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A PRACTICAL APPROACH TOWARDS SUSTAINABLE RENOVATION

FARHANG ERFAN

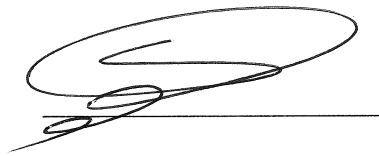
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To my beloved Mother and Father

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## ABSTRACT

Due to the negative environmental impacts of existing buildings on one hand and energy crises on the other hand, the need for sustainable renovation was felt more than before. Different countries throughout the world have launched several regulations and standards to address the need to minimize the burden of existing buildings on energy resources but the lack of awareness in different strata of the society as well as limited comprehensible numerical energy analyses of existing buildings have troubled the realization of this aim. The present research seeks to identify the importance of environmental aspects of green renovation and obstacles and barriers of its implementation in Malaysia. Apart from these, by utilizing Building Information Modeling tools the study uses a computer simulation model of an existing office building to compare different alternatives of renovation options and their effect on heating and cooling loads. For this purpose, the model was analyzed separately with different alternate building envelope components including the ones with green features. The results were then compared and the energy efficiency of different cases was tabulated. The study results show that a great deal of energy can be saved by renovating the existing buildings with special attention to green alternatives and conditions. The outcome of the energy analyses can perform as a decision-making basis for the professionals to select proper green renovation alternatives considering the amount of energy saved, their technical capabilities and limitations.

## ABSTRAK

Akibat daripada impak negatif terhadap alam sekitar daripada bangunan sedia ada dan krisis tenaga, maka keperluan untuk pengubahsuaian lestari telah diutamakan berbanding sebelumnya. Banyak negara di dunia telah melancarkan beberapa peraturan dan piawaian dalam mengutarakan keperluan untuk meminimumkan penggunaan sedia ada bagi sumber tenaga di dalam bangunan. Namun, kekurangan kesedaran dalam pelbagai lapisan masyarakat serta kekurangan analisis tenaga di dalam bangunan sedia ada secara keseluruhan telah memberi masalah dalam merealisasikan tujuan tersebut. Kajian yang dijalankan adalah untuk menentukan kepentingan pengubahsuaian lestari berdasarkan aspek alam sekitar dan halangan dalam mengimplimentasikannya di Malaysia. Kajian ini juga menggunakan model simulasi berkomputer 'Building Information Modelling' pada bangunan sedia ada untuk membandingkan beberapa pilihan terhadap kaedah pengubahsuaian dengan mengambilkira kesan terhadap bebanan kepanasan dan kesejukan. Untuk tujuan, model tersebut telah dianalisis secara berasingan dengan mengambilkira keadaan komponen bangunan yang berbeza termasuk yang mempunyai ciri hijau. Seterusnya keputusan analisis telah dibandingkan dan kecekapan tenaga dalam pelbagai kes telah dijadualkan. Hasil kajian menunjukkan bahawa penggunaan tenaga dapat dijimatkan sekiranya pengubahsuaian hijau dilaksanakan pada bangunan sedia ada. Analisa tenaga yang dihasilkan boleh digunakan oleh pihak professional yang terlibat dalam membuat keputusan untuk memilih alternatif pengubahsuaian hijau yang sesuai dengan mengambil kira jumlah tenaga yang tersimpan, dan kemampuan teknikal.



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**LIST OF ABBREVIATIONS**

<b>ACEM</b>	Association of Consulting Engineers Malaysia
<b>BCA</b>	Building Construction Authority
<b>BIM</b>	Building Information Modeling
<b>CIDB</b>	Malaysian Construction Industry Development Board
<b>CREAM</b>	Construction Research Institute of Malaysia
<b>GBI</b>	Green Building Index
<b>GBXML</b>	Green Building XML
<b>GHG</b>	Green House Gas
<b>HVAC</b>	Heating Ventilation and Air Conditioning
<b>IEA</b>	International Energy Agency
<b>IEM</b>	Institution of Engineers Malaysia
<b>IEQ</b>	Indoor Environmental Quality
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>KETHA</b>	Ministry of Energy, Green Technology and Water
<b>KPKT</b>	Ministry of Housing and Local Government
<b>LEO</b>	Low Energy Office
<b>MEWC</b>	Ministry of Energy Water and Communication
<b>NGO</b>	Non-Governmental Organization

<b>NPP</b>	National Physical Plan
<b>NREB</b>	Non-Residential Existing Building
<b>NRNC</b>	Non-Residential New Construction
<b>PAM</b>	Pertubuhan Akitek Malaysia
<b>PTM</b>	Pusat Tenaga Malaysia
<b>PWD</b>	Malaysian Public Works Department
<b>RNC</b>	Residential New Construction
<b>UHI</b>	Urban Heat Island
<b>UNEP</b>	United Nations Environment Program
<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>USGBC</b>	U.S. Green Building Council
<b>UTM</b>	Universiti Teknologi Malaysia
<b>WH</b>	Watt-hours
<b>ZEO</b>	Zero Emission Office

## CHAPTER 1

### INTRODUCTION

#### 1.1 Background of the Study

The world today is suffering from many environmental issues. The scale of environmental problems has increased from local and regional to global. Unplanned and unsustainable development, rapid industrialization, urbanization, and other technological developments especially in recent decades have contaminated air, water and soil quality and therefore have interfered with the basic needs of the society. Public awareness of environmental issues such as global warming, acid rain and ozone depletion has increased substantially over the last few years (Harris, 1999, Sonnemann, 2004).

While buildings provide countless benefits to society, they also have significant impacts on the environment especially the ones that have been constructed without any sustainability considerations. In Kuala Lumpur, Malaysia alone; 85% of whole stocks of office buildings are existing ones and only 15% are from new construction. In the life cycle of a building various natural resources are consumed including energy resources, water, land, and minerals and many kinds of pollutants are released back to the environment. These environmental inputs and outputs result in significant environmental consequences including global warming, acidification, air pollution, resource depletion, and waste disposal (Li, 2006, Harris, 1999).

Some of the facts that ought to be mentioned include the following:

- Rapidly increasing prices of the main energy carriers, natural gas and electricity, provide a strong motivation towards improving the energy performance of the housing stock.
- The building sector's energy consumption is significantly high in comparison to other sectors. In the U.S., buildings account for 39 percent of the total primary energy consumption and 70 percent of the electricity consumption (Wang, 2005a).
- Building construction is believed to consume around half of all the resources taken from nature (Assefa, 2007).
- The built environment contributes to global warming by the release of greenhouse gases into the atmosphere both directly as a result of energy and indirectly by the use of manufactured products. It is estimated that the built environment accounts for about 40 percent of world greenhouse gas emissions (Assefa, 2007, Reilly, 1997).
- In many parts of the world fresh water is an increasingly scarce resource. Buildings account for 16 percent of the water used annually worldwide (Public Technology Inc., 1996).

This trend is still going on due to the existing buildings; the aging and deteriorating housing stock increases the need for renovation and could at the same time be used for increasing the energy performance. As the demand for housing is not expected to decrease, extending the lifetime of the existing housing stock represents a far cheaper option than building new houses. In addition to these two, sustainable renovation may also help to make a beneficial environment for housing renovation.

In most developed countries the need for sustainable and green renovation has been felt in their Green Buildings Rating Systems as a tool for greening existing buildings. In Malaysia also a new GBI hand out has been launched for Non-Residential Existing Building in 26 of April 2010.

A comparative study between a renovated building considering green features and the existing situation of the building should be implemented to illustrate the amount of energy consumption reduction resulting from this renovation.

## **1.2 Problem Statement**

The renovation market has faced growing needs worldwide in the last recent years according to the change to social structures and an increasing awareness of the need for sustainability.

Many home owners suffer for years, living in houses that are hot and humid (in Malaysia, and other places perchance cold and drafty), unhealthy, uncomfortable and outdated with having high air conditioning bills and many problems at the time of selling their houses and on the other hand the old buildings stocks have disastrous impacts on the environment. In the inauguration ceremony of GBI Rating tool for Non-Residential Existing Building on 26 of April 2010, Malaysian Institute of Architects (PAM) president, Yang Berhormat Dato' Sri Peter Chin Fah Kui stated that "Some changes are imminent, such as rising energy costs, reduced energy subsidies, and increased international market expectation on building performance, and as such there is an urgent need to ensure that our construction and property development industry is future-ready when faced with these demands and challenges."

These facts show the importance of renovation of old buildings considering sustainable features according to the current green construction technology. Leafing



through literature regarding green renovation shows that few studies have been conducted to put renovation theories into practice. This study seeks to find a practical approach to green renovation to urge the homeowners in one hand and the facilitators and contractors on the other hand to consider green aspects of renovation in their practices.

### **1.3 Aim of the Research**

This research aims to propose a practical approach towards sustainable renovation in Malaysia.

### **1.4 Objectives of the Research**

The objectives of the research are as follows:

1. To identify the importance of sustainable renovation in terms of environmental issues.
2. To identify problems and obstacles of sustainable renovation in Malaysia.
3. To develop a comparative case study of thermal analysis between an outdated existing building and a renovated building.

### **1.5 Scope of the Study**

The current research covers general obstacles and problems in Malaysian green building renovation industry. Comparative case study for thermal analysis with

different envelope elements alternatives of an existing institutional office building in Johor-Malaysia will be carried out in the second phase.

## **1.6 Overview of Research Methodology**

### **Phase one**

For the first stage, the investigation started and obtained through the literature review and the data obtained from different sources including governmental statistics, books, magazines, articles, journals, websites, and other published information supporting environmental issues relevant to outdated existing buildings.

### **Phase two**

This phase consisted of preparing and collecting the data through interviews with experts to validate the findings through the previous literature review.

The data was collected from the experts such as architects, engineers, contractors, energy efficiency campaign leaders, consultants, developers, and others who have done some project related to sustainable renovation.

### **Phase three**

For the accomplishment of the third objective a proposed outdated institutional office building in UTM (B11) was analyzed thermally with different envelope design alternatives with the aid of Autodesk Ecotect Analysis software that is a comprehensive, concept-to-detail sustainable design analysis tool, providing a wide range of simulation and analysis functionality on a single platform. In order to do this a 3D geometry model of the building was developed in Revit Architecture Software often referred to as simply Revit which is a Building Information

Modelling software developed by Autodesk. It allows the user to design with both parametric 3D modelling and 2D drafting elements.

The exported Green Building XML (gbXML) model from Revit imported to Ecotect Analysis performing the thermal analysis such as heating and cooling loads calculations and passive gains breakdown. The model was analysed initially with its existing state and then with the proposed green renovated features.

The comparison between these two models in terms of consumption of energy in the heating and cooling loads criteria, illustrates the effectiveness of different envelope alternatives in a renovation.

## **1.7 Findings**

The results of this research clarify the importance of sustainable renovation, obstacles and problems related to sustainable renovation practices in Malaysia and the feasibility of green renovation in terms of energy consumption reduction benefits based on comparative study.