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The Benefit of Climate Neutral Principles Design in Malaysian's Construction Industry

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ABSTRACT

Climate neutral principles have been widely practiced in European countries. The climate neutral principles focuson selection of materials, and energy use. This paper aims to highlight the benefit of design principle application in achieving climate neutral design in construction industry. The paper review the climateneutral design approaches that has been applied in established construction projects. This research proven that the climate neutral design principle which relates to material selections and energy usage is beneficial to the end-users, community, surrounding and economy. The climate neutral design principles should be widely practiced in the built environment in Malaysia in order to make the environment more sustainable.

KEYWORDS: Climate Neutral, Energy Use, Materials, Principle, Passive Design

INTRODUCTION

Climate change is the greatest long term challenges faced by the world[1]. Due to these challenges, United Nation hasintroduced Climate Neutral in order to enhance the balance between carbon emissions and theabsorptive capacity of the earth.

[2] defined climate neutrality as means of livingin a way which produces net zero greenhouse gas (GHG) emissions. In order to achieve this climate neutral, United Nations Environment Program (UNEP) has underlined the method of reducing GHG emission and using carbon offsets to neutralize the remaining emissions.

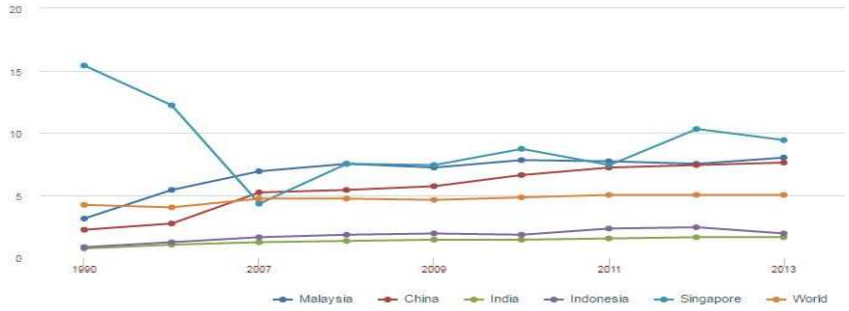

Figure 1: Carbon Emissions in Metric Tons per Capita (1990-2013)
Source: World Bank (2017)

[3] identifies that Malaysia has steadily increasing carbon emissions to the world average emission compared to other developing countries such as China, India, Indonesia and Singapore as in Figure 1. Therefore, this paper aims to identify the benefit of design principle application in achieving climate neutral specifically related to materials and energy used, so that they will be widely applied in the Malaysian's construction industry.

LITERATURE REVIEW

Climate Neutral Building (CNB)

Primary contribution of Green House Gas (GHG) emission is the results of fossil fuels that being used to generate electricity used for building's operations. [2] reported that buildings are the largest source of GHG emissions which is more that third of the energy used on the planet. Due to this, [4] found that the approach of zero carbon building has already been applied in many countries as a government strategy for addressing climate change. [5] identified that a carbon-neutral building must mitigate the carbon emissions released in the

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materials fabrication, construction and continued operations of the buildings by generating more energy than the buildings consumes over lifespan of the building through renewable energy resources. [6] definedCarbon Neutral Building (CNB) as building that significantly consumes less energy while increasing the low carbon energy sources.

Design Principles to Climate Neutral Building

In order to achieve the CNB, there were several designs principle outlined by various parties to ensure the reduction of GHG emission of the building as in Table 1.

Based on Table 1, it is found that most of the researcher and local government agreed that passive strategies and designing a high performance building envelope is the most important design principles that need to beconsidered in order to achieve towards neutralclimate building. [7] identify that passive design strategies is important due to its response to the local climate and site conditions in order to maximise user's comfort and health while at the same time minimizing energy use of the building. For example, in order to reduce energy use, the building orientation must be considered to maximise the opportunities for solar heat gain, natural ventilation and daylighting.[11] strengthened that the designer may take advantages in designing the building by takes into account the sunlight available and provides shelter from prevailing winds. This will increase the amount of sunlight receive and reduced the dependency on artificial lighting.

Table 1: Summary of Design Principles for Climate Neutral

Design Principles	Department for Communities and Local Government. (2008).	Anderson et al. (2009)	Carruthers & Casavant (2013)	Perth &Kinkross Council (2014)	Boake (2015)	Working Borough Council (2015)	Total
Technical Feasibility	X						1
Relevant carbon reductions	X						1
Selection of materials	X	X					2
Passive strategies and designing a high performance building envelope	X	X	X	X	X		5
Active strategies specifying energy efficiency (HVAC System, lighting and appliances)	X	X	X	X			3
Offsetting			X		X		2
Pollution				X			1
Water				X		X	2
Waste				X			1
Travel				X		X	2
Meet loads efficiently and effectively					X		1
Installing on site renewable energy use on site generation/renewable energy			X		X	X	3

Source: Adapted from various Authors.

Besides that, the selection of materials is one of the important design principles that need to be taken into account due to its significant impact on a buildings' carbon emission. This can be in terms of the materials' performance within the building, the embodied energy and the suitability of the materials [7]. This principle suggests the use of local materials which will reduce the travel distance needed for transportation which relates to carbon emission, and choosing materials with low carbon footprint. [8] listed the six main materials used in construction and their relations to its carbon footprint in Figure 2.

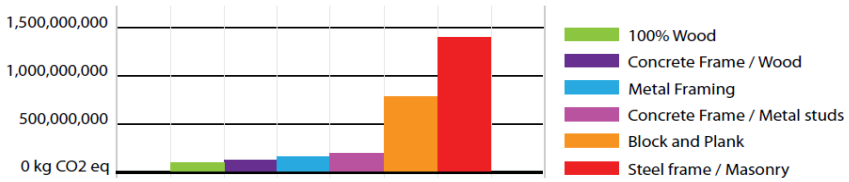

Figure 2: Carbon Footprint impact of six construction materials
Source: Anderson et al. (2009)

Other important design principle that lead to climate neutral is the use of on-site generation or renewable energy. Using renewable sources of energy will reduce the need for mechanical heating or cooling which leads to the reduction of GHG emissions by burning fossil fuels to generate electricity. [9] has outlined several

practice guide related to the use of on-site renewable energy. Firstly, the energy consumed by a development should reduce the GHG emission to a level equivalent to 80% of CO2 emission. Secondly, making the development less dependent on grid distributed energy and fossil carbon fuels. And thirdly, the energy source should be from on-site generation of sustainable energy or renewable energy. The common methods of power generation are: solar photovoltaic, wind turbines, combined heat and power (CHP), and geo-exchange.

RESEARCH METHODOLOGY

This research engaged a qualitative approach and has been divided into two stages in order to gather the related information. For the first stage, the literature review from previous studies, reports, journal and internet resources were used to understand deeply on carbon neutral and benefit of it. The second stage of this study is the case study analysis. It consists of three buildings applied the design principle in order to achieved zero carbon emission. The case studies were chosen based on functionality and its characteristics that relies on CNBs. Since, Malaysia has limited educational building that achieved CNB, two case studies from United Kingdom and United States have been selected. Both case studies have received awards on CNB[10]. The result of the case study is summarized in a table to compare the design approaches or principles applied by different CNBs.

FINDINGS AND DISCUSSION

The CNBs studied are Amanjaya Specialist Centre, The Long Studio and Durant Road Middle School. The reasons in choosing the three case studies were 1) the core function of the building and 2) the effect of CNBs towards building. The Climate Neutral criteria that has been considered for these case studies were material, energy sources and passive design as stated in Table 2.

Table 2: Summary analysis of case studies

CASE STUDIES			
Type	Medical Building	Educational Building	
Name	Amanjaya Specialist Centre	The Long Studio	Durant Road Middle School
Overview	Area: 3-storey, 100,000 sq ft. Location: Malaysia. Team comprising: SCFC Architect (Architect) – Perunding THD Sdn Bhd (M&E Engineer) – Greenscapes Sdn Bhd (GBI Facilitator) – Environmental Design Architect (Landscape Architect)–JUB Mutiara (QS)	Area: 30sq ft. Location: Norfolk, United Kingdom Team comprising: UK artist commissioned London's Threefold Architect, Jack Hosea Jack (director) Cost: £35,000 (about $60,000) to design and build.	Area: 89031 sqft. Location: Raleigh, North Carolina Team comprising: Innovative Design, Inc (architect) - Lysaght and Associates, Inc (Structural engineer) - Senior Environmental Consultants, Inc (civil engineer)- Community Land Design (Landscape architect)
	Aim : To become the first purpose-built green hospital.	Aim: to reduce waste and make it easier, quicker, cheaper and carbon neutral.	Aim: To achive overall sustainable design concept specifically on the daylighting.
Project Information	Material : Storage and collection of recyclables materials that available in the region.	Material: sheep's wool insulation, recycled paper, sustainably-harvested wood, and recycled cellulose fibers	Material: Using local brick and durable CMU block- Structure of the building using local and durable materials.
	Energy : Renewable energy- Photovoltaic (PV) – Motion and photo sensors – rainwater and water harvesting – water recycling – Green vehicle ready power supply bay – Turbine ventilator for central courtyard.	Energy: -Rainwater harvesting system -Photovoltaic cells located on the garden-facing roof. - Heated with a striking wood-powered stove.	Energy : Control of artificial lighting using photocell occupancy and lighting level sensors and control. - HVAC and lighting technologies. Ventilation system increase the fresh- air ciculation. - Using water- efficient toilets. Use mulch to improve water retention.
	Passive design : Grasscrete for landscape – Blinds and curtains for glare control – Low VOC paints – Roof insulation.	Passive design : The energy-efficient windows allow the cool ventilation. Windows and doors are double glazed with low-emissivity glass and hardwood timber frames-limiting heat loss and contributing to the building's zero-carbon status. Building Orientation- the low winter sun streams in through the glass doors to naturally warm the space.	Passive design : Overhang and interior baffles shield. - Building orientation- increase glazing for the lighting and reduce heat gain. Roof equipped with radiant barrier. - Low e-glazing for all low view glass.

From these case studies, there were several benefits that can be gained, such as reduced CO2 emission and GHG emission, controlled indoor air quality (IAQ) and increasing the use of natural lighting. The natural lighting can be controlled by installing overhang and interior baffles shield that provide shading and minimize

glare. Furthermore, a good design of building orientation plays an important role by increasing the glazing for lighting and reduce the amount of heat gain. This will lead to reduce the amount of CO2 emission and in the same time ensuring the environment free from carbon.

All the CNBs studied generate renewable energy by using PV panels. This type of renewable energy is highly profitable to the building owner. If there is excess energy produced by PV panels, it will be transferred to the national grid which is encouraged by government. Furthermore, this transferred energy will reduce the electricity bill for the buildings. In the other hand, by using water harvesting in the building, it can reduce the level of dependence on the use of the main water resource.

Different function of building, lead to different amount of CO2 produced by the building. Hospital's building was the highest amount of CO2 emission due to 1) laundry room that used a lot of heater machine, 2) amount of artificial lighting used in Operation Theater was higher, and 3) the usage of chemical material in hospital. Thus, it is crucial for designers in ensuring the design of the building, construction and operation of the building which may reduce the amount of carbon emission. The designers in Malaysia must take into account the benefits of design principle application approach which lead to climate neutral and build zero carbon building. This will help Malaysia in reducing the carbon emission produced.

CONCLUSION AND RECOMMENDATIONS

From the research, there are three main important design principles that need to be adopted by Malaysian construction industry, which consists of (1) passive design, (2) material selection and (3) the usage of renewable energy. The research also found that, one of the key towards good CNBs is from the site orientation of the building. The location site increasing the advantages of CNBs to be manipulated by the building.Furthermore, it also beneficial to the end-users, community, surrounding and economy in Malaysia To ensure the reducing of GHG emission amount, every designer in Malaysia should strength their design on designing a building that lead to CNBs. Thus, by adapting these climate neutral design principles in Malaysia's construction industry, the CO2 produced by Malaysia will be reduced and making Malaysia more sustainable and green for the future generations.

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