

ENVIRONMENTALLY-SUSTAINABLE AFFORDABLE DESIGN ELEMENTS  
IN HOUSING: (A case study on middle-income people in the context of Malaysia)

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*Dedicated to,  
Loving memory of my mother,  
Brothers and sisters,  
The honorable spirit of my father,  
Friends and all beloved and important persons in my life,  
For all your love and encouragement,  
You are my inspiration...*

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## ABSTRACT

Hot humid tropical conditions in Malaysia create high temperature and humidity as well as low air flow which affect human comfort especially in residential buildings. Recently, the Malaysian government focused on delivering more number of affordable public and private housing units to the middle-income population. With the global awareness on sustainability, the purpose of this study was to investigate whether environmentally-sustainable design elements in housing design can be integrated within the affordable range of this target group. The research followed the basic three methodological steps namely data collection, data analysis and data interpretation. Secondary data was collected from literature in order to identify all possible sustainable design elements related to the context including both passive and active elements. Seventeen passive and two active elements were identified. After that, they were put together and were divided into two different categories. The first category included those which were within the designers' control and were expected to be integrated within the design process with affordability entrusted with the designers. The second category included those which remain to be within this targeted owners' decision to choose from, depending on their affordability. From analysis, fifteen passive elements were drawn into the first category, and two passive and two active elements were included in the second category. Afterwards, a market study which included interviews with contractors and manufacturers, were conducted in order to determine the market price of each of these elements. A five-point Likert-scale questionnaire survey was conducted through conditional sampling (sample size: twenty) in order to test opinions of the target group on these four elements regarding affordability. It was found that only one of them namely solar water heating system was within their affordable range. Totally, sixteen elements were found to be affordable by this target group. Qualitative interpretation was drawn with the help of open ended interviews with selected owners in order to find out the reasons. Finally, some recommendations were made which could help improve the environmental sustainability of the affordable housing targeted to middle income people in Malaysia.

## ABSTRAK

Keadaan iklim tropika di Malaysia yang panas lembap mewujudkan/menghasilkan suhu tinggi dan kelembapan serta aliran udara rendah yang mempengaruhi tahap keselesaan manusia terutamanya dalam bangunan kediaman. Terkini, kerajaan Malaysia telah memberi tumpuan terhadap keperluan menyediakan perumahan awam dan swasta mampu milik khususnya kepada golongan berpendapatan sederhana. Dengan kesedaran global mengenai kemampuan, kajian ini bertujuan menyiasat keupayaan elemen-elemen reka bentuk yang mampan dalam mereka bentuk sesebuah kawasan perumahan untuk kumpulan sasaran ini. Terdapat tiga tahap asas kaedah kajian iaitu pengumpulan data, menganalisis dan mentafsir data. Data sekunder telah dikumpulkan dari pelbagai kajian untuk mengenal pasti elemen-elemen reka bentuk yang mampan sama ada elemen pasif atau aktif. Tujuh belas elemen pasif dan dua elemen aktif telah dikenalpasti. Kedua-dua elemen telah digabungkan bersama serta dikategorikan kepada dua jenis kategori berbeza. Kategori pertama ialah orang yang berada di bawah pengaruh pereka bentuk yang mereka bentuk mengikut kemampuan pereka. Kategori kedua termasuk orang-orang yang tetap berada dalam keputusan untuk memilih dari, bergantung kepada kemampuan mereka ini pemilik disasarkan. Dari analisis, lima belas unsur pasif telah ditarik ke dalam kategori yang pertama, dan dua pasif dan dua elemen aktif telah dimasukkan ke dalam kategori kedua. Selepas itu, satu kajian pasaran yang termasuk temu bual dengan kontraktor dan pengeluar, telah dijalankan untuk menentukan harga pasaran kbolehpasaran setiap elemen-elemen ini. Soal selidik skala Likert lima mata telah dijalankan melalui penyampelan pensampelan bersyarat (saiz sampel: dua puluh) untuk menguji pendapat kumpulan sasaran atas empat elemen mengenai kemampuan. Ia telah mendapati bahawa hanya salah satu daripada mereka iaitu air solar sistem pemanasan adalah dalam lingkungan yang berpatutan mereka. Enam belas elemen telah ditemui untuk menjadi berpatutan oleh kumpulan sasaran ini. Tafsiran kualitatif telah disediakan dengan bantuan wawancara berakhir terbuka dengan pemilik terpilih untuk mengetahui sebab-sebab.

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# **CHAPTER 1**

## **INTRODUCTION**

In the near past, human being has been consumedly using fossil fuels to produce required objects. By that time - coincided with the industrial revolution- applying fossil fuels for technology had been defined as progress and advancement in the lifestyle. In contrast, nowadays mankind faced to some universal problems as global warming, air pollution, high carbon emissions, deforestation etc. So, reduction in energy consumption with the sustainable development is a priority for many countries. Sustainability is the minimum condition that the planet needs to continue to maintain all life and systems in the future.

### **1.1.Research Background**

The Tropics regarded as a region where the human evolved and comfort has often been taken for granted, built environments are increasingly becoming issues of public concern. In tropical climates, buildings are overheated during the day due to solar heat gain through the building envelope and solar penetration through windows (Rajapaksha, 2003). In the context of Malaysia, overheated outdoor environment of the city has contributed to a growing preference for a lower comfort temperature indoors. This in turn has put an immense pressure on the energy demand in the cities. So, it requires lowering of indoor daytime temperature below the outdoor temperature using building elements and by passive or active systems. In another

hand, currently providing affordable housing plays a significant role to attain the government objectives in terms of housing sector.

Studies have been done before in the hot humid climate indicated some environmentally sustainable design standards that can be considered in such climate as:

Natural night ventilation in summer and full-day ventilation in mild seasons were found effective (Nguyen and Reiter, 2012). Improvement of glass windows using solar film coating were able to reduce energy consumption in both lighting and cooling systems (Kwong and Ali, 2011). Building with projected balcony design that is adjacent to the window wall partially promotes overall indoor climate satisfaction through thermal, visual and acoustics comfort perceptions (Dahlan et al., 2009). High reflective coatings for the urban environment and for buildings are low cost and easily accessible and when used can substantially reduce outdoor and indoor temperatures. Zones adjacent to the courtyard with suitable openings in two sides will be able to release the heat through natural ventilation and experience better thermal condition (Sadafi et al., 2011). The use of appropriate materials and insulation has significant effects on a properly planned passive house which could be further enhanced with the use of light colors for the roof surface (Jayasinghe et al., 2003). Solar chimneys are receiving considerable attention for reducing heat gain and inducing natural cooling or heating in both commercial and residential buildings (Omar and Syed-Fadzil, 2011). Quality of materials and construction, maintenance practices and management plays an important role to ensure the sustainable public housing (Hashim et al., 2012).

It is observed that considering a range of environmental and social criteria can largely influence affordability of the areas compared to concentrating merely on financial issues. Two effective assessments are introduced that can be used internationally. COPRAS and MCDM, the latter one can help stakeholders to make more precise decisions regarding affordability, measuring quality and also sustainability of a housing location instead of focusing solely on housing cost and incomes (Mulliner et al., 2013). In general, previous research concerning affordable



housing has indicated that affordable housing in different countries has got diverse and complex concepts. Internationally, comparing the relationship between housing expenditure and household income is the most common way to measure housing affordability.

Housing affordability is aimed to ensure the housing provided is affordable by every income earner group whether low-income, middle income and high income group. The middle class is a class of people in the middle of a societal hierarchy. The middle class is the broad group of people in the contemporary society who fall socio-economically between the working class and the upper class. The common measures of what constitutes middle class vary significantly between cultures.

Due to high humidity in such climate, air movement is crucial to help perspiration to evaporate. According to previous studies there are a number of design tips that should be considered in the hot and humid climate such as:

- Windows opposite each other to allow cross-ventilation;
- Long, narrow floor-plan in sleeping zone, to maximize through ventilation in bedrooms;
- Open-plan living areas with high ceilings, to maximize air movement and reduce radiant heat to occupants.
- Choose window type for good airflow as, louvers rather than awning/hopper windows.

## **1.2. Problem Statement**

Previous studies just concentrated solely on environmentally-sustainable design standards in the hot and humid climate, they have not been considered whether such codes (environmental factors) are affordable for medium-income population to apply in their housing units or not. In addition, prior research is more

conducted based on living level of low-income population. There are only a few ones which have considered the housing for middle-income people in the context of Malaysia. In the other hand, housing affordability is frequently assessed only in terms of economic viability; other important issues such as sustainability, housing location and quality are sometimes overlooked.

Hot humid tropical conditions in Malaysia create the high temperature and low air flow which affect the comfort especially in residential buildings. In such climate, the problem emphasized by the fact that it is important to understand the solar radiation, temperature and wind profile outside buildings in order to achieve indoor thermal comfort. So the most important problems are:

1. What are the environmentally-sustainable elements for housing design in tropical hot humid climate of Malaysia?
2. Which kind of those elements are affordable for medium-income population to be applied in their housing units within the context of Malaysia?

### **1.3. Research Objective**

The aim of this research is to introduce those environmentally-sustainable design elements that are affordable for medium-income people to use in their housing units within the tropical hot and humid climate of Malaysia. Thus, the objectives of this study are as follow:

1. To find out those sustainable elements that can be applied in the design process only by architectural design.
2. To find out those sustainable elements in the design process which are

directly depended on occupants' opinion in terms of affordability.

3. To find out whether middle-income people can afford to pay for active design elements in their housing units.

#### **1.4. Research Questions**

The following questions will be addressed in this study:

**Q1.** Which kind of sustainable elements can be applied in the design process by architectural design?

**Q2.** Which kind of sustainable elements in housing design process depend on occupants' affordability?

**Q3.** Can medium-income people afford to pay for active design elements in their housing units?

#### **1.5. Significance of the Research**

Recently, the Malaysian government focuses on helping to make available more affordable public and private houses costing RM 300,000 and below in view of current house prices being beyond the reach of the middle-income population, Deputy Prime Minister Tan Sri Muhyiddin Yassin said here. He said the government had realized the problem some years back and was drawing up strategies to handle the situation in line with its "people first" concept. "House prices are too high. An individual starting work as a government employee is unable to buy an affordable house. It is well known in Malaysia the difficulty in ownership of housing especially for middle income category. Hence, findings of this study will

enable and provide the building designer with wider range of options in selecting appropriate tropical building design strategy and also achieving the balance between residents' income and rent of their housing units.

### **1.6. Scope of the research**

The scope of this study is to evaluate those environmentally-sustainable design elements which are affordable for medium-income people to use in their housing units within the hot humid climate of Malaysia. In order to achieve the objectives of the research and to answer the research questions, both “field research” and “desk research” have played major roles through the research process. Thus, the methods of collecting the required data is divided into two parts; “primary data” such as face to face interview with building specialists as well as contractors and receiving some catalogues from them regarding sustainable design elements; distribution of questionnaire among people by using “Likert Scale” and “Scoring Methods”. The second type of gathering data is “Secondary data” such as literature reviews and documentary analysis.

### **1.7. Limitation of the Study**

“Insufficient time “and “shortage of the reference” are the major constraints through this research.

### **1.8. Organization of the Research**

The report is divided into seven chapters as summarized below:

**Chapter one** introduces the main issue of this research. This chapter discusses the research background, problem statements, research objective, questions, scope and limitations of the study, significance of the research and the overall research structure.

**Chapter two** presents the literature review of building design principle in tropical hot humid climate. This chapter introduces an overview of four keywords which are Environmental Sustainable Housing, Affordable Housing, Middle-Income People in Malaysia and Hot Humid Climate. Each of them is separately enumerated in their own sections. Finally, despite of a number of studies concerning such keywords, there is not still enough study about housing with the combination of sustainability, affordability, middle-income group of people in the context of hot humid climate within Malaysia.

**Chapter three** discusses the research design and the methodology implemented in affordable housing design principle. The justification of selecting the methodology for this study is also elaborated. The investigation conducted in this research was explained, including “field research” and “desk research”. Moreover, three major steps of classical research methodology are described including; data collection, data analysis and data interpretation finally, the research process is shown through a diagram.

**Chapter four** presents all the necessary methods of gathering information, both “field research” and “desk research” has played major roles through the research process. Thus, the methods of collecting the required data is divided into two parts; “primary data” such as face to face interview with building specialists as well as contractors and receiving some catalogues from them regarding sustainable design elements; distribution of questionnaire among people by using “Likert Scale” and “Scoring Methods”. The second type of gathering data is “Secondary data” such as literature reviews and documentary analysis.

**Chapter five** analyzes those sustainable elements that were acquired from the literature reviews to find out how many of such items are compatible with the mid-

rise housing in the context of Malaysia. Finally at the next stage, the affordability of those items for medium-income people will be considered in details.

**Chapter six** interprets In the results of questionnaire based on the correlation between three issues including participants' characteristics in terms of age, gender, education level, marital status and their occupation; participants' knowledge about solar energy as well as sustainability issues and finally their financial power to use environmentally-friendly materials and solar devices in their houses. Besides, to estimate the agreement level of participant relating those sustainable items, the scoring method is discussed.

**Chapter seven** concludes the study by summarizing the major findings of the research. It also outlines the suggestions for appreciating environmentally-sustainable housing for medium-income people in the context of tropical hot humid climate within Malaysia.

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