

MATERIALS AND DESIGN IN GREEN BUILDING FOR SUSTAINABLE CONSTRUCTIONS

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ABSTRACT

In this globalization era, sustainable constructions turn into the key to stimulate green building practice. One of the notable ways in practicing green building is through conservation of materials and resources and sustainable design of the building itself. Building materials and methods that are originally used have given rise to problems related to the environment and human's health. In Malaysia, people are less aware about green building and they have minimum understanding and know-how about green materials and sustainable design. Therefore, this study aims to explore building materials and design employed in green buildings to achieve sustainability and to identify the benefits of utilising green materials and sustainable design. This study was carried out using a case of construction sector in Malaysia. The data were collected via an interview with Eco World Development Sdn Bhd. The company utilizes materials like polyvinyl chloride (PVC) for water and cable work installations, laminated timber and porcelain or ceramic tiles as flooring, creeper plants as the insulation material, and bricks and reinforced concrete for interior wall construction. The company also involves in recycle practice by reusing the formwork in constructing the buildings. In addition, Eco World Development Sdn Bhd focuses on passive design such as cross ventilation and solar shading to reduce energy consumption. Due to time constraint, there is only one company that has been interviewed. It is recommended that more property development companies should be interviewed in order to obtain more comprehensive results.

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

INTRODUCTION

Buildings have a large contribution on the green issues (Wong & Fan, 2013). Hence sustainable constructions become the key to promote green building practice all over the world. Sustainable constructions refer to the ways on how the developers design, develop, build and control a project that make the negative impacts on the environment and public as little as possible (Nazirah, Nor'Aini, & Ayman, 2013). According to U.S. Environmental Protection Agency (EPA), green building is the exercise of establishing and employing healthier and more resource-efficient prototypes of construction, renovation, operation, maintenance, and demolition (EPA, 2014). It also refers to the building structure itself. There are five major measures that green building takes into account, which mainly comprise sustainable site design, water conservation and quality, energy efficiency, indoor environmental quality, and conservation of materials and resources (Jackson, 2010). In Malaysia, Green Building Index (GBI) is used by the construction industry as a tool to rate the

buildings (Yeong & Putuhena, 2015). In this study, the researcher is going to focus on the conservation of materials and resources and the design of green building. It is crucial for developers to know which type of materials they should use in the buildings to achieve sustainability. Apart from the materials, design of a building is another matter to consider.

There are a few problems that encourage the researcher to carry out this study. Firstly, the demand for buildings increases which raises the pressure on resources such as energy, water and raw materials (WBDG Sustainable Committee, 2014). Secondly, building materials and methods that are originally used have given rise to problems related to the environment and human's health. Thirdly, in Malaysia, people are still not much aware about the green building (Shari & Soebarto, 2013). They are lack of knowledge and expertise on green building materials and design.

Three main objectives of the research are listed as below:

1. To explore green building materials used in the construction industry to achieve sustainability.
2. To explore building design made for green buildings in attaining sustainable constructions.
3. To identify the benefits of using green materials and sustainable design in green buildings.

LITERATURE REVIEW

Sustainable construction

Sustainable construction is defined as the establishment of buildings that utilize little untouched materials and energy, and create minimum pollution and waste (Zimmermann, Althaus, & Haas, 2005). The main objective of sustainable construction is to establish a healthy set up surroundings based on effective utilisation of materials and resources and brilliant sustainable design of the buildings (Hwang, Zhao, & Tan, 2015). Sustainable construction can be divided into three different aspects which are environmental, social, and economic sustainability (Hong Kong Housing Authority, 2009).

Green building

Green building is found to be 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 throughout its entire life cycle (Glavinich, 2008). Green building is required to fulfill the fundamental building code terms and reduce its life-cycle environmental impacts and cost as well (Ali & Al Nsairat, 2009). The objective of practising green building is to reduce environmental impacts through conservation of energy and water, and by restricting local disruptions to the building site. Besides, green building also helps to enhance residents' health by means of the design of a healthy interior environment (Allen et al., 2015).

Green building rating tools are used to evaluate if a building has successfully met an anticipated level of performance according to the stated standards (Ali & Al Nsairat, 2009). Green rating tools recognize green buildings by granting them a certain grade. There are three green building rating tools that had been studied, which are Leadership in Energy and Environment Design (LEED), Building Research Establishment Environmental Assessment Methodology (BREEAM) and Green Building Index (GBI).

Green building materials

Green building materials are crucial for the design, construction and operations of sustainable buildings. They are eco-friendly. In other words, green materials are recyclable, reusable, sustainably harvested, rapidly renewable, non-toxic, and local. Three major criteria that are used to select green materials are aesthetics, maintainability, and energy conservation. Environmental impacts, resource efficacy, waste reduction, life cycle cost, social welfare, and performance competence are the important factors to be considered in selecting appropriate green building materials (Akadiri & Olomolaiye, 2012). Different kinds of materials are used to build different building elements, as for the doors, windows, flooring, piping and wire and wire insulation.

Sustainable building design

Sustainable building design involves building envelope design and passive cooling strategy. There are two distinct types of envelope design regarding to building's energy performance. One is known as the "active" design and another is the "passive" design. The active design seems to isolate the internal environment of the building from the exterior surroundings by focusing on the insulation element of the building. All the envelope components are applied with insulation features considerably in order to minimize heat transfer between the internal and external sides of the building. Buildings of this design depend solely on the air-conditioning system for heating and cooling purposes (Hossam & Molina-Prieto, 2015). On the other hand, buildings of passive design rely more on the natural ventilation system. It encourages favourable interactions between buildings and the external environment. Passive design also promotes controlled ventilation which allows movement of air in and out of the buildings to supply fresh air and to maintain the indoor temperature at comfort zone (Hossam & Molina-Prieto, 2015).

There are two different kinds of passive cooling strategy, namely, solar shading and radiative cooling. Solar shading design is most relevant to thermal cooling buildings particularly in those developing countries focusing on the cost effectiveness, and it is easy to implement. Solar shading equipment is divided into two groups, the external shading and internal shading. The external shading normally is made up of overhangs, louvers, vertical fins and awnings whereas the internal one contains various forms of shadings depending on the building's aesthetical design and functions. Solar shading equipment that is well designed can not only effectively minimize building's peak heat gain and cooling loads but also enhance the natural lighting quality inside the building. The shading equipment is designed based on the sun orientation of a particular building façade. In radiative cooling, the roof of a building plays two different roles: nocturnal radiator and cold store. Same as solar shading, radiative cooling is also a cost-effective solution. There are two types of roof that have been used for radiative cooling. One is the diode roof and another is the roof pond (Hossam & Molina-Prieto, 2015).

METHODOLOGY

Qualitative research

Qualitative research is a research in which the outcomes cannot be measured or quantified, and it is suitable for small samples. Non-numerical data utilized in this kind of research enable researchers to discover the quality and nature of how people act, practice and comprehend (Hamza, 2014). Qualitative research aims to provide a complete, detailed description of a research subject. The data presented are in the form of words, images or objects. Qualitative research is a matter of subjective. Therefore, individual understanding of happenings is crucial and this can be obtained by using participant observation and in-depth

interviews (Langkos, 2014). There are several disadvantages of conducting qualitative research, namely, time-consuming, lack of trustworthy and difficult to generalize the outcomes.

Data collection method

Basically, there are two types of data, the primary data and secondary data (Blessinger, 2015). Primary data is the data collected from primary sources. Primary data refers to the data that has never been collected before, it cannot be found in the websites or anywhere else. Interview is one of the approaches to collecting primary data. Interview is a superior approach to discover the structure and discussion of implications of a subject matter in a natural circumstance (Cohen, Manion, & Morrison, 2007). Furthermore, Berg (2007) adds that interview allows interviewees to speak in their own voice and convey their own opinions and perceptions (Berg, 2007). It involves two-way communication. There are four different types of interview that can be adopted by qualitative researchers in collecting data (Hamza, 2014). They are structured (close-ended) interview, unstructured (open-ended) interview, semi-structured interview and focus group interview. In this research, the researcher collected the data through a semi-structured interview with Eco World Development Sdn Bhd, a property development company located in Penang, Malaysia.

Secondary data is the data collected from secondary sources. It refers to the data that has been collected by previous researchers and presented in the form of words or pictures, and is used by the current researchers to do their research. This kind of data can be easily found from the websites, books and other related materials. One of the advantages of utilizing secondary data is time and cost saving (Blessinger, 2015). Literature review is an example of making use of secondary data. In this research, the researcher had studied several journal articles related to the research topic and then made some reviews on it.

Data analysis method

There are two methods can be used to analyse data. One is through coding analysis and another is through content analysis. In this research, the researcher adopted coding analysis to analyse the data collected from the interview. Coding analysis consists of two distinct stages. The first stage is to produce significant data units, and the second stage is to categorize and arrange these units. This two-stage process will eventually cut down the amount of data collected (Hamza, 2014).

FINDINGS

Green building materials

Materials used for water and cable work installations

Eco World Development Sdn Bhd uses polyvinyl chloride (PVC) materials for water installations like piping and also for cable work and related installations. PVC is not an environmentally-friendly material. Usually they are thrown into the landfills after use and they will release chemicals which are harmful to the environment. However, PVC materials are often preferred due to its low cost and durability compared to the materials made from metals which are more costly and easier to corrode when exposed to air and water (Greener Ideal, 2013).

Flooring materials

Eco World Development Sdn Bhd normally uses ceramic or porcelain tiles as the flooring material. Sometimes, laminated timber flooring is used instead of ceramic or porcelain tile flooring. Ceramic or porcelain is an environmentally-friendly flooring material because it is natural and can be found locally. Laminated timber flooring is also an eco-friendly material as it eliminates the need for harvesting natural timber resources (Schneider, 2013).

Insulation materials

The insulation material employed by Eco World Development Sdn Bhd for the buildings is the creeper plants. These plants can help to reduce heat effect on the buildings by serving as a screen to minimize direct sunlight penetrating through the walls (Barber, 2014).

Materials used for interior wall construction

Eco World Development Sdn Bhd builds the interior walls of their buildings with bricks or reinforced concrete (RC). Bricks are the most sustainable green building material as they are mainly made from natural ingredients such as clay and shale. Brick is one of the few construction materials that can be left natural and still remain attractive after eras of wear and tear (Gibson, 2010). Concrete is traditionally made from a mixture of cement, coarse aggregates like gravel, finer particle aggregates like sand, and water. It is not an environmentally friendly material. This is because in order to produce this material, a great deal of energy and natural resources is required to gain the raw materials like cement. Furthermore, cement production releases extremely huge amount of carbon dioxide emissions into the atmosphere which contribute to global warming (Murray-White, 2015).

Recycled materials

There are only a few choices of recycled construction materials found in the market (Zalina & Veronica, 2013) and the area at which the materials are applied is limited. Therefore, instead of using the products which are made from the recycled materials, reusing the materials is more practical to perform in the construction industry to achieve sustainability. For example, the formwork is used repetitively at the construction site.

Sustainable building design

Cross ventilation

Cross ventilation is a type of passive cooling strategy using the moving air or wind to cool the buildings. Window openings are maximized for cross ventilation to happen in a building. The windows have to be opened and be built facing different directions in order for the moving air to travel in and out of the building (Designing Buildings, 2015). Before designing the windows, it is essential for developers to find out the orientation of a building. Windows should be avoided from facing both the East and West directions to prevent sunlight from directly irradiating into the building.

Solar shading

Eco World Development Sdn Bhd has made the windows of the buildings tinted so that the sunlight can be screened out to a lower level before entering the buildings. This indirectly reduces heat from the sunlight that goes into the buildings (Glenside Glass, 2010). Apart from being tinted, the windows are made from the glass which is able to reduce the amount of heat penetrating through it. External shading equipment such as coping and eave is also utilized.

Benefits of employing green materials and sustainable design

According to Whole Building Design Guide (WBDG), one of the major benefits is minimizing harm to the environment (WBDG Sustainable Committee, 2014). Besides, indoor environmental quality of a building is improved significantly (Allen et al., 2015). Furthermore, by employing green materials and sustainable design, human health is enhanced. Apart from that, utilizing green materials considerably reduces costs such as processing cost, transportation cost and maintenance cost. Another utmost benefit gained from utilization of green materials and sustainable design is energy saving. In addition, the adoption of green materials can enhance the aesthetics of a building. Last but not least, buildings that are built with green materials and sustainable design tend to be more sustainable than the conventional buildings.

CONCLUSION

In conclusion, materials and design are the two dominant components in practising green building. Green building is the key to achieve sustainable development without causing any adverse effects to the environment and people. It is essential for developers to exercise green building practice in the industry as it produces buildings with higher sustainability, eliminates unfavourable impacts on the environment, and optimizes well-being of the occupants.

This study shows a variety of materials and design employed in green building based on the case of the property development company, Eco World Development Sdn Bhd. The company is currently using some non-eco-friendly materials like polyvinyl chloride (PVC) and concrete in the buildings. It is crucial for the company to search for other eco-friendly materials to replace those harmful materials in order to achieve a comprehensive, sustainable green building. Manufacturers are also encouraged to produce more different types of construction materials that are made from the recycled contents to optimize the utilization of recycled materials in the industry.

In future studies, more companies should be interviewed in order to acquire a more comprehensive result. Besides, it is recommended that future studies incorporate all the aspects of green building, which are listed in Green Building Index (GBI), in their research work. Nonetheless, the significance of this study is not affected, as the limitations do not weaken it, but barely provide the opportunity for further studies.

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