CONCEPTUAL RETROFIT DESIGN OF A GREEN BUILDING OFFICE FROM AN EXISTING BUILDING

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This report is submitted
in fulfillment of the requirement for the degree of
Bachelor of Mechanical Engineering

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DECLARATION

I declare that this project report entitled "Conceptual Retrofit Design of A Green Building Office From An Existing Building" is the result of my own work except as cited in the references.

Signature : .....

Name : LUA YONG WENG

Date : .....

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

Signature : .....

Supervisor Name : ASSOC. PROF. DR. TEE BOON TUAN

Date : .....

DEDICATION

My humble effort I dedicate to my loving father and mother for their endless love, support and encouragement along my life.

ABSTRACT

Green building is superior in carbon savings and cost savings. Green buildings use lower energy and are healthy for occupant during living or working inside as compared to a conventional building. One of the green building criteria is to achieve good indoor environmental quality. The main objective of this study is to conduct a comparative analysis on the retrofit design of sustainable green building office by determining the indoor environment condition in term of temperature, relative humidity and carbon dioxide on Centre for Languages and Human Development (PBPI) building located at the UTeM's main campus. Thermal comfort and indoor air quality analysis were conducted to evaluate the indoor environment quality of the lecture room. The analysis consists of physical measurement and subjective measurement. Physical parameter data are collected in two sessions which is from 9 am to 12 pm and from 2 pm to 5 pm with a gap of 5 second interval for 5 minutes in each zone. Physical measurements were conducted with occupancy and no occupancy condition while subjective measurement was carried out through the questionnaire. The result shows that the indoor air quality in term of carbon dioxide of the building is more than 1000 ppm during occupancy, hence it is not within the GBI Standard. The total average relative humidity was recorded 58.35% within GBI Standard (55%-70%). The average operating temperature was recorded 22.21°C less than GBI Standard (23°C - 26°C). Based on the findings, the indoor environment quality improvement retrofit design are proposed with a green building element.

ABSTRAK

Bangunan hijau lebih baik dalam penjimatan karbon dan penjimatan kos. Bangunan hijau menggunakan tenaga yang lebih rendah dan sihat untuk penghuni yang tinggal atau bekerja di dalamnya berbanding dengan bangunan konvensional. Salah satu piawai bangunan hijau adalah untuk mencapai kualiti keadaan persekitaran dalaman yang baik. Objektif utama kajian ini adalah untuk menjalankan analisis komparatif mengenai pengubahsuaian reka bentuk bangunan pejabat hijau yang mampan dengan menentukan keadaan persekitaran dalaman dari segi suhu, kelembapan dan karbon dioksida di dalam bangunan Pusat Bahasa dan Pembangunan Insan (PBPI) yang terletak di kampus Utama UTeM. Kajian keselesaan terhadap suhu dan mutu udara dalaman dijalankan untuk menilai mutu keadaan persekitaran dalaman bilik kuliah. Analisis ini terdiri daripada pengukuran fizikal dan pengukuran subjektif. Maklumat pengukuran fizikal dikumpulkan dalam dua sesi iaitu dari 9 pagi hingga 12 malam dan dari pukul 2 petang hingga 5 petang dengan jurang selang 5 saat selama 5 minit dalam setiap zon. Pengukuran fizikal dijalankan dalam dua bentuk, iaitu semasa mempunyai penghuni dan semasa tiada penghuni manakala pengukuran subjektif dijalankan melalui soal selidik. Hasilnya menunjukkan bahawa mutu udara dalaman dari segi karbon dioksida bangunan lebih tinggi daripada 1000 ppm semasa mempunyai penghuni, oleh itu ia tidak mematuhi Piawaian GBI. Jumlah kelembapan purata dicatatkan 58.35% iaitu mematuhi piawaian GBI (55% -70%). Suhu operasi purata dicatatkan 22.21°C, iaitu lebih rendah daripada Piawaian GBI (23°C - 26°C). Berdasarkan hasil kajian, mencadangkan pengubahsuai reka bentuk untuk meningkatkan keadaan persekitaran dalaman dengan mengambil kira unsur bangunan hijau.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBEREVATIONS

ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineer
BEAM Plus	Building Environment Assessment Method
BREEAM	Building Research Establishment Environmental Assessment Methods
CASBEE	Comprehensive Assessment System Built Environment Efficiency
DOSH	Department of Occupational Safety and Health
EER	Energy Efficiency Ratio
EPA	Environmental Protection Agency
GBCA	Green Building Council of Australia
GBI	Green Building Index
HVAC	Heating, Ventilation and Air Conditioning
IAQ	Indoor Air Quality
IEQ	Indoor Environmental Quality
IGBC	Indian Green Building Council Rating
IoT	Internet of Things
ISO	International Organization for Standardization
LEED	Leadership in Energy and Environmental Design
MGBC	Malaysia Green Building Confederation
MS	Malaysia Standard
NASA	National Aeronautics and Space Administration
PBPI	Pusat Bahasa dan Pembangunan Insan
PPM	Parts per million
SALL	Self-Access Language Laboratories
USGBC	United State Green Building Council
UTeM	Universiti Teknikal Malaysia Melaka
VOC	Volatile Organic Compounds
WGBC	World Green Building Council

LIST OF SYMBOLS

CO_2	-	Carbon Dioxide
°C	-	Degrees Celsius
m^2	-	Square meter
ppm	-	parts per million
%	-	Percentage
≤	-	Less than or equal to in value
≥	-	Greater than or equal to in value
V	-	Voltage
Ph	-	Phase
Hz	-	Hertz
Ft	-	Feet
W	-	Watt
kW	-	kilowatt
hr	-	Hour
BTU	-	British thermal unit
TR	-	Tones Refrigerant

CHAPTER 1

INTRODUCTION

1.1 Background of study

Public are now talking of how to make their buildings green. They want to have a place like a house or work in the building which has less harmful effect to environment and human health. That is because buildings have a significant and continuously increasing the effect to the environment through carbon dioxide (CO_2) releases. Green building criteria include efficiently using energy, water, other resources and reducing waste to environment. Besides, protecting occupant health and have a good indoor air quality (Ramachanderan, Venkiteswaran and Chuen, 2017).

The human activities such as deforestation, vast use of electricity and burning fossil fuels has made the (CO_2) increase to 409 parts per million (ppm) in year 2018. Recent researches show that global temperature has increase quickly, the year 2016 ranks as the warmest on record. In fact, the risen of global temperature will cause land ice melts, it adds freshwater to the oceans causing sea levels to rise. Besides that, global average sea level has risen nearly 178mm over the past 100 years with rate of change 3.2 ppm (NASA, 2018). The temperature rises will also increase the frequency of severe storms, droughts, floods and climatic changes.

The population of the world in year 2017 has risen to 7378 from 133 countries; representing 16.9 percent of the global population compare to year 2015 has population of 7025 from 99 countries; representing 11 percent of the global population (UN Environment, 2018). Undoubtedly, this growth in population is associated with higher demand for water,

energy and natural resources which in return will overburden the ecosystems and increasingly deteriorates the environment. Besides that, continually uses of natural resources will has ability to affect future generations.

One of the ways to minimize the global warming of the Earth is to conserve the energy uses globally. Research shows that the existing building consumes around 30 percent of the accumulated energy uses in modern countries and will produce almost 30 percent of carbon emissions due to energy use (Eurostat, 2009). As being demonstrated in previous works (Ciulla, Galatioto and Ricciu, 2016) that green retrofit of existing building can improve their energy efficiency, which is essential for the promotion of environmental sustainability (Ma *et al.*, 2012). Research shows that the green building is cheaper than conventional building by save up to 10 percent of energy consumption (Tang, 2018).

1.2 Problem Statement

Powering building can make up to 75 percent of a city's carbon pollution, yet much of that energy is wasted through drafty windows and outdated technology (NRDC, 2018). By research, the existing building have consumed 30 percent of the heap up energy uses in modern countries and may produce almost 30 percent of carbon emission due to energy use (Eurostat, 2009). One of the criteria in green building is efficient use of energy. A green building is essential to achieve an optimal energy efficiency by reducing the energy wastes impact toward academic building. Improving the energy efficiency of the existing building may reduce the carbon emission.

This project aims to conduct comparative analysis on the retrofit design of academic building in Universiti Teknikal Malaysia Melaka (UTeM) and to provide design methodology improvement of the existing building.

1.3 Objectives

The objectives of the project are:

i. To conduct a comparative analysis on the retrofit design of a sustainable Green Building Office.

ii. To conduct indoor environment in term of temperature, carbon dioxide and relative humidity measurement as baseline for green retrofit designs.

iii. To develop and propose the retrofit design with green building elements based on the current existing building.

1.4 Scope of Project

This study will focus on the academic building in Universiti Teknikal Malaysia Melaka (UTeM). The selected building consists of an air conditioning system as where the Indoor Environmental Quality (IEQ) and energy consumption will be observed. In this study, the case study building will be in building of Centre for Languages and Human Development (PBPI).

1.5 General Methodology

The methodology that will be carried out to achieve the objectives in this project are outlined below as shown in **Figure 1.1**.

1. Select the academic building in UTeM

   Choose the building that has air conditioning.

2. Study the building system and conduct literature review

   Journals, articles, or any materials regarding the project will be reviewed.

3. Measure Indoor Environmental Quality

Prepare the measurement equipment then conduct the physical measurement. The measurement will be conducted at the air conditioning area.

4. Choose proper criteria

   The data measurement will be analyzed. Solutions will be proposed based on the analysis.

5. Building improvement

   Design concept of existing building will be proposed.

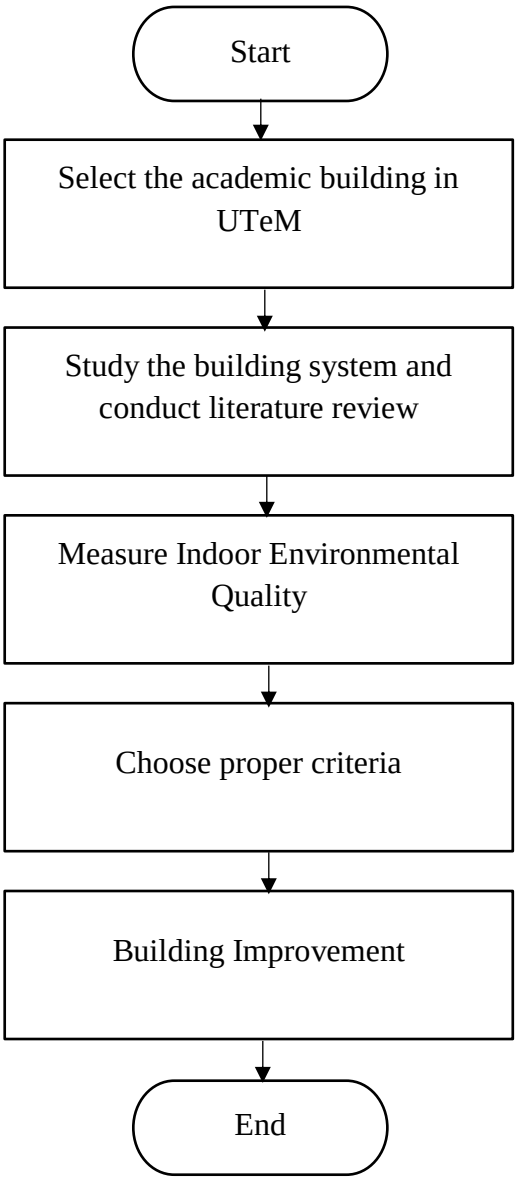

Figure 1.1: Project flow chart

1.6 The Importance of The Study

Throughout this research, the prospect of retrofitting the green building design on the current university existing building can be evaluated and determined whether it meets the required design. The measurement data on the indoor environment will also contribute to the evaluation on the current condition in term of healthy environment to the occupants. It is hoped that this study will be a benchmark study for future implementation of green building design in university buildings.

1.7 Project Outcome

At the end of this project, analysis of indoor environment and energy consumption as part of green building criteria will be done. The data measurement result of the building will be recorded. Besides that, building retrofit design based on green building criteria for existing building also will be proposed.