

A MARKET DRIVEN FRAMEWORK FOR GREEN AFFORDABLE HOUSING  
CRITERIA IN MALAYSIA

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## **DEDICATION**

To my beloved husband, Nor Radzlan Abdul Ghani, my lovely daughter and sons, Rania Qaisara, Khalish Reezqin and Danish Daniyal, my parents, Allahyarham Zulkepli Darus and Siti Ishah Mohamad, siblings, and my true friends for supporting me all the way with their words of encouragement and prayers.

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In the name of Allah, the Most Gracious, the Most Merciful

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## ABSTRACT

Green Affordable Housing (GAH) criteria and features are crucial in the development of affordable housing. Developed countries such as United States, United Kingdom and Australia have their own GAH criteria and features for GAH development. In Malaysia there is a Green Building Index (GBI) which is the green rating tools consisting of six criteria; energy efficiency, indoor environmental quality, sustainable site planning and management, material and resources, water efficiency and innovation for green housing development. There is also an affordable housing development guide by the National Housing Policy (NHP) based on two criteria; housing price and income. Since GAH is not completely implement in Malaysia, as such, this study aims to fill the gap that is found in GBI and NHP and match it with the current GAH criteria and features from previous studies. This study also aims to develop a market driven framework representing GAH criteria and features in Malaysia, emphasizing on the real estate market interaction. Data was gathered through a survey distributed to potential home buyers of middle income groups and developers who are certified with GBI in three major cities which are Klang Valley, Penang and Johor Bahru. Data obtained from potential home buyers' was analyzed using logistic regression analysis, while data derived from the developers was analyzed using descriptive analysis. Next, the perspectives of both respondents on the criterion and features of GAH were matched and analyzed using cross tabulation analysis for framework development purpose. Statistical results confirmed that 75.8 percent of potential home buyers' were willing to pay more for GAH criteria and features. In fact, both parties agreed to adopt 10 percent incremental costs for GAH. The finding also indicated that six GAH criteria as in GBI and 10 features were suitable to be incorporated into affordable housing development. Finally, the framework development was conducted to put the priority of the important features using Analytical Hierarchy Process (AHP) method. The market driven framework revealed five priorities on the important features for GAH having the weight between 10.6 to 16.9 which are water saving appliances and fittings; design leads to low pollutants; reduce, reuse and recycle materials; energy saving appliances and light fittings; and extensive landscaping. Additionally, 29 eco-labelling components from Product Criteria Document (PCD) by SIRIM were also adapted to the framework in accordance with the government's requirement. A further framework validation was obtained through feedback from the market and stakeholders and the results illustrated the agreement of market driven framework for green affordable housing criteria that contributes to the establishment of the GAH concept in Malaysia. It also serves as a tool for decision making particularly for developers in GAH development.

## ABSTRAK

Kriteria dan ciri-ciri Perumahan Hijau Mampu Milik (GAH) sangat penting dalam pembangunan perumahan mampu milik. Negara maju seperti Amerika Syarikat, United Kingdom dan Australia mempunyai kriteria dan ciri-ciri GAH mereka sendiri untuk pembangunan GAH. Di Malaysia terdapat Indeks Bangunan Hijau Malaysia (GBI) yang merupakan alat penarafan hijau yang terdiri daripada enam kriteria; kecekapan tenaga, kualiti persekitaran dalaman, perancangan dan pengurusan tapak lestari, bahan dan sumber, kecekapan air dan inovasi untuk pembangunan perumahan hijau. Terdapat juga panduan pembangunan perumahan mampu milik oleh Dasar Perumahan Negara (NHP) berdasarkan dua kriteria; harga perumahan dan pendapatan. Oleh kerana GAH tidak dilaksanakan sepenuhnya di Malaysia, maka kajian ini bertujuan untuk mengisi jurang yang terdapat dalam GBI dan NHP serta memadankannya dengan kriteria dan ciri-ciri GAH semasa daripada kajian sebelumnya. Kajian ini juga bertujuan untuk mengembangkan kerangka kerja berdasarkan pasaran yang mewakili kriteria dan ciri-ciri GAH di Malaysia yang menekankan kepada interaksi pasaran harta tanah. Data dikumpulkan melalui soal selidik yang diedarkan kepada bakal pembeli rumah berpendapatan sederhana dan pemaju yang diperakui dengan GBI di tiga bandar utama iaitu Lembah Klang, Pulau Pinang dan Johor Bahru. Data yang diperolehi daripada bakal pembeli rumah dianalisis menggunakan analisis regresi logistik, sementara data yang diperolehi daripada pemaju dianalisis menggunakan analisis deskriptif. Seterusnya, perspektif kedua-dua responden mengenai kriteria dan ciri-ciri GAH dipadankan dan dianalisis menggunakan analisis tabulasi silang untuk tujuan pembangunan rangka kerja. Hasil statistik mengesahkan bahawa 75.8 peratus bakal pembeli rumah bersedia membayar lebih untuk kriteria dan ciri-ciri GAH. Malah, kedua-dua belah pihak bersetuju untuk menerima 10 peratus kos tambahan untuk GAH. Dapatan kajian juga menunjukkan bahawa enam kriteria GAH seperti dalam GBI dan 10 ciri sesuai untuk dimasukkan ke dalam pembangunan perumahan mampu milik. Akhir sekali, pembangunan kerangka kerja dilakukan untuk meletakkan keutamaan ciri-ciri penting menggunakan kaedah Analisis Proses Hierarki (AHP). Kerangka kerja yang didorong oleh pasaran mendedahkan lima keutamaan tentang ciri-ciri penting GAH yang mempunyai pemberat antara 10.6 hingga 16.9 iaitu peralatan dan kelengkapan penjimatan air; reka bentuk membawa kepada pencemaran rendah; mengurangkan, menggunakan semula dan mengitar semula bahan; peralatan penjimatan tenaga dan kelengkapan cahaya; dan landskap yang luas. Selain itu, 29 komponen pelabelan eko daripada Dokumen Produk Kriteria (PCD) oleh SIRIM juga dipadankan dengan kerangka kerja sesuai dengan keperluan kerajaan. Pengesahan kerangka kerja lebih lanjut diperolehi melalui maklum balas daripada pasaran serta pihak berkepentingan dan hasilnya menunjukkan kesepakatan kerangka kerja yang dipacu oleh pasaran untuk kriteria perumahan hijau mampu milik yang menyumbang kepada pembentukan konsep GAH di Malaysia. Ia juga berfungsi sebagai alat untuk membuat keputusan terutamanya bagi pemaju dalam pembangunan GAH.

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## LIST OF ABBREVIATIONS

GAH	-	Green Affordable Housing
GBI	-	Green Building Index
GBIM	-	Green Building Index Malaysia
PHB	-	Potential Home Buyer
DEV	-	Developer
AHP	-	Analytical Hierarchy Process
NMP	-	Ninth Malaysia Plan
NHP	-	National Housing Policy
MESTECC	-	Ministry of Energy, Science, Technology, Environment and Climate Change
MHLG	-	Ministry of Housing and Local Government
NGTP	-	National Green Technology Policy
EE	-	Energy Efficiency
WE	-	Water Efficiency
SM	-	Sustainable Site and Management
MR	-	Material and Resources
EQ	-	Indoor Environmental Quality
IN	-	Innovation
FTWS	-	Fast Track Wall System
FTW	-	Fast Track Wall
WTP	-	Willingness to Pay
VOC	-	Volatile Organic Compound

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# CHAPTER 1

## INTRODUCTION

### 1.1 Research Background

Housing is a basic human requirement. Affording housing with economic, social and environmental supports is the fundamental right of human beings to live in an appropriate living environment. Getting a house in the market that meets all the best aspects is dependent on individuals and households. The level of income and affordability become a benchmark in shaping the factor in a housing consumption decision. Thus, implementing the green building concepts into a housing construction signifies the latest trend in sustaining the environment. This effort has received attention into the development of green affordable housing in order to overcome the environmental issue of affordable housing.

The 2030 Agenda for Sustainable Development has identified 17 Sustainable Development Goals (SDGs) aimed at balancing economic growth and protecting the environment (United Nations, 2014). Affordable housing address the all the dimension of sustainability (economic, social and environment) as well as directly and indirectly influence 13 out of 17 goals that have been set in SDGs (Yıldırım and Yıldırım, 2020; Mukherjee, 2015). Affordable housing is projected to result in the financial and social inclusion of the Economically Weaker Section (EWS) and the Low Income Group (LIG) as address in Goal 11 of SDGs to make cities and human settlements inclusive, safe, resilient and sustainable. The greening of affordable housing (GAH) creates a strong connection between social justices, and environmental sustainability, and thus it constructs an economic value of affordable housing development (Wells et al., 2007). In addition, Olanrewaju and Tan (2018) and Gruswitz (2008) claimed that this kind of development offers special prospect to a new cooperation of developers, communities, designers, local authorities, and policy makers in an effort to provide affordable housing with healthier indoor environments and quality of life for the

occupants. This concept should influence the private and public sectors as it is the advocator of sustainable development.

Several green building criteria and features for housing construction are being used around the world such as the Building Research Establishment Environmental Assessment Method (BREEAM) in 1990, and Leadership in Energy and Environmental Design (LEED) in 1998. As a result of this dynamism, Green Star in Australia was established in 2002, followed by the Comprehensive Assessment System for Built Environment Efficiency (CASBEE) which was introduced in Japan in 2004. This was followed by other Asian nations such as The Singapore Building and Construction Authority (BCA) Green Mark in 2005, the Hong Kong Building Environmental Assessment Method (HK-BEAM) in 2008 and Malaysian Green Building Index (GBI) was introduced in 2009.

As an initiative to support the sustainability as well as to improve the quality of life for low- and middle-income households, the aforesaid green building standard and certification was further enhanced by a new standard to green affordable housing (GAH) with criteria and features that are green and affordable as well. GAH concept is a term that generally refers to a reasonable housing price that incorporates green criteria and features to support the environment, as well as to improve the quality of life for low- and middle-income households (Olanrewaju, Tan, Rashid, and Aziz, 2018). The GAH concept has become increasingly common in the United States, United Kingdom, and Australia due the adoption of state and local policies which require green building practices to be applied into the residential development. In United Kingdom, the latest version of BREEAM which is called EcoHomes (Hayles, 2005; BRE, 2012), while in the United States, the LEED version of GAH is called Green Communities (Trassos, 2005). In Australia, the Green Star version of GAH is called Ecocents Living (Pullen et al., 2009). In Asian countries, the concept of GAH is not yet being well established. None of these countries has the GAH guidelines as practice in UK, US or Australia. However, the idea of intersecting the green building criteria and features to affordable housing development has been adopted in Japan, China and Singapore (Sekisui, 2005; Howe et al., 2007; Konami, 2009; Solidiance, 2010; Yeong, 2013). Currently, Malaysia use the GBI tools to evaluate the new

construction of residential areas and the green housing concept has set its foot in 2007 (Chua & Oh, 2011; Alias et al., 2010).

The concern of Malaysian government towards GAH concept was outlined in the Eleventh Malaysia Plan (2016-2020) and the National Housing Policy (NHP) (2018-2025). The Eleventh Malaysia Plan (2016-202) highlights the environmental protection as one of the main principle to control the resources intelligently due to an increase in energy prices. On the other hand, NHP was aimed to provide affordable and adequate housing to improve the quality of life among low and middle-income groups. This was highlighted in three out of the six thrusts of NHP such as environmental-friendly housing development concept with new technologies and innovations in energy efficiency, designing of buildings, the use of recyclable materials, and the smart buildings development and improve the level of social amenities, basic services, and liveable environment. Similar concern of GAH development specified by the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) through the National Green Technology Policy (NGTP). Wherein, the ministry highlighted main areas such as creating new technology, techniques, and applications to decrease the cost of green technology in order to encourage its practice. This strategic trust is equivalent to GAH purpose to incorporate green criteria and features that are suitable to affordable housing within the affordable housing price.

The objective of this study is in line with the implementation level of GAH in Malaysia context through above mentioned policy. Malaysian government has focused on the green building criteria and features as contained in Green Building Index (GBI) to deliver the affordable housing. Taman Puchong Utama apartments in Puchong, Selangor is currently the first Green Building Index (GBI) certified affordable housing project in Malaysia which costs range from RM 100,000 to RM 220,000. The significance of green building criteria and features throughout this affordable housing development has been revealed in the study conducted by Olanrewaju et al.,(2018) and Howe et al., (2007) which found that GAH associated with requirements to reduce operating costs for building occupants. Furthermore it also supports local needs and values, utilizes responsible materials, and minimizes the environmental impact

through self-sustaining sites design. This study can be considered as an effort of improving the GAH practice in Malaysia as Ang, Olanrewaju, Chia and Tan (2017) and Olanrewaju and Tan (2018) mentioned that that GAH culture in Malaysia is still inactive and lack of standardised GAH guidelines and standards.

## **1.2 Issues and Problem Statement**

In Malaysia, the issues of affordable housing development was on quality and design (Abdul Rahman et al., 2013; Elforgani & Rahmat, 2011, Hanafi, 1999; Mousavi et al., 2013). Therefore, Hannula (2012) and Geng (2004) suggested an innovative and upgraded affordable housing to cater the affordable housing problem (Hannula, 2012; Geng, 2004). Incorporation of certain green building criteria and features appear the best solutions, but green price are not affordable even it offers economic, social and environmental benefit. GAH was introduced as a potential solution to lower the utility cost burden and improve health of the homeowners in the long run especially for low and middle income households (Alias et al., 2010; Hancock & Scott, 2008; Bradshaw, 2005).

The Government of Malaysia through the MHLG and MESTECC had outlined a comprehensive guideline to promote the sustainable housing and development along with the thrust and policy documents. Nevertheless, these guidelines does not cover the GAH development since affordable housing has its own guidelines, and the only two criteria for affordable housing in Malaysia are housing price and income (Azmi et al., 2015; 2016b; Aziz et al., 2011; MHLG, 2010; Hashim, 2010; Bujang, 2006; Gabriel et al., 2005). Likewise, GBI in Malaysia only covers the development of green housing. On top of that, study by Olanrewaju and Tan (2018) has revealed that more than 90 percent of affordable housing in Malaysia has not been planned or designed to meet the green requirements. Similarly, the report from GBI (2018) also supports that only 183 from 450 certified green buildings in Malaysia have incorporated green building criteria and features into their design and construction.

Past studies on GAH in Malaysia were focused on different scopes of research or different fields of study with certain green building criteria and features focusing on

design criteria to be incorporated into affordable housing (Olanrewaju & Tan, 2018). Furthermore, Mousavi et al. (2013) for example conducted a study on GAH in the context of identifying the elements for sustainable affordable housing based on passive and active sustainable features among middle income group in Malaysia. On the other hand, Tawil et al. (2011) developed a module of Commercially Affordable Sustainable House (CASH) emphasizing only on water efficiency criteria with rain water harvesting as its key features. Meanwhile, a study by Abdul Rahman et al., (2013) concentrated on developing future affordable housing design typology based on environmental comfort criteria and humane design criteria, while Abd Majid et al.(2012) studied a prototype package on GAH using fast track wall system (FTW) by focusing on material and resources criteria. Nevertheless, all of these studies had limited criteria and features to incorporate into GAH and to suite with affordable housing price. Therefore, the current study would fill the gaps by using the GBI criteria and features as a basis and adapting other findings that suit the local condition in order to generate the GAH criteria and features in Malaysia.

Nonetheless, some studies have shown that the value of GAH is dependent on market-driven interactions between developers and potential home buyers. (Yau, 2012b; Jefferson & Sellwood, 2010). Martin, Swett, and Wein (2007) developed a strategic Market Engagement Framework (MEF) for residential green building industry which involved three main stakeholders namely home buyers, industry and government. Their study suggested that all the stakeholders should first gain the full understanding of the marketplace in order to enter the market. The connection between the combined stakeholders' resources and economic pressure controlled the overall setting. Zainul Abidin (2010) agreed and his study highlighted that all stakeholders (developers, consultants, contractors, local authorities, manufacturers and purchasers) should be engaged to make sure the project activities produce the least impact to the environment. Furthermore, as emphasised by Olanrewaju and Tan (2018) the developers' stance towards protecting the environment may not be related to the social and economic factors as these developers are more profit driven and are looking for tangible and intangible benefits for their investments. That is why all the stakeholders should be engaged as the developers' actions are affected by the market situation and demand. In keeping with Olanrewaju and Tan (2018) and Bujang (2010), if housing is developed without considering the preferences of potential home buyers', poor

satisfaction, high level of adjustment, maintenance and operating cost will arise. If these developers know and understand the demand for GAH among the potential home buyers, this will push the housing developers into incorporating certain green building features to attract more of these buyers (Zainul Abidin, 2010).

Studies by Kats (2010), Ling and Gunawansa (2011), (Yau, 2012b), and Estep et al. (2013) found that more than 70 percent of potential home buyers were willing to pay more for green criteria and features. However, the findings also revealed that potential home buyers were only willing to pay less than 10 percent of the incremental costs for green criteria and features incorporated into affordable housing development (Kats, 2010; Ling & Gunawansa, 2011; Mousavi et al., 2013). On the other hand, according to Hong (2014), the developers highlighted that incorporating green into affordable housing is an expensive exercise and it will likely lead to an increase in the price of affordable housing as the construction costs would have also increased. This has been proven by the studies conducted by Foy (2012), Halim (2009), Issa, Rankin, and Christian (2010), Kathy and Cowan (2008), Kellogg and Keating (2011), Pullen et al. (2009), Wells, Bardacke, Cepe, Cramer, Delaney, Landman and Peterson (2007), Zhang, Platten, and Shen (2011), and Zulkepli, Sipan, and Jibril (2013). These developers would only implement the GAH criteria and features if there is demand, and that they can sell the affordable houses higher than the stipulated price according to the criteria and features implemented. Unfortunately, Hong (2014) verified there is no indication which green criteria and features are preferable and willing to pay by the potential home buyers.

Therefore, due to insufficient guide for GAH criteria and features, GAH market are difficult to standardise. Consequently, developer will face difficulties in applying or build GAH as they are not clear what criteria and features are required to meet the needs and affordability of potential home buyers. This study is conducted to fill the gap of knowledge by determining the GAH criteria and features for GAH development in Malaysia with housing price affordability ranging from RM 120, 000 to RM 180, 000 for middle income group with income between RM 2000 and RM 8000. This study also attempts to bridge the gap by investigating from both the demand and supply perspectives. From the potential home buyers' perspectives, this study focus on the

GAH criteria and features, and the extra cost for green those potential home buyers are willing to pay. The developer's perspective is based on their readiness to adopt the green criteria and features that suit the affordable housing as well as the benefits accrued to them in terms of increased profit margin. The GAH criteria and features in this study refers to those the developers are ready to adopt with extra cost for each criteria and features. This study would determine the match and mismatch of the GAH criteria and features according to both parties' perspectives. Interaction of demand and supply is important in order to create equilibrium of market for the GAH.

### **1.3 Research Gap**

The Green Building Index (GBI) is a basis for GAH criteria and features in this study. GBI is the first environmental rating system for buildings in Malaysia to evaluate the building design and performance based on six main criteria. However, the GAH concept has not yet been fully practiced in Malaysia. The green building criteria and features in GBI Malaysia still do not focus on affordable housing. Since there is no actual GAH in Malaysia, this study tends to fill up the gaps that exist between GBI and NHP and match it with the current GAH criteria and features from previous studies. To recap, the initiative of combining green building criteria innovations with affordable housing needs is new in some ways, but the general overlapping of interests is well established. Countries such as United Kingdom, United States, and Australia have already adapted the concept of GAH based on their local conditions. Therefore, this study is to establish the criteria and features for GAH that are compatible to local condition as a guide to the developers and stakeholders for future GAH development. The framework would determine the matching GAH criteria and features from potential home buyers and developers perspectives which are not only green but also affordable to the middle income group of potential home buyers.

Generally, as observed from prior studies, many criteria and features can be incorporated into affordable housing to make it GAH. GAH criteria and features are those that lead to energy efficiency, improved indoor environmental quality, sustainable site, conservation of material and resources, water efficiency and latest innovation. Thus far, it is not known which of the criteria and features are preferred by

the potential home buyers and whether the developers are willing and ready to adopt them. Unfortunately, even if the potential home buyers are willing to pay for the preferred criteria and features, it is still unsure whether the developers are ready to adopt them. Thus, it is interesting to identify the criteria and features these developers are ready to adopt to maximize their profit. This is due to the fact that incorporating green criteria and features to affordable housing may affect the incremental costs for the developers. These incremental costs subsequently will increase the price of affordable housing, and the burden for these incremental costs will ultimately be borne by the potential home buyers. The question is how much the potential home buyers are willing to pay more for the incremental costs? And also how much the developers are willing to absorb the incremental cost for each of the GAH features? Whether or not the costs of criteria and features preferred and willing to be paid by the potential homebuyers are within the range of incremental costs to be borne by the developers is unknown. So far there are no known criteria and features that can match for both potential home buyers and the developers.

All of the questions raised have indicated that there is a mismatch between the perspectives of both parties. However, previous studies on the issue did not simultaneously observe the real estate market interaction between demand of potential home buyers and supply from the developers. For instance, many of these studies focused only on one side of the market either the demand or supply sides. An involvement of the two type of respondents with different interest in the housing market would have captured the GAH market efficiently. Developers and potential home buyers may have their own perspectives towards the GAH criteria and features. A study is needed to determine the green criteria and features that both the potential home buyers are willing to pay and the developers are ready to adopt as previous study do not sufficiently covering both perspectives. The mismatch of the criteria and features from both perspectives contributes to the whole picture of the GAH development in Malaysia. Therefore, this study attempts to reduce the gap of mismatch by investigating these issues. Following the above discussion, the knowledge and practical gap of this study has been conclude in Figure 1.1.

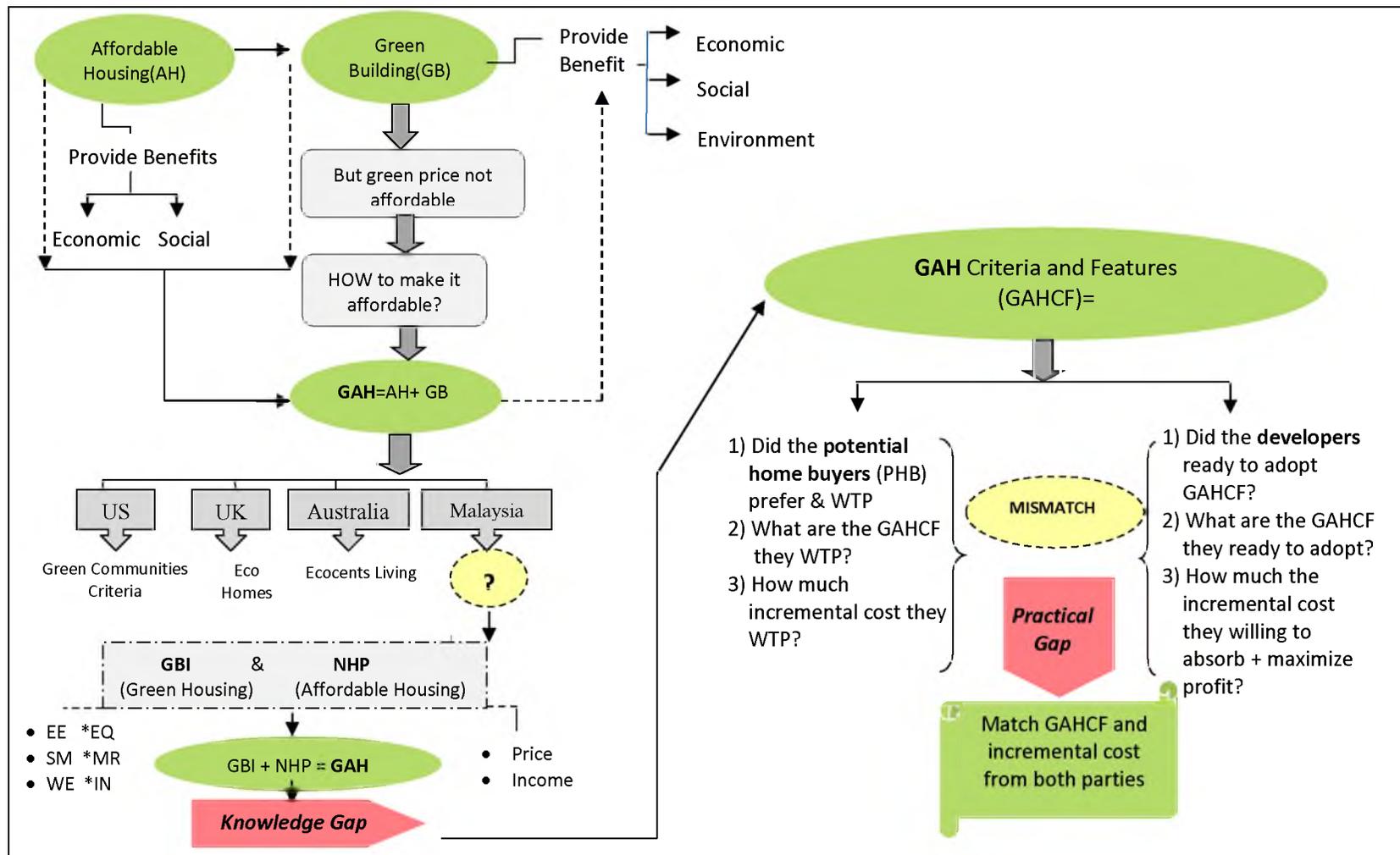


Figure 1.1 Gap Analysis Review for GAH in Malaysia

## **1.4 Research Questions**

Research questions have been formulated in order to guide the research and achieve the research objectives. Therefore, the following research questions are outlined as follows

RQ1.1: What are the concepts and criteria of green affordable housing?

RQ 2.1: What are the green affordable housing criteria and features that potential home buyers prefer and willing to pay more?

RQ 3.1: What are the appropriate criteria and features that should be incorporated by the developers into green affordable housing in Malaysia?

RQ 3.2: How much incremental costs are incurred and house prices increased if the green criteria and features are incorporated into affordable housing based on perspectives of developers.

RQ 4.1: How is the market integration framework of GAH from the both parties' perspectives will be developed?

RQ 4.2: What are the practicable and important criteria and features based on the framework can be incorporated by the developers to green affordable housing in Malaysia?

## **1.5 Research Objectives**

The main goal of this study is to develop a framework towards producing appropriate green criteria and features to be incorporated into affordable housing. The framework is developed to guide developers in the development of green affordable housing. In order to accomplish the goal, four objectives have been outlined as below:

- 1) To identify the criteria and features of green affordable housing.
- 2) To determine the potential home buyers' preferences and willingness to pay for green affordable housing criteria and features.
- 3) To determine the developers' perspectives towards green affordable housing criteria and features.
- 4) To develop a framework for green affordable housing criteria and features based on potential home buyers' and developers' perspectives.

## **1.6 Research Scope**

This study has selected three groups of respondents, namely; potential home buyers, developers, and experts in three research areas which are in Klang Valley, Johor Bahru and Penang. These areas have been chosen due to a lot of registered and certified green housing projects. According to Green Building Index (2016), from total 353 certified projects by states or territories, 306 projects are from these three areas. In fact, total certified projects in Klang Valley are 251 projects, Johor Bahru with 32 projects and Penang with 23 projects. Moreover, this area has been chosen due to similar market features such as active market with highest demand and supply gap in Malaysia (Lee et al., 2020; Chan and Lee, 2016). Moreover, as this study focus on affordable housing, the market features are similar due to affordable housing is a control market in Malaysia (Tobi et al., 2020; Masram and Misnam, 2019).

This study targets on potential home buyers who are interested in buying, and those who are capable to buy but they might not buy (Zhang et al., 2011; Ling & Gunawansa, 2011, Gunawansa et al., 2010; Martin et al., 2007). According to Dawson (2008), the classification of potential home buyers should be based on market segmentation that was derived from their income, age, gender, geography and other characteristics relating to buying. Nevertheless, the focus of this study is only on potential homebuyers' willingness to pay for GAH criteria and features and not on the potential homebuyers' other characteristics. WTP for potential home buyers in this

study focus on asking potential home buyers in advance about their own estimate of their future willingness (Abualtayef et al., 2019).

The scope of this study also targets the potential home buyers in the middle income group. According to the National Census in 2020, the middle income (M40) household which covered 40 percent of the Malaysian population received RM4,850 to RM10,959 per month. However, findings from a study by Aziz, Hanif and Singaravello (2011) in Klang Valley, Johor Bahru and Penang revealed that these three areas are categorized as higher income proportion due to the urbanization and per-capita income for these cities. This affects the categorization of household income per month for middle income in these three cities to be between RM 2000 and RM 8000 with housing price affordability ranging from RM 120, 000 to RM 180, 000. This is a serious issue for this middle income groups as affordable housing provided by the government only cater the needs for the lower income groups (Aziz et al., 2011; Musa et al., 2011; Tawil et al., 2011; Mousavi et al., 2013). In contrast, the problem in ownership of housing for middle income group especially in these developed cities have been given less attention by the authorities and also the researchers (Aziz et al., 2011, Tawil et al., 2011). This study used stratified sampling for potential homebuyers. However the analysis done as whole with combining the repondents from the three cities follow the previous study done by Lee et al., 2020, Yap and Ng (2018) and Chan and Lee (2016).

This study also emphasizes on 15 certified developers with Green Building Index (GBI) for newly constructed green residential property in the study area. From the fifteen developers involved in this study, ten developers were from Klang Valley, three developers from Johor Bahru, and two developers from Penang. The total green housing projects for each of the developers were three projects in Johor Bahru, twelve projects in Klang Valley and seven projects in Johor Bahru. The expert panels in this study were selected based on their expertise in the field of landscape, marketing, project management, architecture, quantity surveying, engineering, consultancy, policy makers, local authorities, researcher, and academic.

In order to develop a framework for green affordable housing criteria and features, this study also focuses on affordable housing price range between RM 120, 000 and RM 200, 000 for landed and stratified residential property. The GAH criteria and features in this study are focusing in building design that comply with affordable housing prices. The selected green criteria and features to be incorporated into affordable housing also did not target on getting certification as current green housing projects in Malaysia. This study only followed the GBI by focusing on the criteria and features that match with the affordable housing criteria. Finally, the market features covers in this study related to potential homebuyers' willingness to pay (WTP) for GAH criteria and features, extra cost potential homebuyers' WTP, developer readiness to adopt extra cost for adoption of GAH Criteria and features and extra cost for adoption of GAH criteria and features.

### **1.7 Research Significance**

This study contributes to the increasing body of knowledge in GAH development specifically the gap regarding the criteria and features that suit the GAH. The aim of this study to develop a market driven framework for GAH and provides a list of GAH criteria and features, which could help developers to bring better affordable housing that suite to local condition of the humid region environment in Malaysia. The framework also acts as a green and affordable housing solution (environmental friendly, affordable price, economic and social benefit). In addition the framework would boost the development of GAH in Malaysia as an approach highlighted in the National Housing Policy, Ministry of Housing and Local Government (MHLG) and Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC). The market driven framework also provides a good foundation for an establishment of a formalized GAH in Malaysia and may be applied to complement the GBI.

The contribution of this study is obvious as the outcomes leading to guidelines for relevant parties such as developers, potential homebuyers, local authorities, policy makers, and academician. The developed framework could assist developers to make decision towards the criteria and features in the development of GAH in Malaysia. The

finding also could encourage developers to allocate budgets to construct and incorporate GAH criteria and features based on their importance as provided by the framework. On the other side of demand, the framework would help the potential home buyers to make choice on GAH purchase based criteria and features, and the price of housing within the incremental cost they are willing to pay.

In addition, the uniqueness of the framework significantly contributes to guide the local authorities and the policy makers such as KPKT and KeTTHA to monitor and encourage the GAH development in Malaysia. It also facilitates them to formulate the future planning for GAH development at all district, state, and national levels. Thus, in an effort to give extra understanding concerning the future planning of GAH, this framework drives the existing boundary by connecting the affordable housing with green building criteria and features. Finally, this study can be used as a guide and reference for academician and future researcher regarding the topics. The result from this study can be used for further research in the field of GAH development.

## **1.8 Overview of Research Methodology**

Towards developing a framework for GAH criteria and features, this study identified the green criteria and features for affordable housing development based on parameters gathered from the previous literature. Accordingly, the GAH criteria and features were determined based on the potential home buyers' preferences and willingness to pay, and the developers' perspectives in terms of readiness to adopt. Furthermore, the framework for GAH criteria and features from both parties' perspectives was developed. Acknowledged the characteristic of the proposed study, cross sectional survey design was adopted for the data collection. Through this research design, data was collected at one point in time and helped to determine the current thought and practices within limited time frame (Creswell, 2003, 2009; Cooper & Schindler, 2014). A quantitative methodology was employed with quantitative survey questionnaires were distributed to the selected area of study.

The methodology for this study consists of four main phases in order to achieve the four objectives; 1) To identify the criteria and features of GAH; 2) To determine

the potential home buyers preferences and willingness to pay of GAH criteria and features; 3) To determine the developers' perspectives towards GAH criteria and features and 4) To develop a framework for GAH criteria and features based on both parties perspectives. The explanation of each Phase has been divided into research methods, data analysis, and outcome of each objective. The details of each phase are illustrated in Figure 1.2.

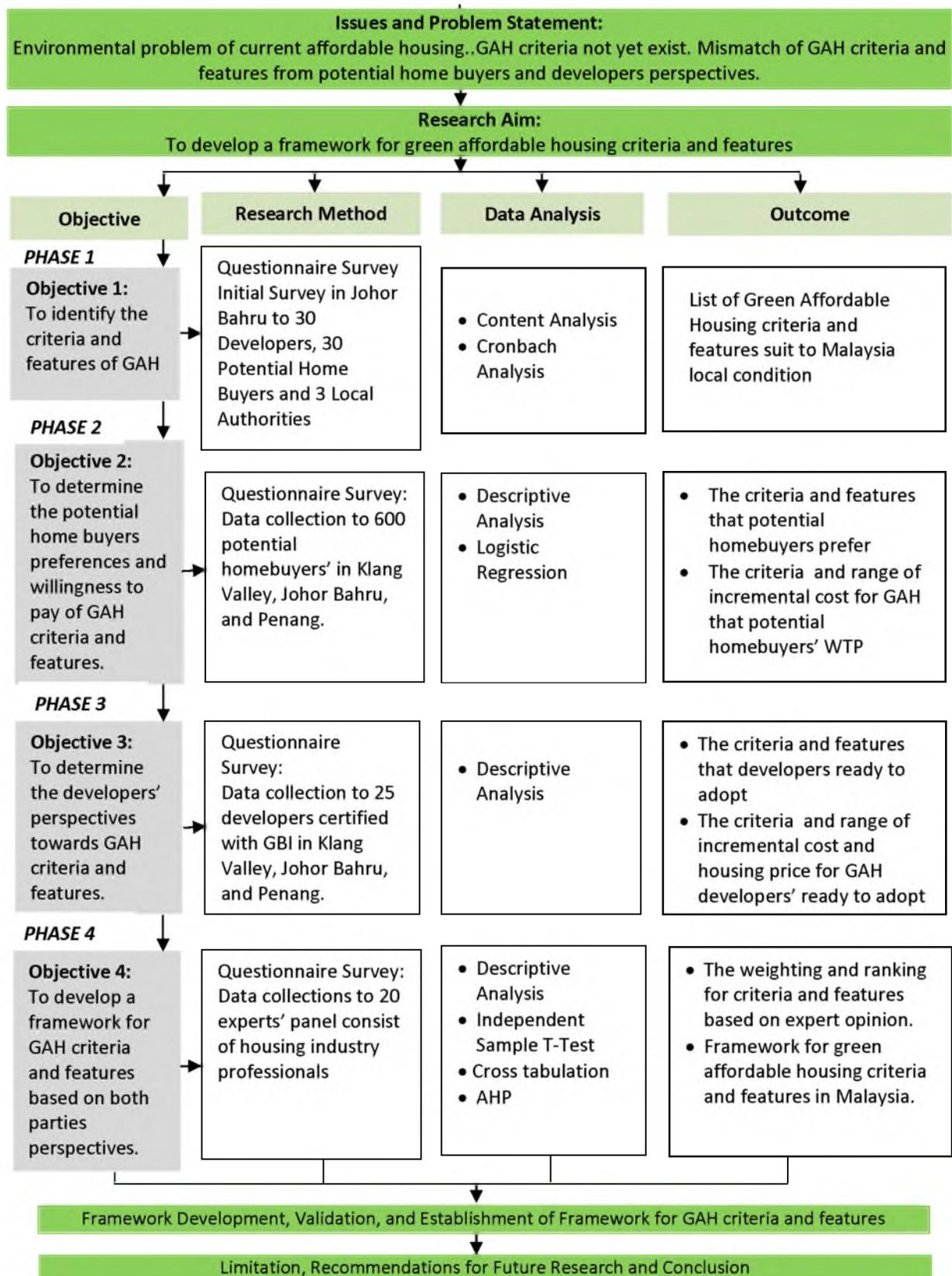


Figure 1.2 Overview of Research Methodology

## **1.9 Organisation of Chapters**

The structure and content of this thesis are divided into four parts. Part A is general introduction of the thesis consisting of Chapter 1. Part B discusses the literature review and study methodology which consists of Chapter 2, Chapter 3, and Chapter 4. Part C explains the study findings, framework development, and validation with two chapters, Chapter 5 and Chapter 6. Finally, Part D is the conclusion of the thesis comprises of Chapter 7.

Generally, Part A introduces the thesis which include Chapter 1. Next, Part B consists of an overview of the relevant literature available regarding the concept of GAH as in Chapter 2, market perspectives of GAH as in Chapter 3, and research methodology as in Chapter 4. Further, Part C discusses the findings of the study from the data analysis and results in Chapter 5. This chapter explains the Logistic Regression Analysis and descriptive analysis which are used to analyse and present the statistical results from the data. Accordingly, Chapter 6 in this part is clarifies the process of framework development in five stages using Independent Sample T-Test, Crosstabs and AHP method before validating the framework.

Finally, part D of this thesis which is the conclusion chapter, Chapter 7 summarizes the findings based on the objectives, contribution of study based on knowledge and practical contribution, the limitations of study and suggestion for future research. Figure 1.3 provides a detail explanation of each Part and Chapter with schematic representation of the organisation of this thesis.

## **1.10 Chapter Summary**

This chapter opens with the background of the study and further discuss the issue and gap of green affordable housing criteria in Malaysia. This is followed by the research questions, scope, significance of the research, and overview of research methodology. This chapter concludes with the organisation of the thesis. The following chapter is designed at explaining a review of the literature on the concept of green affordable housing.

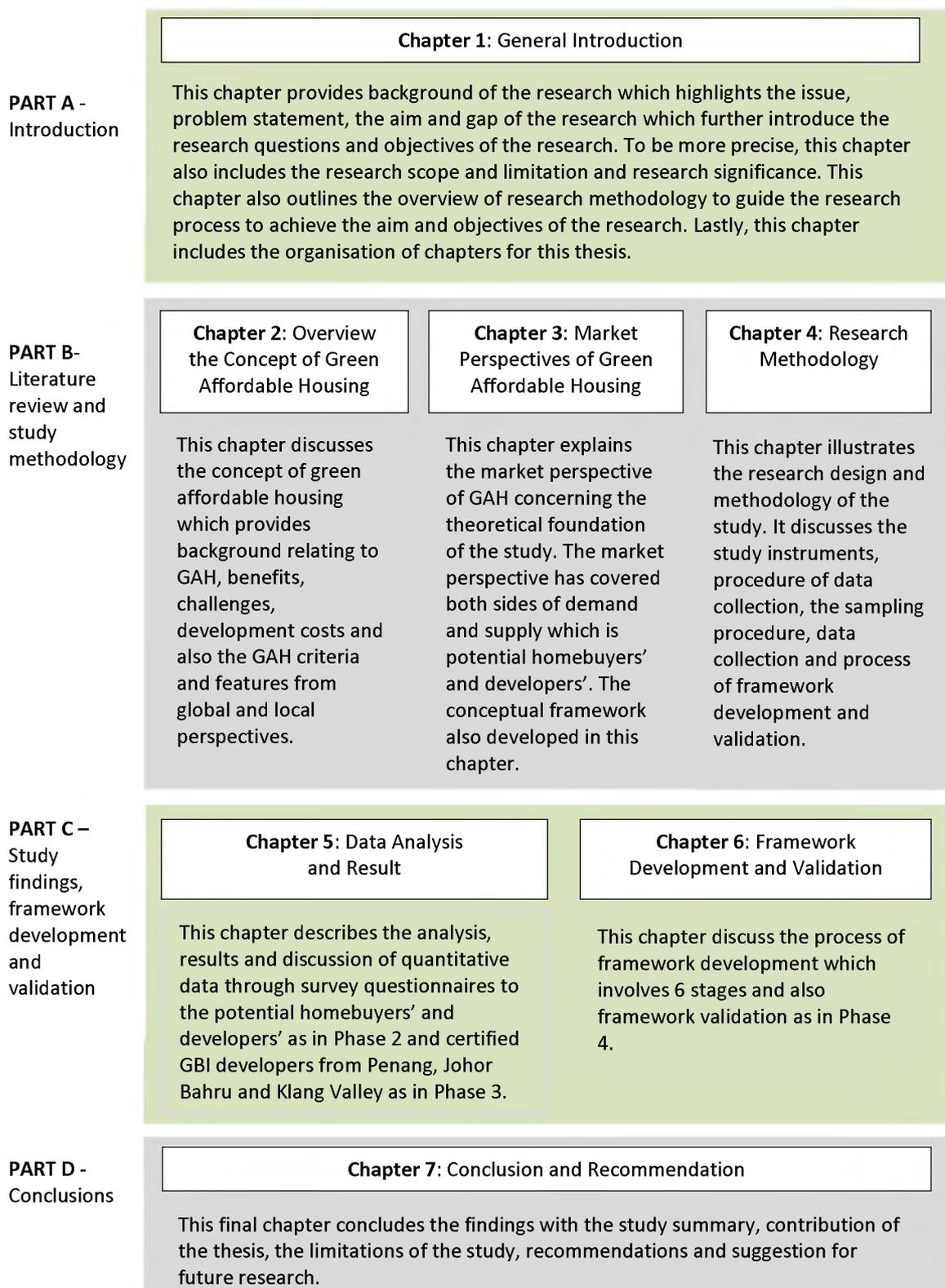


Figure 1.3 Organisation of Thesis Chapter

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