

GREEN BUILDING FEATURES AND CONSTRUCTION COST IN
HOUSING PROJECT

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requirements for the award of the degree of
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DEDICATION

To my beloved father, mother, sister and brothers,

Thanks for understanding, supports, encouragement and love.

To my respected supervisor,

Associate Professor Sr. Dr. Mohd Bin Saidin Misnan

Thanks for your guidance, encouragement, advice and knowledge

And to my lovely friends.

Thanks for the support and encouragement all the way

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ABSTRACT

Green building is a building which its construction and lifetime of operation assures the healthiest possible effects on the environment. Green buildings with green features are sustainable buildings and have less harmful effects on the natural environment, resource consumption and human health. Since the global warming issue has worsened and the number of housing is increasing, the role of green features in green housing has become highly important in creating a good sustainable living environment. However, to date, the level of developed green housing is still below the mainstream housing even though Green Building Index (GBI) has been implemented in Malaysia. The objectives of this research are to identify current green features that are applied in housing, to quantify the construction costs of green features that are applied and to identify the factors that influence the acceptance levels of green housing. The scope of the study included collecting data from developers through five case studies of housing projects. Thereafter, structured interviews and document reviews were carried out on either the developer or architect for each of the case study. In addition, questionnaires have been distributed to survey 120 home buyers in Johor. Subsequently, the data was then analysed using content analysis method. Based on the findings, current green features that are mostly applied by housing developers are passive green features such as building orientation, window and daylight. From the perspectives of cost effectiveness and to meet the purpose of comfortable housing, developers will choose to apply passive green features. The study also found that the construction cost of green feature window and daylight is the highest (2.21%). In general, the average construction cost for green features for one unit of house in current Johor housing is average 3.95% of the construction cost. Moreover, based on the findings the main factors that influence the acceptance level of green housing by home buyers is the comfort of green housing followed by the green housing pricing. Further, the research recommends looking into the details of the cost of savings in the long term for green features and developers' opinions on the perception of the home buyers when it comes to factors that influence their acceptance level of green housing. It is recommended that an in-depth study be conducted on green features to study the problems and issues related to improve the green features design.

ABSTRAK

Bangunan hijau adalah bangunan dimana pembinaan dan operasi sepanjang tahunnya menjamin kesan yang paling sihat terhadap alam sekitar. Ciri-ciri bangunan hijau adalah bangunan mampan dan mempunyai kesan yang kurang memudaratkan persekitaran semula jadi, penggunaan sumber dan kesihatan manusia. Memandangkan isu pemanasan global semakin serius dan bilangan perumahan semakin meningkat, peranan elemen hijau dalam perumahan hijau menjadi semakin penting dalam mewujudkan persekitaran hidup yang mampan. Walau bagaimanapun, tahap perumahan hijau yang telah dibangunkan masih di bawah perumahan arus perdana walaupun Green Building Index (GBI) telah dilaksanakan di Malaysia. Objektif penyelidikan ini adalah untuk mengenalpasti elemen hijau yang telah digunakan di perumahan, mengira kos pembinaan elemen-elemen hijau yang digunakan dan mengenal pasti faktor-faktor yang mempengaruhi tahap penerimaan perumahan hijau. Skop kajian ini termasuk pengumpulan data daripada pemaju melalui lima kajian kes projek perumahan. Temu bual berstruktur dan kajian dokumen juga dijalankan sama ada pemaju atau arkitek bagi setiap kajian kes. Di samping itu, soal selidik diedarkan kepada 120 pembeli rumah di Johor. Seterusnya, data tersebut dianalisis menggunakan kaedah analisis kandungan. Berdasarkan dapatan kajian, kebanyakan elemen hijau yang digunakan oleh pemaju adalah elemen hijau pasif seperti orientasi bangunan dan tingkap. Dari perspektif keberkesanan kos dan untuk memenuhi tujuan perumahan yang selesa, pemaju akan memilih untuk menggunakan elemen hijau pasif. Kajian ini juga mendapati kos pembinaan elemen hijau yang paling tinggi adalah tingkap iaitu 2.21% daripada kos pembinaan. Purata kos pembinaan bagi elemen hijau untuk satu unit rumah Johor semasa adalah 3.95% daripada kos pembinaan. Di samping itu, berdasarkan dapatan kajian, faktor utama yang mempengaruhi tahap penerimaan perumahan hijau oleh pembeli rumah adalah penyelesaian perumahan hijau diikuti dengan harga perumahan hijau. Selanjutnya, penyelidikan mengesyorkan untuk mengaji kos penjimatan dalam jangka panjang untuk elemen hijau dan pendapat pemaju mengenai persepsi pembeli rumah berkaitan dengan faktor-faktor yang mempengaruhi tahap penerimaan mereka terhadap perumahan hijau. Kajian yang mendalam di atas elemen hijau juga disyorkan untuk mengkaji masalah dan isu-isu yang berkaitan bagi memperbaiki reka bentuk elemen hijau.

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LIST OF ABBREVIATIONS

GHG	-	Greenhouse Gas
SREP	-	Small Renewable Energy Power Programme
PAM	-	Pertubuhan Akitok Malasia
ACEM	-	Association of Consulting Engineers Malaysia
GBI	-	Green Building Index
EE	-	Energy Efficiency
EQ	-	Indoor Environment Quality
SM	-	Sustainable Site Planning & Management
MR	-	Materials & Resources
WE	-	Water Efficiency
IN	-	Innovation
AAC	-	Autoclaved Aerated Concrete
RWHS	-	Rain Water Harvesting System
UBBL	-	Uniform Building by Law

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Global warming which known as an international environmental issue is getting important as it has adverse effect on the environment and humankind. In recent years, the climate change and global warming issue are being addressed at international, national and local level. Before 20th century, the global warming issue was well under control but the situation started to become worsen at the beginning of the current century (Shahzad & Riphah, 2015). The primary sources of the global warming are believed is due to the increase of greenhouse gases and carbon dioxide emission. The climate change causes snow melts and the sea level rises (VijayaVenkataRaman, et al., 2012).

According to (Shahzad & Riphah, 2015), 97% of the climate scientists and researchers agreed that human activities have caused the changes of the overall climate in dramatic ways. Figure 1.1 shows human activities enhanced the greenhouse effect and increased the level of greenhouse gases leads to global warming. The increase of greenhouse effect gases causes the heat trap in the atmosphere and less heat escapes into the space. This causes the increase of temperature in atmosphere and lead to global warming.

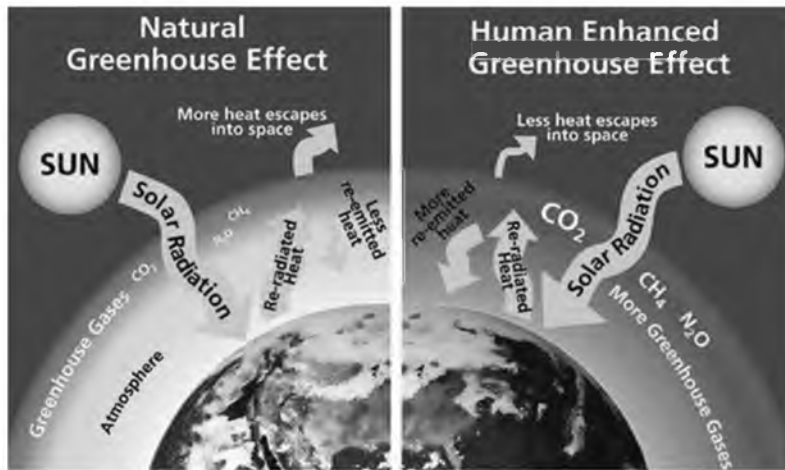


Figure 1.1 Types of greenhouse effects (Shahzad & Riphah, 2015)

Based on (Sagheb, et al., 2011), there are eight main sectors which are releasing significant amount of greenhouse gases into the atmosphere annually. Figure 1.2 shows the distribution of greenhouse gases based on sectors which included power station (21.3%), industrial processing (16.8%), transportation fuels (14.0%), agricultural by-products (12.5%), fossil fuel retrieval processing and distribution (11.3%), residential, commercial and other sectors (10.3%), land use and biomass burning (10.0%) and waste disposal and treatment (3.4%). The emission of carbon dioxide from building industry, industrial processing is believed have shared about 80% of carbon dioxide emissions (Sagheb, et al., 2011).

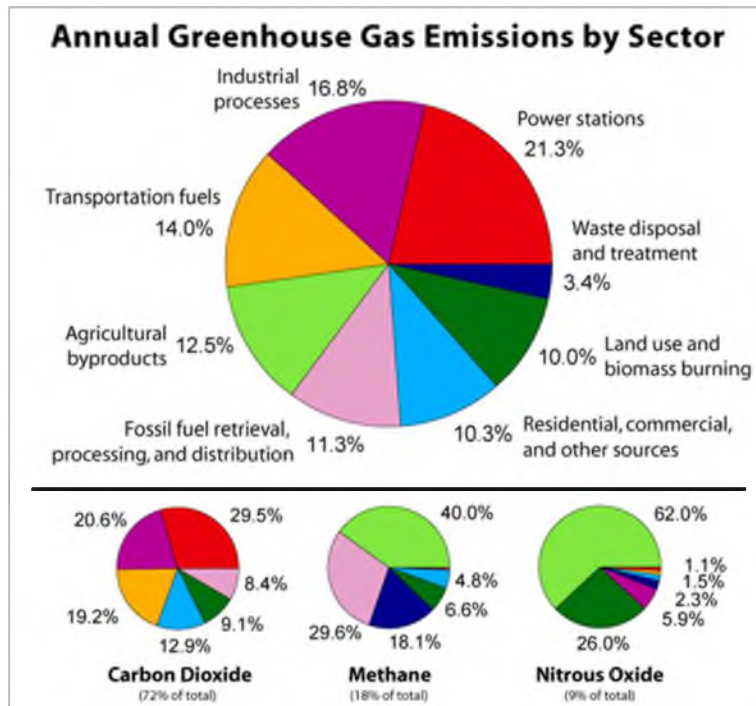


Figure 1.2 Distribution of greenhouse gases (Sagheb, Vafaeihosseini, & Ramancharla, 2011)

According to (Sagheb, et al., 2011), buildings are the dominant greenhouse gases emitters and energy consumers in both the developing and developed countries. Since buildings are the dominant energy consumers, the property sector therefore plays significant role in reducing the energy consumption and ensure sustainability achievement through the adoption of energy efficient practices.

Buildings are estimated in consumption more than 40% of the global energy and release one-third of global Greenhouse gas emissions (GHG) (Reddy.Vanakuru & Giduthuri, 2017). Based on (Reddy.Vanakuru & Giduthuri, 2017), the growth rate of carbon dioxide emissions recorded between year 1971 to 2004 through the use of electricity in commercial buildings is estimated as 2.5% per annum whereas for residential buildings is 1.7%. Generally, the building sector has higher responsibility compared to others because the building sector energy is consumed from begin to the end of building cycle. Figure 1.3 shows the greenhouse gas emission life cycle for buildings. The building sector has consumed energy and emit carbon dioxide during manufacturing of building materials, transport of materials, construction and operation of buildings and demolition of buildings.

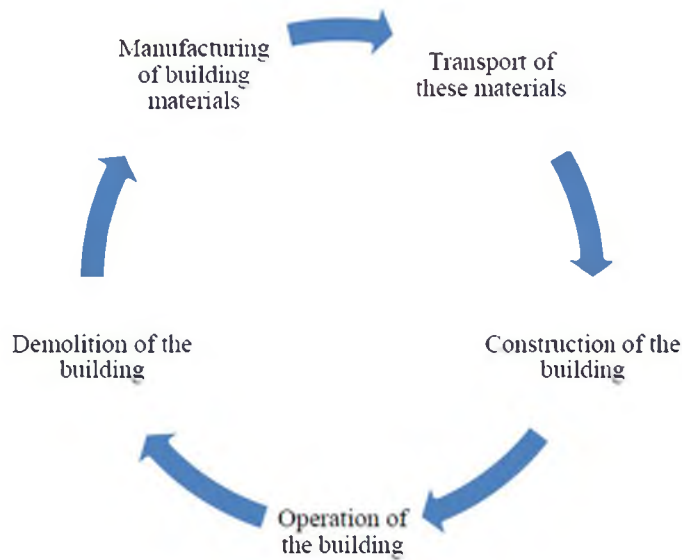


Figure 1.3 Greenhouse gas emission life cycle for buildings (Reddy.Vanakuru & Giduthuri, 2017)

Since Malaysia known as one of the faster growing and developing country in Asia, it is highly need to explore for options energy sources in support of its inhabitants or business energy needs. Malaysia is a country blessed with the tropical forests and moist climate all the year round which is abundance with the natural resources such as water, wind and solar. In the efforts to reduce the climate change, Malaysia government has put much effort to find and utilize renewable resources to enhance the energy supply mix in the country. It will be sustainable if the renewable energy resources are able to be generated at the same rate that they are being utilized. The most effective way to reduce the emission of gases is using renewable energy (Shahzad & Riphah, 2015). Figure 1.4 shows the electricity saving and electricity demand reduction by the Malaysia energy efficiency action plan from year 2016 to 2025. The figure has shown that the target of electricity saving and electricity demand reduction for housing is gradually increased from year 2016 to 2015 (Suruhanjaya Tenaga, 2017). Hence, renewable energy should be highly encouraged and applied in housing.

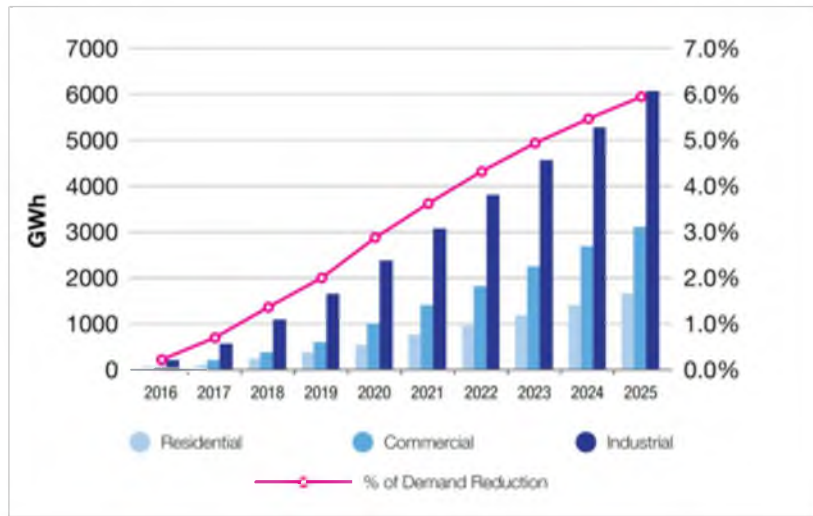


Figure 1.4 Electricity saving and electricity demand reduction by the Malaysia Energy Efficiency Action Plan (2016-2025) (Suruhanjaya Tenaga, 2017)

Green buildings play an important role in combating climate change by conserve the nature resources and maintain harmony with the nature. The demand for green buildings has been increased as the environmental awareness grows especially among developers and professionals since the existence of Green Buildings Index (GBI) and Singapore’s Building and Construction Authority’s Green Mark Scheme (BCA). Both of GBI and BCA Green Mark Scheme are initiative to promote sustainability in the built environment. The developers and government are also putting more effort in developing energy efficient homes to reduce the impact of buildings on the environment. Energy efficient homes is housing design or concept which generally make the best use of the sun, wind and rainfall to supply the energy and water needs to house owners. Since the rising of energy prices last few years, the property industry has increased in participate the housing sustainability through efficient housing design and construction. The effort is focused on energy efficient in residential house design, efficient cooling and construction materials.

It is still at an early state in Malaysia, while energy efficient homes have been constructed in the United States, Australia and Europe. Ken Holding was the private housing developer to construct the first green homes in Malaysia during year 2017 (Tan, 2012). Ken Holding has achieved the Green Mark Gold standard certification from Singapore’s Building and Construction Authority. After that, housing

developers in Malaysia are counselled to go green by constructing green-certified properties. At the same time, the local council also requires high-end project site to designate an open green space for recreation purposes. For green housing, there are some efforts such as using recycled materials in construction, collect rainwater and orientated houses in a North-South manner to allow maximum ventilation and natural lighting. In addition, residential development also designs with extensive greenery landscape and features in the structure that would help inhabitants save energy. The eco-friendly housing has provided conducive living environment.

According to (Darko, et al., 2018), the apply of green feature in green building brings benefits in aspects of environmental, economic and social to the construction industry, which are important for the industry to contribute to sustainable development. Green building with green features helps to deliver sustainable buildings and have less harmful effects on the natural environment, resource consumption and human health (Darko, et al., 2018). The implementation of energy alternatives in green building enable to minimize the energy costs through using electricity or fuel more efficiently or help to eliminate the costs entirely with incorporate the renewable energy sources (Vanek & Vogel, 2007). Sustainable construction addresses the social, economic and ecological issues of a building in the context of its community (Charles J. Kibert, 2016). With the benefits of green building, the green building is highly encouraged to be implemented in most of housing development for sustainable development and better future.

1.2 Problem Statement

Eco-friendly homes are implemented with the Malaysian government's move to promote the adoption of energy efficient measures for residential properties (Green Building Index, 2013). According to (Green Building Index, 2013) report, the applications for GBI certification has shown that developers and investors that planning their projects as "green" developments have been increased.

However, to date, the level of developed green building is still below the mainstream and only focus on the big project. Although GBI has been implemented in Malaysia, the achievement is still below the targeted level required by the Minister of Natural Resources Malaysia. The green features are still less emphasised by the developers while developing new housing. One of the main reasons is due to the higher construction cost of housing with green features. According to (Lee, 2014), green housing costs were 10.77% more than the traditional housing. The green building projects usually more costly due to require the special specifications, materials, construction methods and building practices (Lam, et al., 2010). In green building, the green equipment and materials is important thing to achieve green construction (Hasan & Zhang, 2016). Due to some of the green features are still new in market, new technology or with limited supplier, the pricing might be much higher. For example, the green material Autoclaved Aerated Concrete (AAC) only have limited suppliers such as Greencon and Starken AAC in Johor. This cause the pricing for the material not stable and even costly from year to year.

According to (Samari, 2013), the environmental impact of buildings is often underestimated, while the perceived costs of green buildings are overestimated. Most developers are highly emphasised and control in the construction cost as it influences their selling price and profit. Developers refuse to build housing with green feature due to green features incurred high cost (Alias, et al., 2010). The drop of market economic latterly indirectly has caused the drop and unstable of selling price of housing in Malaysia. Figure 1.5 shows the transaction volume and value of property market activity has dropped since year 2014. Then, Figure 1.6 shows that the overall sales performance for residential market was unstable and dropped since year 2015 (Valuation and Property Services Department, 2019). Since the construct of green housing increases the selling price, this causes the developers more preference to design housing with limited green features or just normal housing. They are more consider on the selling price of housing that affordable to the customers.

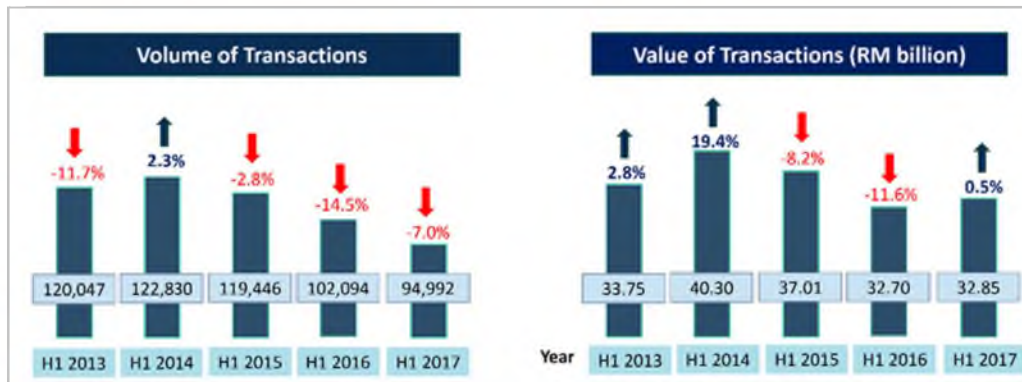


Figure 1.5 Property market activity-Transaction volume and value from 2013 to 2017 (Valuation and Property Services Department, 2019)

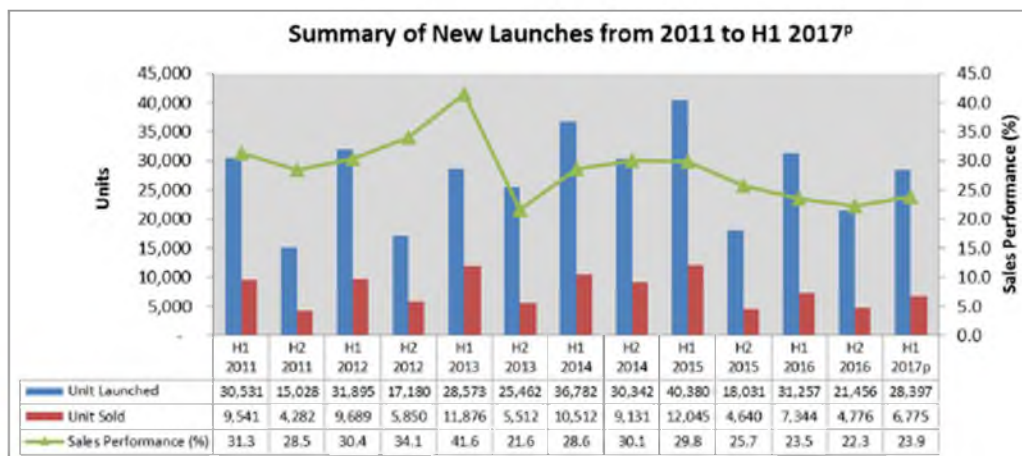


Figure 1.6 Summary of new launches of residential market from 2011 to 2017 (Valuation and Property Services Department, 2019)

The minimal increases of about 2% in upfront costs to support green design would result in project life cycle savings of 20% of total construction costs, which is estimated to be more than ten times the initial investment (Samari, 2013). According to (Samari, 2013), green buildings mainly help savings in the maintenance part and utility costs. The benefits and potential cost savings of the green features only can be seen in long term. In some of house buyers' perception, they only highlight on the pricing for house with green features are much higher without consider the important in go green (Hasan, et al., 2018). According to (Qian, et al., 2015), the highest risk in green building development is the uncertainty about the market and consumers by developers. Some owners even not really appreciating the green features that constructed in their houses. There are still many people lacking of knowledge and awareness on the benefits of green features that will bring to them in long terms. The

lack of understanding on the factors that influence the acceptance levels of buyers on green housing is one of the barriers for the development of green products (Handayani & Prayogo, 2017).

Green housing is even more important in the future as the demand and numbers of housing keeps increasing in consistence with the rising number of global populations (Ibrahim, et al., 2014). Green housing features play a vital role to improve liveability, sustainability and reduce the carbon footprint of the built environment. The green housing has encouraged the uses of renewable energy and reduce the consumption of non-renewable energy such as fossil fuel that may emit more greenhouse gases.

So, this study is important because the costing of green features and factors consider by buyers on green housing features will be identified. The information obtain from this study enables the developers to find most optimum way to implement green housing with the consideration of factors that buyers focus on. Then, developers will be able to develop effective green housing that are more acceptable by buyers. The green features will be encouraged to incorporate into the housing design and construction. The benefits of green features are not significant since there are only certain green features applied in most of the green housing. Through this study, the more comprehensive housing with green features will be developed and the benefits of green features able to be seen more significantly. This indirectly further increase the acceptance of people on green housing features.

1.3 Research Questions

Based on the problems of the scenario, some research questions have been raised to guide and facilitate this study. The research questions are as below:

- i What are the current green features that are applied in housing?
- ii What is the construction cost for green features?
- iii What are the factors that influence the acceptance level of green housing?

1.4 Research Aim and Objectives

The aim of this study is to clearly understand the green features including its construction cost and the factors that influence the acceptance level of green housing. The objectives of this study are as below:

- i To identify current green features that are applied in housing.
- ii To quantify the construction cost of green features.
- iii To identify the factors that influence the acceptance level of green housing.

1.5 Scope of Study

In this study, the green housing's features are only focused on specific highlighted green features for housing but not cover all of the criteria for green housing in green rating assessment tools. This is due to limited time and would like to more focused on the selected green features. In order to study the green features effectively, Johor Bahru where the development of housing keep on increasing is chosen as a study area. Case studies on five (5) housing projects in Johor are selected from developers to further study on green features that have been applied in the housing design. The information about the costing of the green features also is collected to quantify the construction cost of the green features. The information of

the case studies also further supported by conducting interview. In addition, the information in respect of the perception of developer or architect on the green features in relation to the development also have been collected through interview. Then, the factors that influence the acceptance level of green housing also are identified through the questionnaires to survey the factors consider by home buyers on green housing.

1.6 Significance of Study

By conducting this study, the stakeholder such as developers, consultants and residents can have better understanding on the green features in housing design or construction. They can aware and understand more on the concerns or perceptions of home buyers on green features and green housing. The more comprehensive housing with green features will be developed and the benefits of green features able to be seen more significantly. The results of the study are expected to benefit stakeholders and encourage developers to implement more green features in housing construction and as a result of which it is believed that it can lead a city towards sustainable development. The well-being and healthier living environment in future will be possible.

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