ENERGY LIFE CYCLE COST ANALYZING (ELCCA) IN RESIDENTIAL
BUILDING TO ENERGY EFFICIENCY APPROACH IN MALAYSIA

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ABSTRACT

The usage of residential electrical appliances for the last two decades has increased rapidly in Malaysia together with the increasing income per capita. Like other developing countries with hot and humid climates, Malaysia has been experiencing dramatic growth in the number of use of air conditioners, and the usage will be higher in the future. So, energy efficiency is one of the most important issues that be faced in Malaysia. The aim of this research is making optimal decision for energy efficiency in residential building sector through analyzing results of energy life cycle costing (ELCC) research. Energy life cycle cost analyzing (ELCCA), as a subset of LCC is a decision-making tool for building owners and designers. It provides a means of comparing the present values of two or more design alternatives. A material model is developed early in the design process using energy modeling software for the basic building design. The results shows that single materials layer (brick, concrete and hollow concrete block) with high dense insulation panel are the optimal ones in compare of others. Meanwhile, double materials with insulation panels which have the lowest energy consumption rates, are not effective. The outcomes of the study would help construction professionals specially designers to make a better decision in selecting external wall materials for energy efficiency purpose.

ABSTRAK

selama dua dekad terakhir ini, penggunaan peralatan elektrik perumahan telah meningkat di Malaysia bersaing dengan peningkatan pendapatan per kapita. Sama seperti negara-negara membangun yang lain beriklim panas dan lembap, Malaysia telah mengalami pertumbuhan dramatik dalam jumlah penggunaan hawa dingin, dan penggunaan semakin betambah di masa depan. Kecekapan tenaga merupakan salah satu isu yang paling penting yang dihadapi di Malaysia. kajian ini membantu keputusan yang optimum untuk kecekapan tenaga di sektor bangunan perumahan. Ia dilakukan melalui hasil analisis kitaran tenaga kehidupan (ELCC). Analisis tenaga analisis kos kitaran hidup (ELCCA), sebagai sebahagian daripada LCC adalah pengukur dalam membuat keputusan ke pada pemilik dan perekalentuk bangunan dan desainer. Ini menyediakan kaedah membandingkan nilai sekarang dari dua atau lebih alternatif rekabentuk. Sebuah model dibangunkan pada awal proses rekabentuk menggunakan perisian pemodelan tenaga untuk rekabentuk bangunan asas.Keputusan kajian menunjukkan bahawa tunggal bahan (batu bata, konkrit dan angka konkrit berongga) dengan panel insulasi kualiti padat adalah yang optimum dalam berbanding orang lain. Sementara itu, bahan berlatris dengan panel insulasi yang memiliki tingkat penggunaan tenaga terendah, didapati tidak berkesan. Hasil kajian ini akan membantu profesional pembinaan untuk membuat keputusan yang lebih baik dalam memilih bahan dinding luaran untuk tujuan kecekapan tenaga.

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CHAPTER 1

INTRODUCTION

1.1   Introduction

Buildings and structures enabled mankind to meet their social requirements for shelter, to meet economic needs for investment and to satisfy corporate objectives. However, the satisfaction of these needs usually comes with a high price i.e. an irreversible damage to our environment. This lead to a growing realization around the world to alter or improve our conventional way of development into a more responsible approach which can satisfy our needs for development without harming the world. The opportunity for improvement arrived when a new philosophy called 'sustainable development' was introduced in 1987 in Brundtland Report. Since that, many progressive world events had taken place to increase the awareness on environment and sustainability agendas such as Rio Earth Summit 1992, Maastricht Treaty 1992, Kyoto Conference on Global Warming 1997, Johannesburg Earth Summit 2002 and Washington Earth Observation Summit 2003 (Copenhagen, 2009).

In addition, the present era is one in which energy costs have escalated in real terms and are likely to continue to do so for the foreseeable future. According to the 1996 edition of the World Energy Outlook, oil prices are expected to rise from USD17 per barrel in year 2000 to USD25 by year 2005. Imported gas prices and liquefied natural gas (LNG) prices in the Asia-Pacific region are assumed to rise roughly in line with the oil price.

Accordingly, electricity generation is expected to increase at average annual rates of 6.5% from 1993 to 2000 and 5.3% from 2000 to 2010. Total electric power generation in the Asia region is expected to increase from 1683.9 terawatt hours (TW h) in 1993 to 2960.8 TW h in 2000 and 5542.8 TW h in 2010. These rates are much higher than the global averages, which are expected to be 2.4% and 3.1% in the respective periods. (S.C. Sekhar, 1998)

In 1970, residential buildings consumed approximately 3.5 billion kw h and commercial buildings, 4.3 billion kwh. By 1987, residential buildings in ASEAN consumed 22 billion kwh and commercial buildings, 23 billion kwh. The total annual cost of electricity for buildings in ASEAN (45 billion kwh) is about USD4 billion and because electricity consumption has grown rapidly in buildings and continues to grow, electricity costs in the sector are likely to increase markedly over time. (M.D. Levine, 1989)

There are now many ways to improve the energy efficiency of existing or new buildings, some involving the way buildings are run, others requiring capital investment in various possible retrofit measures. Many of these improvement measures involve familiar recognizable techniques such as higher efficiency plant, Building Automated Systems (BAS), and special type of glazing and walls, intelligent for life time cost. (Robathan, 1989)

Since green building initiatives are predicated on the understanding that benefits accrue over the life of the project, LCC applied to development of sustainable design is appropriate when choosing to build green. The necessity of implementing LCC analysis early in the design phase and using multi-disciplinary teams parallels the green building philosophy of front loading or designing for end use/ least cost objectives.

Since 1975, the State of Washington has required that an Energy Life-Cycle Cost Analysis (ELCCA) be performed during the design of all publicly owned or leased facilities. The intent is to help build cost-effective, efficient public facilities. The ELCCA encourages energy efficiency by evaluating the total cost of ownership of several competing design alternatives.

The ELCCA is a decision-making tool that compares the owning and operating costs for energy using systems: heating, cooling, lighting, building envelope, and domestic hot water. The analysis accounts for the initial cost of construction or renovating a facility, as well as the cost of owning and operating a facility over its useful life. These costs make up the total cost of ownership for a building. The ELCCA provides a method for the owner to evaluate different energy using system options and to select the most cost-effective ones. The completed ELCCA report recommends the alternatives that make the most economic sense while providing for the comfort, health, and the productivity of the building occupants (Energy Life-Cycle Cost Analysis Guidelines for Public Agencies in Washington State, 2005).

At last, this matter should be mentioned that certain barriers to increased green building have been addressed relating to education/training in sustainable design and construction, availability of materials, code issues, safety/liability, and financial concerns. Within the financial barriers to increased green building practice, surveys reveal major concerns with the higher initial project costs and lack of owner education toward the cost benefits of sustainable construction over the life of the project. As a result, a gap between the level of interest and voluntary (versus mandated) adoption of sustainable building practice exists.

1.2   Problem Statement

The usage of residential electrical appliances for the last two decades has increased rapidly in Malaysia together with the increasing income per capita. Like other developing countries with hot and humid climates, Malaysia has been experiencing dramatic growth in the number of use of air conditioners, and the usage will be higher in the future. (T.M.I. Mahlia, 2001)

On the other hand, as a developing country, Malaysia realized that the construction industry plays a significant role in its economic growth. Over the last 20 years, the industry has been consistently contributing between 3% - 5% of the national GDP. However, the industry is not without weaknesses. The Construction Industry Development Board Malaysia , with the main function of developing, improving and expanding the Malaysian construction industry has identified the environment and other sustainability related issues as one of the top issues of the construction industry. CIDB calls upon the researchers and construction practitioners to reassess the process of construction to develop good construction planning and management to safeguard the environment (CIDB, 2000).

For complying the movement towards sustainable construction in Malaysia, it needs to improve current building practices by implementing exact tools in design and development of projects. The increasing use of life cycle costing (LCC) in design and development of projects should lead to increase sustainable practice. A number of professionals in the building sector have emphasized the importance of LCC to prove the long term economic benefits of environmentally sound building alternatives, however little evidence exists confirming that LCC is being used to the full capability suggested (Nornes, 2005).

In addition, energy life cycle cost analyzing (ELCCA), as a subset of LCC is a decision-making tool for building owners and designers. It provides a means of

comparing the present values of two or more design alternatives. A computer model is developed early in the design process using energy modeling software for the basic building design. Various changes are made to the model that reflects design alternatives. The model calculates the energy costs for each alternative. For each alternative, first costs and maintenance costs are calculated, and along with the energy costs, is input to the ELCCA spreadsheet. As alternatives are adopted, the model is refined. A cost-effective design may consist of many decisions based on this process (general administration state of washington, 2010).

1.3   Aim of the Research

The aim of this research is making optimal decision for energy efficiency in residential building sector through analyzing results of energy life cycle costing (ELCC) research.

1.4   Objectives of the Research

The objectives of this research are:

i.   To specify the alternative building components for fifty years life external walls and analyze relevant costs and thermal properties.

ii.   To calculate resource consumption of the case study based on each panel by modeling and simulation using Autodesk Ecotect®.

iii.   To calculate and analyze ELCC relevant to each alternative.

1.5   Scope of the Research

The scope of the study focuses on a residential building in Malaysia. Furthermore, the study was done on a case study which is single story typical house located in sri pulai neighbour in Skudai, Johor. It also focuses on external walls as a one of the most important elements in buildings that involve in energy wastage. There are three main materials were considered in this study which are brick, concrete and hollow concrete block.

1.6   Brief Methodology

This part covers topics of methodology used in this research. The research method describe the different steps required achieve the goal of making optimal decision in residential building sector through analyzing results of energy life cycle cost (ELCC).

Phase one

For the first part, twenty four alternative wall panels were selected by searching and also were reviewed to be match with construction details in Malaysia. Then, thermal properties were analyzed for each panel. Furthermore, all costs relevant to study which

are initial, maintenance and replacement cost were calculated by using rate schedule book (JKR). At the end of this phase the first objective was completed.

Phase two

For complying this part, at first the case study building was modeled and simulated by Autodesk Ecotect software. Then, thermal data had been analyzed in first part was put in software. And also the new file about weather location relevant to Johor Bahro was created. At last by using these data, resource consumption for full air-conditioning based on each alternative panel was calculated. By finishing this part the second objective was achieved.

Phase three

At the last part, the energy life cycle cost (ELCC) for each wall panel was calculated by using data information which was output from two previous phases. Then, by analyzing and comparing the results, the optimum alternative was selected. By finishing this phase, the methodology applied should helps to achieve all objectives of the study.

Phase one

SPECIFYING ALTERNATIVES

Analyze the Thermal Properties

Find and select the Alternative panels and review them to match in Malaysian Construction

Find out Initial, maintenance and replacement costs relevant to each panel

Phase two

CALCULATION OF RESOURCE CONSUMPTION

Modeling and simulation of the case study based on Autodesk Ecotect

Calculation of resource consumption

In putting data relevant to panels and location weather to software

Phase three

ELCC ANALYZING

ELCC calculation for each panel
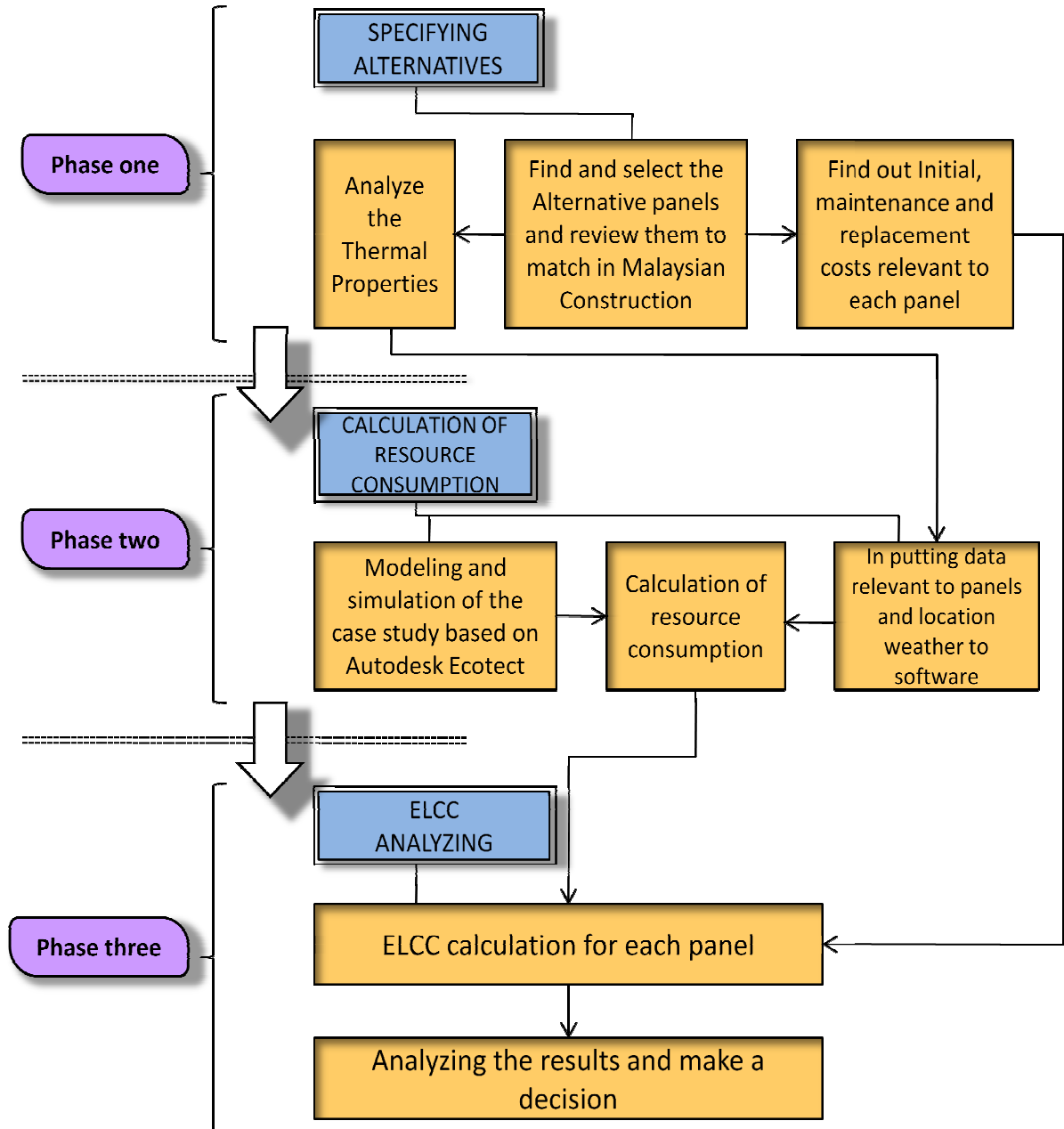
Analyzing the results and make a decision

Figure 1.1 Research methodology flew chart

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