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The Influence of Climate Change Towards Building Performance and Building Climate

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ABSTRACT

This paper focuses on the influence of climate change towards building performance and building climate. The objectives of the paper were to identify and discuss the influences of climate change in areas that affects building performance and building climate. The results of the study revealed that the main areas that influences of building performance and building climate were energy consumption, building envelope, building materials and building design.

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INTRODUCTION

Recently, climate change is happening rapidly around the world. According to Agrafioti (2011), climate change is defined as a long-term changing in the weather statistical distribution patterns over a period of time that may range from decades to million years. The changes might be in the average weather conditions or distribution of weather events with respect to the normal average, such as more or fewer extreme weather conditions, and it is limited to a specific area and region, or being all rounder across the whole earth (Agrafioti, 2011). National Oceanic and Atmospheric Administration (NOAA) in Agrafioti (2011) stated that there are seven (7) indicators that would be expected to increase in a warming world. They are troposphere temperature, humidity, temperature over oceans, sea surface temperature, sea level, ocean heat content and temperature over land, whilst three indicators that are expected to decrease are sea ice, snow cover and glaciers (Agrafioti, 2011). Many sectors have been affected by this natural incident. Changing in climate has affect the economics of a country, such as Malaysia in general. Malaysia is facing a non-stable climate in the past few years such as the raining season which is longer than usual and happened during the non-raining season that results in series of flash flood in unexpected areas. Ecosystem of a small areas are also disturbed due to the change in climate. The obvious example that can be seen was the population of an area would increase or decrease in a short time. Other than that, obvious change in landscape can also be seen transparently throughout the world and might be increasing in a certain areas. Global warming is also an affected change that happens due to climate change around the world.

Other areas that are and would be affected due to climate change are building energy consumption, building envelope, building materials and building design. These four (4) areas will be looked into detail in this study to discuss on the impact of climate change. Therefore, the objectives of the study were to identify and discuss the climate change influences in areas that affects building climate and building performance.

2. Energy Consumption:

Zerefos, Tassas, Korsiopoulos, Founda and Kokkini (2012) investigate a case involving a contemporary building which was modelled in two different versions in Athens in order to observe the role of building form in energy consumption. The versions of the buildings are one being in original prismatic form and the other of the same form. However, the study focuses on the right angles and retain all volume and area data of the original prismatic building. The building was chosen to examine the behaviour of the building in regards to energy consumption which composed of prismatic and polygonal envelopes, that is located within the Mediterranean climates. The results of the study by Zerefos *et al.*, (2012) reveal that the prismatic formed building contains

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lower of sun gains if being compared to its orthogonal counterpart and consumes fewer and less energy annually. Hence, within the area of Athens and close surrounding countries, it is suggested to have original prismatic form of building for the purpose of energy consumption since it relates to the orientation towards the sun on obtaining lower solar gains.

An experimental study in Shanghai was carried out by Shen, Tan and Tzempelikos (2011) to monitor the energy consumption of identical buildings having three (3) types of coatings. The electricity energy consumption was recorded for a conditioned space in the building and showed reduction of electricity reached to 116kWh compared to buildings without the coatings.

A research by Sait (2012) was on the electric energy consumption for an educational building located in Rabigh City which is 150km north of Jeddah city, Saudi Arabia. The study was commenced for the purpose of the electric companies in Saudi Arabia that were facing hard times to fulfil the increasing demand of electric power. During the research, temperature and relative humidity of several places were taken within the building. These information were then being matched with the thermal images of the building to confirm the building climate condition which also be able to provide information related to temperature and humidity of the building. Based on the analysis of the study, recommendations were made to recommend method to reduce the building climate in which this method will enable to reduce in energy consumption by 35.3% and the efficiency of air conditions can be decreased up to 31% (Sait, 2012). The result from the study carries out by Sait (2012) is beneficial for the operation and maintenance staff as well as the educational organization in order to manage the electric usage and electric bills can be reduced.

All of the above studies indicates that changing in climate around the world does affects the energy consumptions of buildings. Researchers have come out with suggestions and ways to improve the building climate to provide comfortable living for the tenant of the building, as well as maintaining the economics of the countries.

3. *Building Envelope:*

Other than the building envelope above the ground, underground building envelopes do affect with the changing and increasing of climate. A study done by Zhang, Marci and Fu (2010) was on modelling the hygrothermal desorption and absorption on underground building envelopes of three types of common underground building envelopes in the region of Chengdu, China. The underground buildings were tested onto the newly envelopes hygrothermal model which can accurately predict the moisture and heat transfer of building envelopes. Zhang *et al.*, (2010) found that the result of hydrothermal desorption and absorption of underground building envelopes must be taken into consideration when moisture and heat environment were control through heating, ventilation and air-conditioning (HVAC). If these factors is taken into account, then the need of use of air-conditioning equipment can be controlled hence saving a lot of running energy (Zhang *et al.*, 2010).

Desta, Langmans and Roels (2010) ran an experiment to validate a set of heat, air and moisture transport models data of building envelopes and the results were taken over a period of two years time. The building envelopes involved were a full scale light weight building wall under real atmospheric boundary condition, which were tested on the study of heat, air and moisture (HAM) transfer in between the envelopes. Desta *et al.*, (2010) custom made the building envelopes model, and differ by the applied interior finishing. A wall humidity, temperature and heat flux sensors were placed in 3D matrix in between the layers of the building envelopes. During the experimental stage, fiberboards samples, were weigh to quantify their moisture content. The data sets generated from the experiment by Desta *et al.*, (2010) is now being used for the purpose of hygrothermal envelope model validation.

Based on these experiment and cases, change in climate does give impact onto the building envelope where they are reflected in terms of temperature, humidity as well as the heat of the buildings. Building envelopes absorbed the surrounding temperature around it thus reflect on the inner part of the buildings. Since climate change is happening robustly nowadays, it is crucial to have a good building envelope that can maintain the efficiency of the building and brings satisfaction to the building tenants.

4. *Building Material:*

Around the world in general, building construction and civil works consume 60% of the raw materials extracted from the lithosphere. Out of the whole lot, 40% represented by building, and the other 24% of global extractions (Wadel, 2009). The mineral extraction around Europe per capital intended for the building varies from 4.8 tonnes per year per inhabitant in which according the Wadel (2009), is the average weight of a person, which indicates the need to work to the direction of dematerialisation in building. Bribián, Capilla and Usón (2010) claim that great amount of raw materials are widely used in the building industry which involved high energy consumption. By choosing materials with high content in embodied energy indicates an initial high energy level consumption within the building production stage, and going along the determination of future consumption of the energy to fulfil heating, ventilation and air-conditioning demand (Bribián, 2010). The study by Bribián (2010) stated that the products that being constructed can be reduced significantly by enhancing the

use of best techniques that are eco-innovation and available in production plants, changing the use of finite natural resources to waste generated for production processes purposes, as well as to prefer the materials that are available locally. In short, raw materials do involved directly in high energy consumption (Bribián, 2010).

However, Jeanjean, Olives and Py (2013) claim that the most recent concern within worldwide on the energy and environmental issues are the ones that led to a new trend to decrease energy consumption and the release of green house gas within the construction areas. This can actually be achieved by insulation improvement and energy equipments implemented on the existing building. Within France, building energy is the largest need in energy consumer (ADEME, 2011). In order to reduce the energy consumption and green house release, the performances and properties of the building envelopes have to be improved before considering any energetic used of equipments (Jeanjean *et al.*, 2013). Then, attention should be made in the selection process of materials used in the construction work of a building. Jeanjean *et al.*, (2013) also claim that the selected materials of the constructed building also influence the comfort of the inside building user.

These shows that the importance of choosing the best material for building construction is based on the affect of climate change over the period of years. The purpose is to enhance the reliability and usage of the building in order to match with the client needs as well as the climate changes that are happening rapidly every day.

5. Building Design:

Many researchers and practitioners focused on the matter of climate change and they were focusing on the method and ways to achieve a low-carbon buildings in cities, urban areas and future developed areas (Zhu, Chew, Lv and Wu, 2011). There are studies that explored on the implementation of orthogonal experimental design (OED) method to enhance design for the least carbon emissions of operational energy consumption building. Zhu *et al.*, (2011) research focus on the basic principles of building heat transfer based on the implementation of the best design to encounter the problem of climate change. There are other building designer who had already implemented the methods to minimize the operational energy of the building such as Bambrook, Sproul and Jacob (2011) that used a simple model for designing a detached house in Sydney. The design was optimizing the use of building energy simulation to reduce the amount of heat and cold requirement within the building user. Another model to enhance the use for increasing of low-energy building design was applied by Crawford, Czerniakowski and Fuller (2011). They focused in choosing the perfect design for the purpose of maintaining or reducing the energy consumption and moreover they claimed that it was not an easy task. Knudstrup, Hanse and Brunsgaard (2009) discuss on different types of surveys and approached that were suitable to design a sustainable building and in the end they were able to show the result of their decision onto the new Danish detached house project which minimizes the use of cooling and heating.

Another study was done on the matter of implementing correct design of windows onto a building in order to control the climate of the building. Dussault, Gosselin and Galstian (2012) conducted a study on the integration and allocating smart windows into building design which was located in Quebec City, Canada. The smart windows were to reduce the yearly overall energy consumption and leak loads. The windows used composed of double pane glazing unit. Each unit was added with controllable absorbing layers onto the interior surface of the exterior glass pane hence enable full control of the solar incident heat flux entering the building through the windows. Dussault *et al.*, (2012) found that the function of the smart window does help in reducing a significantly amount of total yearly energy consumption as well as cooling peak loads.

The above studies indicate that by applying and choosing suitable design for building materials and building envelopes help to enhance the energy consumption of the building. They also help to maintain the production and function of the building without disturbing the ecosystem within or around the building.

To sum up, climate change does influence building performance and building climate. The results of this study were parallel to the studies of Selkowitz (1979) whereby the thermal resistance windows was integrated into building designs, Yao (2012) on the optimization of building design for different units in building apartment, Youned and Shdid (2012) research on the suitable 3D multiphysics method to prevent air leakage through the building envelopes and Yu, Fung, Haghighat, Yoshimo and Morofsky (2011) where climate change play an important role in influencing building energy consumption, building envelope, building material and building design. Fumo, Mago and Luck (2010) and Liu, Wu and Hu (2012) and Zhao and Magoulès (2012) studies were similar to this study in terms of building energy consumption. Granadeiro, Correia, Leal and Duarte (2013) and Kočí, Maděra and Černý (2012) studies were also focused on building envelope.

6. Conclusion:

The results of the study implicate the governments, local authorities, land developers, town planners, contractors, land owners, researchers and land and building buyers in terms of energy consumption, building envelope, building materials and building design. It is hoped that future study will focus on other factors that influence the building performance and building climate.

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