stated that the ways to enhance the implementation, which is education and training is provided, government initiatives and enhance the level of awareness. The respondents believe that the "government policy" is the least important.

5. Conclusions

The development of GBM can be improve by regulating the policy in Malaysian construction industry specifically by revising the Green Building Index rating tools and MS 1525. Furthermore, with implementation of tax breaks for developers specifically who adopt GBM, which are energy efficiency,

low carbon emission and raw material and waste is recyclable. To control the main barrier of higher cost of GBM, government can implement controlled price or subsidize cost for "sustainable brick", "lightweight reinforced concrete" and "wood flooring". Training can be carried out by all construction stakeholders to ensure their employees are aware of the operation and maintenance cost of the GBM long run is lower. The most effective solution on resolving the low implementation of GBM is education this can be enhanced by compulsory training course for final year graduates in the field of built environment in relation to green building materials and sustainability implemented in construction industry. Therefore, the government should regulate new policy that the school and university should implement the development and knowledge of GBM in the syllabus. The development of GBM should involve the collaboration between government , construction industry stakeholders and education industry stakeholders.

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