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Energy efficiency in green building

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Abstract
Energy efficiency is the key to achieve sustainability in green building. Lowering the energy consumption in construction is starting to become a significant improvement chance for many organizations. This research will identify the benefits of energy efficiency, explore the methods to apply efficient energy usage in green building, and explore the obstacles in attaining energy efficiency in green building. Even though green buildings use a lesser amount of energy compare with usual building, energy efficiency still hard to achieve, due to some barriers to put into practice energy efficiency. This study will interview a property development company in Malaysia. After analysis, energy efficiency contributed two main benefits in the company such as reduced greenhouse gases emission and lower the air pollution problem, and energy saving. The company implemented electrical feeding and sensor system in lighting system, passive design, and cross ventilation to achieve energy efficiency in their development projects. However, cost barrier, information barrier, and outdoor condition and climate barrier are the obstacles in attaining energy efficiency practices. Due to the time constrain, this research only able to interview one company. With the aim of getting more accurate result, should be interview more companies in the future research because of the energy efficiency cover a wide area in the construction field.

Keywords: Energy efficiency, green building, sustainable building, Green Building Index (GBI)

Introduction

Energy efficiency is the key to achieve sustainability in green building. Lowering the energy consumption in construction is starting to become a significant improvement chance for many organizations. According to International Energy Agency (IEA) (2015) [14], energy efficiency refers to the lesser energy usage to provide the same quality of service. Green building is known as sustainable building (Hwang & Tan, 2012) [12]; (Samari, Godrati, Esmaeilifar, Olfat, & Mohd Shafiei, 2013) or "high performance" building (Howe, 2010) [10]. Sustainable building is put into practice all over the whole phases of building, from preconstruction to removal of the construction, lower the dangerous or toxic effect on the environment of building (Hwang & Tan, 2012) [12], is similar with green building is the development of constructing and building structures, and utilizing procedure that are environmental and resource efficient in a construction's activities (Kamarudin, Mohd Fazli, Md Nor Hayati, Ismi, & Norhana, 2011) [13]. In general, green building intended to decrease the environment impacts of the construction activities and it is sustainable. Energy efficiency bring a number of benefits to society, is a key and important point to attain sustainability in green buildings and organizations.

Furthermore, energy efficiency assists to manage of increasing energy costs, reduce environmental impacts such as lower the greenhouse gas emission, and added the value and to enhance competitiveness of green buildings. By using energy efficiency, it is effortless to show the buildings or construction are really green (Howe, 2010) [10]. In this research will explore the methods to apply energy efficiency to achieve sustainability in green building.

Problem Statement

In this twenty-first century, environmental issues are getting serious such as climate change, pollution, and waste problem. Climate change is causing by greenhouse gases (GHGs) emissions that from construction activities such as utilize of fossil fuels and non-renewable energy (Hwang & Tan, 2012) [12]. As construction activities are the major cause of greenhouse gas emission that influence climate changes, applied energy efficiency can lower the impact of GHGs emission. People are less aware about green building, due to lack of information and understanding in sustainability of green building (Zalina & Soebarto, 2013) [30], energy efficiency is one of the criteria in green building and thus this research study will

explore the benefits of energy efficiency in green building. Even though green buildings use a lesser amount of energy compare with usual building, energy efficiency still hard to achieve (Howe, 2010) [10], due to some barriers to put into practice in energy efficiency.

Research Objective

1. The main objectives of this research are listed as below:
2. To identify the benefits of energy efficiency in green building to obtain sustainability.
3. To explore the methods to apply efficient energy usage in green building to accomplish sustainability.
4. To explore the obstacles in attaining energy efficiency in green building.

Literature Review

Energy Efficiency

Energy efficiency is a benchmark of energy utilized for providing a service. By enhancing energy efficiency, public will receive and save more energy from that used energy (Department of Energy and Climate Change, 2012) [4]. Energy efficiency used smaller amount of energy to achieve or produce more works or activities. Moreover, production with energy efficiency have to be seen as a speedy and low-cost source of new energy provide as the cost of supplying energy can be reduced a number of cost (Oyedepo, 2012) [23]. According Murer, Alonso-Herranz, de Waal, Spliethoff1, van Berlo3, and Gohlke (2013) [17], energy efficiency is the essential to achieve sustainability in society. Energy efficiency also take a role to strengten in practices and thus can reduce the energy use to supply more services such as lighting, heating, ventilation, and air conditioning (HVAC) and so on (Weber, 2011); (Oyedepo, 2012) [23]. Energy efficiency is generally acknowledged as a tool to attain reducing in greenhouse gas (GHG) emissions (Zimmerman, 2012) [32].

Benefits of Energy Efficiency

According to Department of Energy and Climate Change (2012) [4], stated the benefits of energy efficiency consist of help in economic development, investment in energy efficiency technology can decrease the cost of innovation, reduce the gas emission, and create a sustainable energy system. Economic studies demonstrate that enhanced energy efficiency can increase the productivity and trim down the inflation problems. Energy efficiency also helps to build a sustainable energy system, throughout decreasing energy consumption (Department of Energy and Climate Change, 2012) [4], and reducing carbon emission has guided to aconcentrate on energy efficiency of buildings (Organ, Proverbs, & Squires, 2013) [22]. The constructed environment details for 30-40% of global energy consumption and connected greenhouse gas (GHG) emissions, presenting the most potential of any field for energy savings and prevention of GHG emissions and at great benefit-cost ratios (Dunphy, Morrissey, & Mac Sweeney, 2013) [5].

Methods to apply Energy Efficiency

Energy efficiency policy is one of the methods to apply and boost energy efficiency. For example, energy efficiency in the United State has performed a wide range of policies to promote energy efficiency, which were initially publicized during the energy crises of the 1970s. Additionally, the energy efficiency policy in Nigeria is also can be concerned, the countrywide energy policy and the outline of energy master plan include fundamental policies and approaches for energy efficiency and conservation. The energy efficiency policy in Nigeria consists of a few terms provides for the following: The encouragement of energy efficiency and conservation in manufacturing, industrial, housing, and transport sectors, creating a program on manufacturing or industrial energy efficiency and conservation in cooperation with Manufacturers Association of Nigeria (MAN) and professionals in higher institutions and research centres, Introduction of fuel efficiency classifying programme in the transportation sector for different types of vehicle, set up codes and measures for energy efficiency and conservation technologies, and implementing the codes and measures (Oyedepo, 2012) [23]. According to Milner *et al*. (2015), decreasing uncontrolled ventilation of residences will also help to enhance energy efficiency and can defend against the entrance of pollutants from the outdoor environment.

Barriers of to Attain Energy Efficiency

Barriers that hinder employing industrial end-use energy efficiency are stated in the following three main categories which are economic and financial, regulatory, and informational (United States Department of Energy, 2015). Moreover, according to Department of Energy and Climate Change (2012) [4], consists of four barriers to deploy energy efficiency which are embryonic markets means undeveloped marketplace, lack of information, misaligned financial incentives in enhancing energy efficiency and underestimating energy efficiency. It is quite similar with the United States Department of Energy stated as above. Greenough and Tosoratti (2014) [8] stated investment of energy efficiency in new develop building or present buildings in the preparing and industrial engineering sector; build up a taxonomy of the barrier to energy efficiency commercial buildings is the gap between the chance for cost effective in investment of energy efficiency and the stages of investment in performance.

Green Building

Green building is also the basis of the sustainable construction development (Samari, Godrati, Esmaeilifar, Olfat, & Mohd Shafiei, 2013), sustainable development has brought out to be a global issue since global climate changes have increasingly turn into a serious concern in the future (Hwang, Zhao, & Tan, 2015) [11]. The main objective of green building is to construct a healthy built environment based on efficient apply of resources. Previous research defined that green buildings can decrease energy and material usage and enhance occupant health and performance (Singh, Syal, Grady, & Korkmaz, 2010). In summary, the concern of sustainability in the environment of construction development includes: efficient resource distribution; reduction of energy consumption; reduction of embodied energy; promote activities reuse and recycling; and others method in short term and long term the natural resources are continued. The action of sustainability had carried with it require for a mechanical frame-capable to evaluate and supervise the environmental performance of constructions or buildings in construction progress itself (Ofori-Boadu, Owusu-Manu, Edwards, & Holt, 2012) [21].

Green Building Index in Malaysia

In Malaysia, the forming of green rating tool or green rating system started in 2009 while the Malaysian Institute of Architects (PAM) collaborate with Association of Consulting Engineers Malaysia (ACEM) have developed Green Building Index (GBI) to enhance the awareness and creating sustainable and green architecture or green building (Abdullah, Jumadi, Sabu, Arshad, & Mohd Fawzy, 2015). According to Green Building Index (2013), it consists of six categories which are energy efficiency (EE), indoor environmental quality (IEQ), sustainable site planning and management (SM), materials and resources (MR), water efficiency (WE), and innovation (IN). The main purpose of GBI is to encourage sustainability built environment and take all the people that involve in the construction industry towards the environmental issues (Fauzi & Malek, 2013), to save energy, resources, recycle materials and adapt buildings to the Malaysia climate, culture and environment (Rahardjati & Khamidi, 2011) and increase awareness among the person who in the construction field and hence will occur environmental friendly in Malaysia (Habibullah, Abdullah Halim, & Abdullah Halim, 2012). The marks for the certification will be given for performance based on the six categories above. The certification will be maintained if the building is reassessed for every three years. The ranking result of GBI is also divided into Platinum, Gold, Silver and Certified which shown in Table 2.2 (Fauzi & Malek, 2013; Wu, Shen, Yu, & Zhang, 2015).

Research Methodology

Qualitative method

Qualitative method was conducted in this research for the purpose of this study. Eco World Development Sdn. Bhd. as a property development company is chosen to interview in this research. Qualitative method is the most appropriate method for this research because it is more narrative the real about the situation in the company which will be researched and interviewed and the time constraints for this research. Qualitative data are analysed for what the data explain about personal's experiences, opinions, and meanings such as they ought not to be made to match to the pre-existing philosophies (Koch, Niesz, & McCarthy, 2014) [15]. There are two types of data such as primary and secondary data and were be used in this research. Primary data for this research were obtained from an interview with an executive from Eco World Development Sdn. Bhd. and observation method also occurred since it usually will be associated with interview together. In this research, secondary data was obtained through literature review, the references from books and electronic media such as websites of internet, articles, journals conference papers, and reports which related to the research.

Data Collection Methods

Data collection in this research was obtained by interview and observation, a property development company which is Eco World Development Sdn. Bhd. was chosen in this research. Interview is a key of qualitative data gathering method which is commonly applied in performing field studies (Qu & Dumay, 2011). In-depth interview is also known as semi- structured interview. Semi-conducted interview can present trustworthy and comparable qualitative data (Newton, 2010) [18]. Semi-conducted interview was selected to collect data in this research because it is useful information from executive in the company, which is Eco World Development Sdn. Bhd in Penang, Malaysia to explore about the practices of energy efficiency and green building applied by their company in development project. The researcher had prepared a set of questions as an interview guide to achieve the research objectives. Observation takes place when researcher gathers the first hand data or information from the process of the interview in this research. The observation data was recorded in stenograph and audio form.

Data Analysis Method

According to Koch, Niesz, & McCarthy (2014) [15], data analysis with inductively is important feature of qualitative research. Collecting and analyzing data are completed in continuous iteration, through analysis conducting more data gathering (Arendt, *et al*., 2012; Koch, Niesz, & McCarthy, 2014) [15]. Interview's reactions, personal experiences and life stories must be recorded in depth because it is an essential data in data analysis process (Carter & Little, 2007). The primary data is the answers given by the interviewee from the company. In addition, secondary data was obtained from literature review from books and electronic media. The researcher will analyze the collected data and make the finding for the company to achieve the company sustainability.

Findings

Benefits of Energy Efficiency in Property Development Company

According to the interviewee, energy efficiency contributed benefits in the company such as reduced greenhouse gases emission and lower the air pollution problem, and energy saving. The property development company using GBI rating system for comply the requirements of energy efficiency in their development project. the best methods to advance energy efficiency are through the activities of reducing GHGs and air pollutants emissions, it can also offer a co-benefit for solve the problem of climate change and air quality increased (Zhang, Worrel, & Crijns-Graus, 2015; Ruparathna, Hewage, & Sadiq, 2015) [26]. Eco World Development Sdn. Bhd used cross ventilation and passive design such as the orientation of windows to prevent the indoor temperature is too high, thus the usage of air conditioner will be reduced, to reduce problem of GHGs emission. Hence, the problem of air pollution and climate changes that caused by human can be reduced in the same time, reduce the total amount of GHGs in the atmosphere is an essential step to decreasing the impact of climate change. Furthermore, by utilized energy efficiency can help to increase energy saving. The property development company used energy management system to achieve energy efficiency in their development projects. The company has a standard to manage and control the usage of energy, it assist them to ensure the waste of energy and energy consumption. The increasing of energy efficiency will gain the energy saving from the investment in efficient technologies. The company used electrical feeding, sensor system and passive design to implement energy saving in their development projects.

Method to Apply Efficient Energy Usage in Property Development Company

In the property development company, they used electrical feeding that is save energy such as using light-emitting

diode (LED) light bulb and sensor system, passive design, and cross ventilation to achieve energy efficiency. In addition, although use the renewable energy like solar energy is another good way to attain energy efficiency, the company does not use solar energy due to the high installation cost of solar energy device.

LED Light Bulb

The company used LED light bulb in lighting system which can save energy and less energy consumption that can achieve energy efficiency effectively in all their development projects. LED light bulb is a lighting system that most energy efficient and growth rapidly nowadays, it can advance energy performance (Ruparathna, Hewage, & Sadiq, 2015) [26]. Furthermore, convert conventional incandescent bulb to LED light bulb is a good practice of energy saving and efficiency in the company. This is because of LED light bulb use less energy to produce light, and the durable is longer than conventional incandescent bulb, whereas a conventional incandescent bulb use a number of energy to produce light and the durable is shorter than LED light bulb (Earth Easy, 2014). When the LED light bulb prevent heat production, the company no need to use external energy like the use of air conditioner to reduce the internal temperature, it will save energy to comply energy efficiency.

Sensor System in Lighting System

In the property development company, they are also using sensor system to trigger the operation, because of not every location have to operate 24 hours such as the lighting of the bulb. Lighting takes around 1/3 of electricity used in buildings and it is a biggest area that can present to enhance energy efficiency and decrease energy used (Soori & Vishwas, 2013). Sensor system in light system also known as automated lighting system. Sensor system used motion or movement detection and sensitive to operate and normally placed on the ceiling. According to the interviewee, the company install sensor system or automated lighting system to avoid the unnecessary or waste of usage of lighting system in their development projects to increase energy saving and achieve energy efficiency, and this action can comply with the requirement of GBI.

Passive Design

Passive design is also a way of reduce energy consumption and increase energy saving to comply with energy efficiency (Ng & Akasah, 2011). Passive design included orientation, placement of windows, shading, size and shape, planning and design, and construction features. The property development company apply orientation of windows and roofs, orientation of the building, and shading in their development projects. According to the interviewee, passive design such as orientation of windows can help to create daylight and natural ventilation or cross ventilation. Thus, they can reduce the use of external energy such as artificial lighting like light bulb and air conditioner to reduce the indoor temperature. the company planned the orientation of windows appropriately to get sufficiency daylight that can reduce the use of electric lighting such as artificial lighting. Moreover, to prevent the high indoor temperature, the windows are tinted, to screen out the sunlight enter the building, the glass itself which can reduce heat and only 70 to 80% sunlight. The company also concerned in the orientation of building to prevent the heating and cooling system. According to interviewee, they avoid the wall facing of east and west; design the wall facing of north and south, so the heat will be reduced.

Cross Ventilation

Ventilation also is a good method to reduce the temperature of building due to it produces more air flow in a space or building. The property development company apply cross ventilation in their development projects. They used the windows' orientation and windows opening to apply natural ventilation and cross-ventilation. The main feature of cross ventilation in building is consist big openings to occur interaction between wind flow from outside flow into building and indoor air flow inside the building (Tominaga & Blocken, 2015). The air flow in the building is free and non-restrict through cross ventilation. According to the interviewee, by using natural ventilation and cross-ventilation, the different of temperature will not be so high, and they no need to use external energy such as air conditioner to reduce the internal temperature, it will save energy and reduce GHGs emission to comply with energy efficiency.

Solar Energy

Solar energy is convert energy from the Sun which is sunlight into usable electricity by solar panel. Solar energy is the largely capable backup energy as it has many benefits over than other non-renewable energy resources (Mekhilef, *et al*., 2012). The most familiar source in solar energy is utilization of solar photovoltaic (PV) panels. Solar PV panels used a PV cell which consist a semiconductor material to absorb sunlight and convert it into usable electricity. In general, installation of solar PV panel is placed at rooftop of a building to harness energy like sunlight from solar radiation during daytime all the year in Malaysia (Woo, Mohd Razali, Almsafir, & Hamid, 2015). The company does not install the solar PV panel due to the high cost installation of its device's manufacture cost is expensive. Solar energy is priceless even though there have a cost to install the panels, solar energy still have a number of advantages such as it can reduce the bill of electricity, does not cause pollution and does not give negative impact to environment and it is infinite.

Barriers in Attaining Energy Efficiency in Property Development Company

There are three main barriers in attaining energy efficiency in the development company which are cost barrier, information barrier, and outdoor condition and climate barrier. Cost is one of the significant barriers to attain energy efficiency in buildings. To achieve high energy efficiency, the most effective way is installing solar photovoltaic (PV) panels for the use of solar energy. However, the installation cost of solar panel is very high as the device itself costs a lot of money. This is because the production cost of crystalline silicon, which is the main component of most solar PV panels, is quite high. Apart from the cost barrier, in the industry, there is also lack of information and expertise on energy efficiency, making it even more difficult for the company to achieve energy efficiency in their buildings. In addition, the performance of energy efficiency is highly dependent on outdoor conditions or the climate. This has caused energy efficiency becomes

unstable to attain. In addition, the performance of energy efficiency is highly dependent on outdoor conditions or the climate. This has caused energy efficiency becomes unstable to attain. For instance, where there is not moving air, cross ventilation cannot occur. Thus, the company has to use external energy from the mechanical ventilation devices like air conditioner or heater are used to cool or warm the buildings.

Conclusion

In conclusion, energy efficiency is a key and important point to attain sustainability in green buildings and organization, it contribute a number of benefits to society. Green building aimed to reduce the negative environment impacts of the construction activities and it is sustainable.

The objectives of this study are to identify the benefits of energy efficiency and to explore the methods and obstacles in attaining energy efficiency in green building. After analysis, the findings of this study showed that there are two benefits of energy efficiency in Eco World Development Sdn. Bhd which are reduce the GHGs emission and air pollution, and energy saving in their development projects. Furthermore, the findings also showed the company is implementing four methods to achieve energy efficiency. These four methods are using high energy efficient electrical feedings in lighting system which are LED light bulb and sensor system, passive design, and cross ventilation.

However, the obstacles for implementation of energy efficiency practices should be minimized and enhance the effective of energy efficiency practices to attaining sustainability to the company. For instance, the high installation of solar energy panel like solar photovoltaic (PV) panels, the Government's Feed-in Tariff (FiT) scheme will also give a great help to the company. The FiT scheme is to support the production of green energy, according to the organizations and house owners can generate renewable energy for the national grid from solar, biogas, biomass and hydro energy and get discounted prices for it (Tan, 2014). This will make the company become more affordable to install solar panels.

Due to the time constrain, the research only able to interview one company. With the aim of getting more accurate result, should be interview more companies in the future researches because of the energy efficiency cover a wide area in the construction field. Besides, future researches also can focus on all the criteria in the GBI to gain more accurate result in their research works. Nevertheless, the key of study still remain, for the limitation of research do not affect from them, but it is provide a good starting point for further researcher.

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