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GREEN BUILDING TOWARD CONSTRUCTION SUSTAINABILITY: ENERGY EFFICIENCY WITH MATERIAL AND DESIGN ASPECTS

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ABSTRACT

In this globalization era, sustainable constructions have taken on some new steps to stimulate green building practice. Green building criteria basis are energy efficiency, material and resource conservation and sustainable design of the building itself. Energy efficiency still has a long way to go, due to some barriers that prevail in the practice of energy efficiency. Similarly, materials and design that are originally used have created various issues related to the environment and human health. In Malaysia, people's level of awareness about green building is still low and they have minimum understanding and lack of familiarity about green materials and sustainable design. According to Klufallah, Nuruddin, Khamidi and Jamaludin (2014), 24% of total of carbon dioxide ($CO_{2)}$ comes from the construction sector in the Malaysia. Therefore, this study aims to look into building energy efficiency and materials and design employed in green buildings to achieve constructive sustainability and to establish the benefits of utilising energy efficiency, green materials and sustainable design. This study will be done using a case of the construction sector in Malaysia. The data will be collected through an interview with several Property Development Companies or projects that apply the green building criteria. The recommendation is that more property development companies should be interviewed so that more comprehensive results can be gathered.

Keywords: *sustainable constructions, green building, energy efficiency, green building materials, sustainable building design, Green Building Index (GBI)*

INTRODUCTION

As can be observed today, the construction industry is undergoing a green revolution (Gou, Prasad, & Lau, 2013). The idea of sustainable construction has gained popularity in the Malaysian housing industry in these few years and a lot of green initiatives have come to surface (Nazirah, Nor'Aini, & Ayman, 2013).

Buildings have a large contribution to give in regard of the green issues (Wong & Fan, 2013). Additionally, sustainable building is put into practice all over the whole

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phases of building, from the preconstruction to the removal of the construction, other than lower the dangerous or toxic effect on the environment of building (Hwang & Tan, 2012). On the same echo, green building refers to the act of developing, constructing and building structures, and utilizing procedure that are environmental and resource efficient in various construction activities (Kamarudin, Mohd Fazli, Md Nor Hayati, Ismi, & Norhana, 2011). Therefore, green building is known as sustainable building (Hwang & Tan, 2012); (Samari, Godrati, Esmaeilifar, Olfat, & Mohd Shafiei, 2013) or "high performance" building (Howe, 2010).

Moreover, Sustainable constructions refer to the ways of how the developers design, develop, build and control a project that can leave as little negative impacts on the environment and public as possible (Nazirah, Nor'Aini, & Ayman, 2013). Also, green building concerns with establishing and employing healthier and more resource-efficient prototypes of construction, renovation, operation, maintenance, and demolition (EPA, 2014). Hence sustainable constructions become the key to promote green building practice throughout the world. It also refers to the building structure itself. Broadly speaking, green building is intended to mitigate the environment impacts of the construction activities and it is sustainable.

In Malaysia, the Green Building Index (GBI) is used by the construction industry as a tool for building rating. (Yeong & Putuhena, 2015). There are five major measures considered by green buildings, which mainly comprise of sustainable site design, water conservation and quality, energy efficiency, indoor environmental quality, and the conservation of materials and resources (Jackson, 2010). Based on literature, people still are of the opinion that energy efficiency is the same as energy conservation, but in fact, there are differences noted (Lawrence Berkeley National Laboratory, 2015) and energy efficiency remains a daunting task to fulfil (Howe, 2010). Also, the demand for buildings increases altogether raising the pressure on resources like energy, water and raw materials (WBDG Sustainable Committee, 2014). In Malaysia, people are still not very aware about green building (Shari & Soebarto, 2013). As it is, the green building will be reevaluated every three years and the certification will resume. Consequently, this paper will search the energy efficiency and material and design as green building aspects toward construction sustainability.

LITERATURE REVIEW

Sustainable construction

Sustainable construction refers to the ways of how the developers design, develop, build and control a project that make as little negative impacts on the environment and public as possible (Nazirah, Nor'Aini, & Ayman, 2013). It is defined as the establishment of buildings that makes use of little untouched materials and energy, and creates pollution and waste that are minimal (Zimmermann, Althaus, & Haas, 2005). According to Hong Kong Housing Authority (2009) environmental, social, and economic sustainability are the three aspects of Sustainable construction. The main objective of sustainable construction is to set up healthy set up surroundings based on effective utilisation of materials and resources and excellent and sustainable building designs (Hwang, Zhao, & Tan, 2015).

Green building

Green building serves as the basis of sustainable construction development (Samari et al., 2013). Green building is claimed to be a building that meets the prerequisite building performance standards while diminishing the disruption to, and enhancing, the ecosystems in the native, provincial and universal circumstances in the whole life cycle (Glavinich, 2008). Additionally, green building also helps to enhance residents' health through the design of a healthy interior environment (Allen et al., 2015).

Green building is deemed necessary to fulfill the fundamental building code terms and reduce its life-cycle environmental impacts and cost (Ali & Al Nsairat, 2009). The decision in selecting an appropriate green building rating tool is highly important and the selection has to lean on the climate and various characteristics of that particular country's agenda (Lizawati et al., 2015), based on four norms namely appropriate, accessible, up-to-date, and quantifiable (Wu et al., 2015). It has to meet an anticipated level of performance according to the standards that have been predetermined (Ali & Al Nsairat, 2009). Also, the Building Research Establishment Environmental Assessment Methodology (BREEAM) is widely employed in the UK especially for companies like the Housing Corporation (Wong & Fan, 2013), and it is applicable to various types of buildings (Chen, Yang, & Lu, 2015).

Green Building Index in Malaysia

Green Building Index (GBI) is the first green rating tool introduced in the Malaysian construction industry. Established in 2009 by Malaysian Institute of Architects (PAM) and the Association of Consulting Engineers Malaysia (ACEM), its aim is to improve the awareness and create sustainable and green architecture or green building (Abdullah, Jumadi, Sabu, Arshad, & Mohd Fawzy, 2015) (Sim & Putuhena, 2015). The establishment of GBI adheres to the initiatives to formulate Malaysian green policies, or specifically the National Green Technology Policies, 2009 (Lizawati et al., 2015). It was devised based on international green building rating systems like USA's LEED and UK's BREEAM, and assessed to become compatible with the Malaysian climate and geographical conditions (Samari et al., 2013). Tropical climate, environmental conditions, and social and cultural needs of Malaysia are all deliberated upon by GBI (Wu et al., 2015).

The main purpose of GBI is to promote sustainability in the built environment and get the involvement of all the players in the construction industry towards the environmental issues. Sustainability consists of six criteria as shown in Table 1.1 (Fauzi & Malek, 2013), seeking to save energy, resources, recycle materials and adapt buildings to the Malaysian climate, culture and environment (Rahardjati & Khamidi, 2011) and it aims to increase the awareness of all the relevant parties in the construction field and hence contributes to the environmentally friendly settings in Malaysia (Habibullah, Abdullah Halim, & Abdullah Halim, 2012). The points for the GBI certification will be given for performance based on the stipulated benchmarks and the current industry practice (Rahardjati & Khamidi, 2011).

Table 1.1
Points Allocations for GBI Criteria.

Criteria	GBI points
Energy Efficiency	35
Indoor Environmental Quality	21
Sustainable Sites	16
Materials and Resources	11
Water Efficiency	10
Innovation	7
Total (%)	100

Source: Fauzi & Malek, 2013

The GBI's ranking result is also divided into Platinum, Gold, Silver and Certified shown in Table 1.2 (Fauzi & Malek, 2013; Wu, Shen, Yu, & Zhang, 2015).

Table 1.2
GBI Rating Award

Rating Award	Total Score
Platinum	Over 86
Gold	76 to 85
Silver	66 to 75
Certified	50 to 65

Source: Fauzi & Malek, 2013

Energy Efficiency

Energy efficiency is regarded as a benchmark of energy utilized to supply a service. By making improvement to the energy efficiency, the public will receive and save more energy from the energy used (Department of Energy and Climate Change, 2012). According to Murer, Alonso-Herranz, de Waal, Spliethoff1, van Berlo3, and Gohlke (2013), energy efficiency is the essence towards achieving sustainability in the society, and it is also broadly acknowledged as a tool to reduce greenhouse gas (GHG) emissions (Zimmerman, 2012).

Next, energy efficiency refurbishment and retrofit will help minimize the gas emission of greenhouse gases (GHGs) (Department of Energy and Climate Change, 2012); (Morrissey, Dunphy, & MacSwee, 2014); (Milner, et al., 2015), and the reduction has led to the energy efficiency of buildings (Organ, Proverbs, & Squires, 2013). The constructed environment point to 30-40% of global energy consumption and connected greenhouse gas (GHG) emissions, enabling any industry to save energy and prevent =GHG emissions (Dunphy, Morrissey, & Mac Sweeney, 2013).

Green building materials

Environmental impacts, resource efficacy, waste reduction, life cycle cost, social welfare, and performance competence are several vital factors that have to be considered when choosing appropriate green building materials (Akadiri & Olomolaiye, 2012). Building material evaluation and selection are two significant phases during the detail design phase as sound decisions have to be made with respect to building assemblies (Gething, 2011). Reclaimed wood is a good material for the doors, and the material that can be used to make wiring is the virgin copper because it

contains impurities that can affect the wire's power-carrying capacity (BuildingGreen, 2015).

Sustainable building design

Sustainable building design manifests itself as building envelope design and passive cooling strategy. Envelope design has two types, namely the "active" design and the "passive" design. Designed buildings are very much dependent on the air-conditioning system for heating and cooling. Passive design also means that the ventilation is controlled, which allows air movement in and out of the buildings to provide fresh air and maintain the indoor temperature in a comfortable surroundings (Hossam & Molina-Prieto, 2015).

Green building rating systems like LEED and BREEAM have came up with a number of passive design tactics easily sorted into building layout, envelope thermophysics, building geometry, and air tightness and infiltration (Chen, Yang, & Lu, 2015). Under the passive cooling strategy, we have the solar shading and radiative cooling. Solar shading using local materials like terracotta tiles, hay, inverted earthen pots and date palm branches can help reduce the indoor temperature dramatically (Hossam & Molina-Prieto, 2015). Radiative cooling includes two roofs, is the first one is the diode roof and another the roof pond (Hossam & Molina-Prieto, 2015).

RESEARCH METHODOLOGY

Qualitative method will be conducted in this research. One of the property development companies will be chosen to be interviewed. Qualitative method is deemed the most suitable for this research because narrates more realistically about the actual situation in the company and it also touches on the actual constraints for this research. Qualitative data are analysed- the data elaborate on personal's experiences, opinions, and meanings such as they are not supposed to match to the pre-existing philosophies (Koch, Niesz, & McCarthy, 2014), Non-numerical data utilized in this kind of research allow researchers to discover the quality and nature of people's actions, practice and comprehension (Hamza, 2014).

Individual understanding of happenings is very important and this can be obtained through participant observation and in-depth interviews (Langkos, 2014). For data gathering, interview will be used, as it serves as a key of qualitative data gathering method commonly applied in performing field studies (Qu & Dumay, 2011). In-depth interview is also known as semi-structured interview, and it can present reliable and comparable qualitative data (Newton, 2010).

According to Koch, Niesz, & McCarthy (2014), an inductive data analysis is an important feature of qualitative research. Collecting and analyzing data will be completed in continuous iteration, permitting a better data gathering (Arendt, et al., 2012; Koch, Niesz, & McCarthy, 2014). Interview's reactions, personal experiences and life stories must be recorded in further detail because it is essential in the data analysis process (Carter & Little, 2007).

CONCLUSION

The goal of our current work is to identify the advantages of energy efficiency and to penetrate into the methods and obstacles in obtaining energy efficiency and to use proper material and design in green building. For instance; to support the production of green energy by using the FiT scheme, the organizations and house owners can yield renewable energy for the national grid from solar, biogas, biomass and hydro energy and the prices are discounted (Tan, 2014). It appears that 24% of total of carbon dioxide ($CO_{2)}$ appears from the Malaysian construction sector (Klufallah, etc. 2014).

By contrast, building materials and methods that are originally used have have created environment and human health-related issues. Signs like breathing trouble, migraine, dejection, and long-term extreme tiredness can be caused by chemical contaminants from paints, diluents, plastics and compound wood as well as biological contaminants (Thakare & Asutkar, 2010). Therefore, green building materials should be very well considered and selected with regard to health and environmental impacts during their life cycle phases. The selection of green materials is determined by multiple criteria from the environmental, socio-economic, and technical perspectives (Akadiri & Olomolaiye, 2012). In sum, the awareness about the green building is still very weak (Shari & Soebarto, 2013). They lack the knowledge and expertise on the green building materials and design, which is why most of our buildings are still 'comfortable' with the conventional construction materials and design (Nazirah, Nor'Aini, & Ayman, 2013). Thus, a research on the current practice seeking to improve energy efficiency and material and design of green building aspects is timely. At the moment, the current researchers seek to look into the current research issues in the construction industry and to establish sound findings for the study.

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