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LOW CARBON CAPABILITY BEHAVIOR FRAMEWORK AS CLIMATE CHANGE MITIGATION FOR URBAN RESIDENTIAL AREA IN PUTRAJAYA, MALAYSIA

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By

ANI SHAZWANI BINTI ABAS

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
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Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

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Chairman : Mohd. Yazid Mohd. Yunos, PhD
Faculty : Design and Architecture

Malaysia's rapid urbanization rate has led the country to contribute relatively high greenhouse gas emissions among the Southeast Asian countries. The carbon dioxide emission from the residential sector is expected to increase by the year 2020, with the emission factor based on residential energy consumption. The carbon dioxide (CO_2), which is well-known as the most prevalent greenhouse gasses that cause global climate change, is scientifically proven are contributed by various human activities, especially in cities. Henceforth, the role of urban residents towards climate change mitigation effort is undoubtedly necessary. Many policies and plans have been developed in Malaysia towards mitigating climate change, including the Low Carbon Cities Framework and Assessment System (LCCF). Unfortunately, there is less focus has been paid to urban residents' low carbon capability behavior in realizing the existing low carbon policies. This denotes that there is a gap between the policies and built plans with the urban resident's low carbon capability behavior. Nevertheless, to promote the low carbon capability behavior, understanding urban resident's climate change awareness is also crucial. Hence, an explanatory research was carried out to explore and propose the Low Carbon Capability Behavior Framework (LCCBF) for the urban residential area as a climate mitigation effort. Putrajaya, one of Malaysia federal territory, has been designed as the garden city, further has remarkably progressed its mission towards green and sustainable cities by the year 2025. Thus, it is selected as the sample population to carry out the research. The expert panel focus group discussion and urban residents survey for the Putrajaya case study was carried out to accomplish the research goal. The expert focus group discussions verified that the LCCBF should consist the main three aspects which are: the low carbon mobility, the low carbon living and housing, and the low carbon community choices. Meanwhile, urban resident's behavior preferences and technology to support low carbon capability behavior is essential under each of the aspects. Whereas, the result of the survey revealed that the highly influencing factors towards urban residents low carbon capability behavior is the value of perceptions. The most preferred low carbon

capability behavior was also highlighted and further proposed to be an indicator for the overall of the LCCBF. This study in additional, will guide local authorities to better understand the urban resident's low carbon capability behavior, and improve their current program and plans towards promoting and implementing low carbon community. Meanwhile, town planners and designers, can enhance their knowledge in planning and designing the low carbon facilities for urban residential area that will encourage low carbon capability behavior.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

RANGKA KERJA KEUPAYAAN TINGKAH LAKU RENDAH KARBON SEBAGAI MITIGASI TERHADAP PERUBAHAN IKLIM DI KAWASAN PERUMAHAN BANDAR PUTRAJAYA, MALAYSIA

Oleh

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Malaysia secara relatifnya telah menyumbang terhadap pembebasan gas rumah hijau yang tinggi berbanding dengan negara Asia Tenggara yang lain disebabkan oleh kadar pembangunannya yang pesat. Penggunaan tenaga di kawasan perumahan telah dikenal pasti sebagai faktor utama kepada pembebasan gas karbon dioksida (CO_2), dijangka akan terus meningkat sehingga tahun 2020. Gas karbon dioksida (CO_2) yang juga diketahui umum sebagai gas rumah hijau paling berbahaya dan menyebabkan perubahan iklim global telah dibuktikan secara saintifiknya dibebaskan oleh pelbagai jenis aktiviti manusia, khususnya di kawasan bandar. Oleh itu, kepentingan peranan penduduk di kawasan perumahan bandar terhadap mitigasi perubahan iklim tidak dapat dinafikan. Selain itu, Malaysia juga telah banyak membangunkan polisi dan pelan sebagai mitigasi terhadap perubahan iklim, termasuklah Rangka Kerja Bandar Rendah Karbon dan Sistem Penilaian (LCCF). Walau bagaimanapun, terdapat kekurangan fokus terhadap keupayaan tingkah laku penduduk di kawasan perumahan bandar dalam merealisasikan polisi rendah karbon sedia ada. Hal ini menandakan terdapat jurang di antara polisi dan pelan yang telah dibangunkan dengan keupayaan tingkah laku rendah karbon di kalangan penduduk di kawasan perumahan bandar. Namun begitu, untuk menggalakkan keupayaan tingkah laku rendah karbon, memahami tahap kesedaran penduduk terhadap perubahan iklim di kawasan perumahan bandar adalah sangat penting. Oleh itu, sebagai usaha membangunkan sebuah Rangka Kerja Keupayaan Tingkah Laku Rendah Karbon (LCCBF), satu kajian eksploratasi telah dijalankan di kawasan perumahan bandar sebagai usaha terhadap mitigasi perubahan iklim. Putrajaya, ialah salah satu wilayah persekutuan di Malaysia, telah direka bentuk sebagai sebuah bandar di dalam taman dan telah berkembang pesat ke arah mencapai misinya sebagai bandar hijau dan mapan menjelang tahun 2025. Sehubungan itu, ia telah dipilih sebagai sampel populasi bagi menjalankan kajian ini. Satu perbincangan kumpulan berfokus panel pakar dan kaji selidik untuk kajian kes di Putrajaya telah dijalankan bagi mencapai matlamat kajian ini. Hasil daripada perbincangan kumpulan berfokus panel pakar telah mengesahkan bahawa LCCBF

perlu terdiri daripada tiga aspek utama komuniti rendah karbon iaitu: mobiliti rendah karbon, perumahan dan kehidupan rendah karbon dan pilihan masyarakat rendah karbon. Manakala, tingkah laku yang disukai oleh penduduk kawasan perumahan bandar dan teknologi untuk mendokong keupayaan tingkah laku rendah karbon adalah penting di bawah setiap aspek tersebut. Hasil daripada kajian ini juga telah menunjukkan bahawa nilai terhadap persepsi adalah faktor yang paling mempengaruhi tingkah laku rendah karbon di kalangan penduduk kawasan perumahan bandar. Tingkah laku keupayaan rendah karbon yang paling disukai juga diketengahkan dan seterusnya dicadangkan sebagai petunjuk keseluruhan bagi LCCBF. Selain itu, kajian ini juga dapat membantu pihak berkuasa tempatan untuk lebih memahami faktor paling utama dalam mempengaruhi keupayaan tingkah laku rendah karbon penduduk di kawasan perumahan bandar dan seterusnya menambah baik program semasa dan perancangan ke arah menggalakkan dan melaksanakan komuniti rendah karbon. Manakala, untuk menggalakkan lagi tingkah laku keupayaan rendah karbon, juru perancang bandar dan pereka bandar juga boleh meningkatkan pengetahuan mereka dalam merancang dan mereka bentuk kemudahan rendah karbon bagi kawasan perumahan bandar.

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I certify that a Thesis Examination Committee has met on 4 August 2017 to conduct the final examination of Ani Shazwani binti Abas on her thesis entitled "Low Carbon Capability Behavior Framework as Climate Change Mitigation for Urban Residential Area in Putrajaya, Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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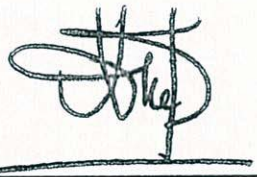

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision reponsibilities as stated in Rule 41 in Rules 2003 (Revision 2012 – 2013) were adhered to.

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Signature : _____
Name of Member of Supervisory Committee : Dr. Faziawati Abdul Aziz

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CO_2	Carbon dioxide gases
GHG	Greenhouse gases
LCCF	Low Carbon Cities Framework and Assessment System
LCCBF	Low Carbon Capability Behavior Framework
KeTTHA	Kementerian Tenaga, Teknologi Hijau dan Air
IPCC	Intergovernmental Panel on Climate Change
DEFRA	Department of Food and Rural Affair, London
EST	Energy Scheme Technology for Energy Saving Trust, London

CHAPTER 1

INTRODUCTION

1.1 Introduction to Chapter

This chapter describes the background of the research, presenting the detailed explanation of its subject, problem statements and gaps in the research, research questions, research aim and research objectives. This chapter also discusses the summary of research scope, research significance, and structure of the research. This research focuses on the topic of community awareness with a global climate change phenomenon, and their behavioral preferences towards the low carbon community, in an effort to develop a framework of low carbon capability behavior that meets the preferences of urban residential communities.

1.2 Background of Study

Access to sustainable life has been the greatest challenge facing by a human being in this era. The world energy scheme that turns to heavily dependent on the fossil fuels during the nineteenth centuries lead humanity to confront the climate change and worldwide environmental pollutions, that will keep threatening our well being and future generations (Jiang et al., 2013). Intergovernmental Panel on Climate Change (IPCC) in its 2014 Climate Change Synthesis Report has broadly concluded that the global average surface temperature has risen over the 20th century by about 0.6°C where snow bury and ice extent have reduced, and global average sea level has increased and ocean heat content has increased (IPCC, 2014). Besides, there is also a 90% chance that this is the result of human activities where Whitmarsh et al., (2011) highlighted numerous scientific evidence indicating that human activity is the most significant contributor towards climate change impact. It is apparent from Figure 1.1 that the melting Arctic sea ice is occurring comparing the year 1980 with current 2012, hence clearly show that the issues of global climate change impact are far critical than many of us think.

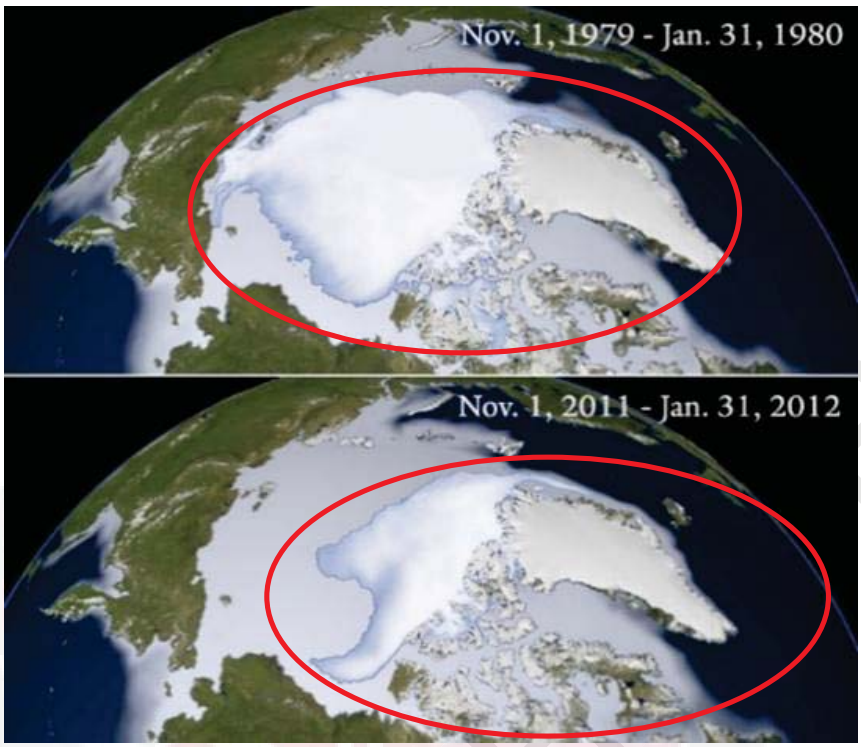

Figure 1.1 : Evidence of global climate change is obvious and happening. The melting Arctic sea ice
(Source : NASA Satellite Images, 2012)

Hence, a serious measure is crucial in order to start cutting down our CO_2 emissions, as it is well acknowledged that our climate change is changing and our activities play their part. The intensity of increasing climate change has been felt worldwide. The IPCC (2014) also warned the Southeast Asia countries that global climate change can cause the threat of sea level rise, where tide gauge data depict that global average sea level increased between 0.1 and 0.2 meters during the 20th century. As can be seen in Figure 1.2, the increased flooding from the sea and rivers in some deltas will put the coastal areas, especially the densely populated mega-delta region in South, East, and Southeast Asia at greater risk, including our countries, Malaysia. If climate change continues unconcerned, major urban cities built near sea level will see significant impacts, resulting from the global climate change.

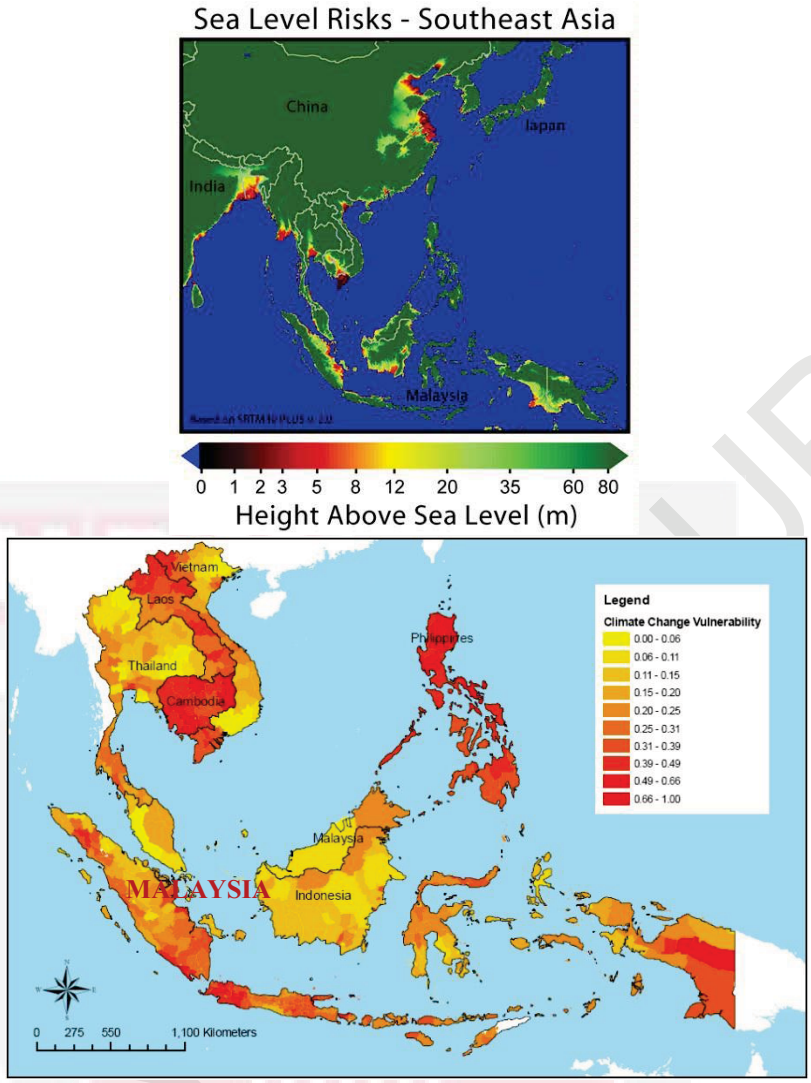

Figure 1.2 : Southeast Asia countries, the sea level risks resulted from global climate change
(Source : climatecentral.org and International Development Research Center)

Meanwhile, Figure 1.3 shows the various climate related disasters that have occurred in Malaysia. On December 2014, heavy flooding hit the east cost Malaysia which record shows the worst in history. Settlements in Kelantan state were seriously affected, which the floods swept away thousands of homes and inundated for more than three days, creating chaos among local people. The post-flood aid is still being tackled by the state authority and government in terms of facilities rehabilitation and providing shelter for the lost. Moreover, the cyclone that never hit Malaysia before had also occurred in Pendang, Kedah state on November 2014 and caused damages to local houses, as reported in local news. Not to forget, in recent June 2015, Sabah state had also experienced a shocking earthquake disaster that has caused a lot of destruction of local communities. Thus, we can never say that climate change is not occurring because our mother-nature has spoken the cause and their consequences to us, and as well as a vast of produce scientific evidence.

Figure 1.3 : A series of recent disaster in Malaysia that could result from global climate change
(Source : Various local news)

Therefore, Casper (2010) highlighted that these global phenomena require the effort of everyone to tackle and manage the growing problems, although some geographical areas will be hit harder than others and different ways affected different areas. Emissions of greenhouse gasses (GHG) such as carbon dioxide (CO_2), methane, ozone, chlorofluorocarbons, water vapor and nitrous oxide were the biggest factor that contributes towards the climate change threat. It was added to the alarming rate in our atmosphere, by our daily activities. Moreover, various activities across the world such as agricultural and deforestation practices also emit greenhouse gases. Hence, gaining an understanding towards various sources of GHG and why controlling them is critical to Earth's future climate change is very important, for people to start taking corrective actions. However, among the GHG's, carbon dioxide (CO_2) is well-known as the most prevalent GHG's in the atmosphere that contributes towards climate change. Figure 1.4 presents the CO_2 as the most anthropogenic gasses, presented by 82% compared to other GHG's that lead towards global climate change.

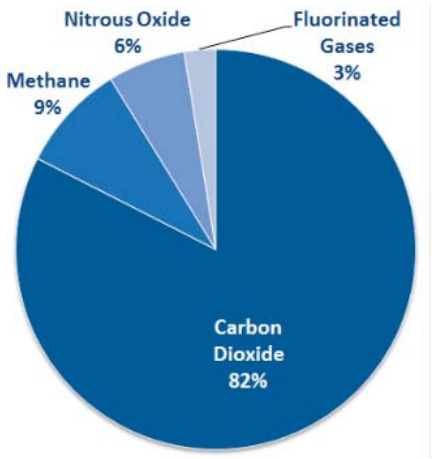

Figure 1.4 : Carbon dioxide (CO_2) as the most anthropogenic gasses among the greenhouse gas (GHG) emissions
(Source : UN-Habitat, Cities and Climate Change - Global Report on Human Settlements, 2011)

According to the IPCC, the year 2010 GHG emissions were largely contributed by the 35% of the energy sector in world urban areas, whereas, DEFRA (2007) pointed out, for many developed nations like Malaysia, carbon emissions were produced mostly from the personal vehicle and domestic energy use. Making it worse, the intense urban development has led to higher carbon emissions, which is the key contributor towards climate change. This is true where an individual car, used daily by urban communities in Malaysia, could emit up to 150 g CO_2 per kilometer of each journey made, contributing to the largest CO_2 emissions (MGC, 2016).

Nevertheless, the world's urban area, which covers 2% of the world's surface and consumes about 75% of the world's energy consumption, are responsible for 80% of the world's GHG emissions. Meanwhile, the increased urban development in Malaysia, which is expected to increase up to 79.6% by the year 2025, making the increase of CO_2 emissions emitted by urban sector is indisputable (Hashim, 2015). Besides, cities are projected to perform an important task in climate change mitigation, given their excessive present influence to GHG productions and that population and economic activity are expected to remain to incline towards them (Hoornweg et al., 2011 and Kennedy et al., 2009). Hence, it is an urge for people to be well informed with their ability to reduce the CO_2 emissions, especially in the urban residential area. However, research has also shown that people's willingness to participate or support the adaptation efforts towards climate change is undermined due to general lack of public awareness, or worse, complete miss-understanding (Lieske et al., 2014). Whereas, Whitmarsh et al., (2011) and Casper (2010) also conclude that this could be due to people's knowledge and behavior engagement towards the issues that are still far lower and yet limited. Therefore, investigating peoples' awareness with regards to climate change issues is a vital step in order to encourage a low carbon capability behavior where the community can further adapt to climate change impact. It is also clear that individuals in a community have the key role to play in focusing the effects of climate change in futures. This is well supported by Hayles and Dean (2015), where they pointed out the important roles of taking ownership and reducing one's own

impact on the planet through the way in which one tackles daily decisions that involve carbon-intensive activities and hence live more sustainably.

1.3 Research Problem

As Malaysia environmental concerns have been highlighted in their Five-Year Plans to accomplish the vision of achieving a developed country by the year 2020, the overarching framework for sustainable development aims that is exemplified in the Third Malaysia Plan (1976-1980) is being incessantly engaged. The green technology portfolio has further strengthened the Ninth Malaysian Plan (2006-2010) in the newly restructured Ministry of Energy, Green Technology and Water. The attempt to decrease emission by climate adaptation and mitigation measures has been also intensified by the government under the Tenth Malaysia Plan (2011-2015) (Ho, 2011). Recently, the Eleventh Malaysian Plan (2016-2020), the Government has set a new milestone in an effort towards carbon reduction, by producing government's Green Environment Low Carbon with the target of 40% carbon emissions reduction by the year 2020.

Moreover, Malaysia has also acknowledged the United Nations Framework Convention on Climate Change (UNFCC) in 1994 and the Kyoto Protocol in 2002 as well. This is well-supported by the First and Fourth Trusts of the National Mission focusing on the avoidance of the carbon emission pathway and minimization of their impacts as one of the potentials for climate change beneficial in the aspects of economic and environmental sustainability. The climate change impacts that had been felt by local area in the past few years across the Malaysian region has driven this commitment. Although Malaysia has still not to face the dangerous effects of climate change, mild climate-related catastrophes such as floods, droughts, storm or wave surges, wildfires, windstorm and landslides are occurring regularly (Ho, 2011). Hence, a wider aspect of awareness with regards to a climate change is needed to be featured in measuring urban community awareness. In fact, a community must first understand the issues and consequences of their personal actions and then be willing to make proper changes in their decisions and lifestyle, in order to make an effective change and forwardly mitigate the global climate change. Evidently, it is an urge for us to start measuring our community awareness towards climate change issues to accomplish the sort of aspiring carbon-reduction goals committed by the Malaysian government.

For that reason, Malaysia, in commitment towards global climate change, has also introduced their Low Carbon Cities Framework and Assessment System (LCCF) under the Ministry of Energy, Green Technology and Water (KeTTHA, 2011). The LCCF is accelerated with the Honorable Prime Minister of Malaysia speech, Dato' Seri Najib Abdul Razak at Copenhagen (COP15) on December 2009, that pledge to lower carbon emission intensity by 40% per GDP by the year 2020. Prior to COP15 as well, the Malaysian government also unconcealed the National Green Technology Policy on 2009 with the policy that built upon four pillars and underlines the five main objectives which include the fifth as "boosting public education and awareness of green technology and promoting its widespread usage". Moreover, the LCCF also targets to "create awareness, encourage and promote the idea of green cities in

Malaysia, thereby assisting to decrease carbon emission in cities and townships". Meanwhile, during the COP20 that was held in Lima, Peru on December 2014, it is clearly stated that our country, Malaysia, has successfully reduced the carbon emissions intensity by 33%, as announced by our Prime Minister during the Climate Summit 2014 in New York, hence, making the country in track with the commitment made during the COP15. Our countries further pledge to cut carbon emissions intensity by 45% by the year 2030 during the COP22 that was held in Marrakech, Morocco in the year 2016. This contain of 35% on an unconditional basis and a further 10% is the condition upon receipt of climate finance, technology transfer and capacity building from developed countries. Besides, the Roadmap of Emissions Intensity Reduction developed by Malaysia in 2014, showed that the country has the chances from various sector to achieve the targets. However, considerable efforts would be necessary to obtain this emissions reduction in light of the challenges and barriers while these opportunities exist (Fulton et al., 2017).

In spite of this, the recent Malaysia Low Carbon Cities Framework and Assessment System (LCCF), only focus on larger scope and wider aspects of parameters to reduce CO_2 emissions. Even though one of the LCCF aims is to create awareness, LCCF provides less focus on the urban residential communities in the aspects of awareness and their readiness to commit with low carbon capability behavior and thus becomes one of the challenges that require effort to realize the countries commitment to reduce the national carbon emissions.

This is due to LCCF that only focuses on bridging the gap between current policies of the government with the many building rating tools that currently available in the markets. LCCF is mainly created to help decrease their carbon emissions, specifically on strategies and measures towards carbon reduction by developing action plans and defining stakeholder priorities in cities and townships. It is undeniable that many sustainability research in Malaysia is currently related to the assessment of the low carbon building, low carbon energy and infrastructure, low carbon transportation and technology and much more. The research is certainly essential in order to realize the government policies of climate change mitigation efforts. Hence, it can be concluded that the current government's climate change mitigation efforts towards implementing low carbon communities and low carbon cities are directing in the top-down approaches.

However, the government policies related to low carbon community, must not only concentrate on the top-down approaches. Instead, it needs to combine both the top-down and bottom-up approaches in its climate change mitigation policies and plans. This is where the study will contribute towards the bottom-up approaches, related to urban resident climate change awareness and their low carbon capability behavior, despite many policies and guideline exist. In dissimilarity to top-down approaches, the bottom-up approach promotes urban communities to employ resident's abilities and knowledge to recognize their variability in behavior that was adapted to their necessities. This self-directed approach joint with capacity building efforts is likely to improve urban community's adaptive capacity and decrease its susceptibility towards climate change impact (Figueiredo and Perkins, 2013).

Meanwhile, human induced CO_2 which is the main component of green house gas (GHG) emissions, provides significantly to the imminent environmental challenges. Cities also construct an integral part of the sources of solutions although they are being known as the main providers to the global GHG emissions,. Thereby, cities are an ideal place to decrease carbon emissions (Chan et al., 2013). In the case of local context, Malaysia rapid urbanization has lead to the series of environmental challenges including harmful waste secretions, climate change, environmental pollution and ecosystem breakdown, to name a few, are the environmental catastrophes that are accustomed by the general public. These have been long articulated by a significant amount of researchers from varied scientific disciplines (Dominick et al., 2012; Asmuni et al., 2012). Upon higher urbanization rate, municipal solid waste (MSW) is generally known as refuse or garbage that is removed from the residential, commercial and institutional areas (Fodor and Klemes, 2012).

57% of the MSW is composed by organic solid waste and the MSW generation is expected to surpass 9 Mt/yr by the year 2020 based on the existing MSW production rate of 0.5-0.8 kg/person in the case of Malaysia, (Bong et al., 2016). This directs to two main issues, which are limited land area for landfills and growth of GHG emission from the landfill. Apart from the GHG emissions that come from municipal solid waste discarded from the urban residential area, it is also reported that 30% of the CO_2 emission development also came from the residential use and building, road traffic, and electricity and heat productions (Burck et al., 2014). Besides, the aspect of climate change awareness is vital in an effort to realize the shifts towards the low carbon community and the low carbon cities in Malaysia. A recent research by local researchers confirms that the level of environmental awareness towards climate change among Malaysian is lowered compared to the level of environmental awareness towards water pollution, air pollution and waste management (Neo et al., 2016). Meanwhile, Siti Mazwin et al., (2016) also revealed a similar result on the environmental awareness of local Malaysian related to the environmental program. It is found that community awareness can be interpreted as low based on the low number of participants in programs (22.1%) and a low number of respondents who had knowledge of the environmental programs (84.9%).

In related to low carbon community and low carbon cities that have been introduced by local authorities, the local municipalities of Putrajaya has carried out various of the program to introduce the public to the low carbon capability behavior and lifestyle. Moreover, Putrajaya local policies which focused on moving Putrajaya towards low carbon city, enhancing community living environment and implementing integrated transportation system, have provided a good platform for developing a visionary low carbon community and low carbon cities. Nevertheless, the recent Low Carbon Cities Framework and Assessment System (LCCF), has been adopted by Putrajaya local authorities, in the vision of transitioning their cities to low carbon futures. As awareness is defined as the initial phase of the learning process towards pro-environmental behaviour and is highly influenced by various internal and external factors (Zsoka et al. 2013), it is clear that investigating Putrajaya urban resident's awareness with regards to climate change is a vital step to encourage the low carbon capability behavior while measuring Putrajaya urban residents climate change

awareness is an essential step to identify the highly influencing factors towards urban residents low carbon capability behavior.

1.4 Problem Statement and Research Gap

Therefore, the problem statement of this study is defined as below:

"Many efforts to mitigate the global climate change issues in Malaysia are more centered to the top-down approach of policy implementation and bridging the gaps between policies and stakeholders. Moreover, the existing low carbon framework is focused on the bigger aspects of low carbon cities parameters in the context of carbon emissions reduction. Besides, less focus has been given to measure the level of urban residents climate change awareness and their preferences towards the low carbon capability behavior. Thus, there is a need for formulating a bottom-up approach framework, which simply focusing on the urban resident's low carbon capability behavior."

Meanwhile, the research gap in the study is simplified in the Figure 1.5 below:

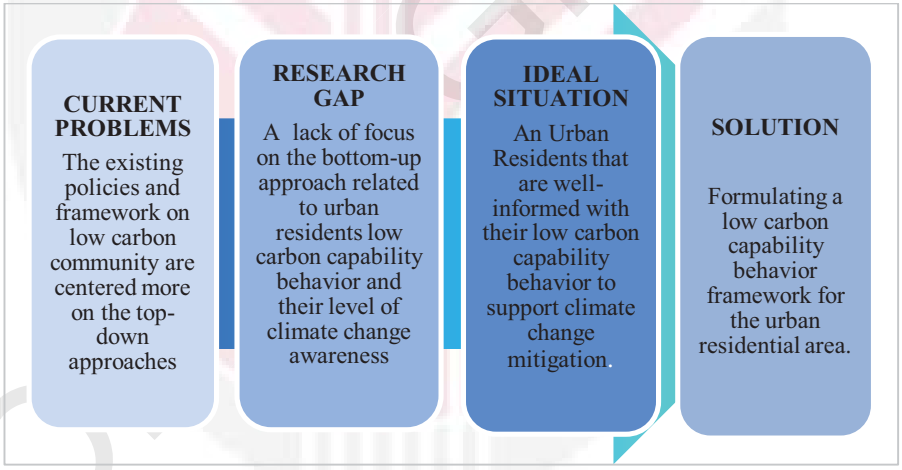

Figure 1.5 : The research problems, research gaps and solution

1.5 Research Goal

The aim of this study is to develop a framework of Low Carbon Capability Behavior for the Putrajaya urban residential area. To attain the research goal, this study pursues the answers to the subsequent research questions.

1.6 Research Questions

1. What is the urban resident's level of awareness towards climate change issues?

2. What is the most preferred low carbon capability behavior among urban residents?
3. What is the relationship of factors towards urban resident's low carbon capability behavior?
4. What are the main factors that will highly influence urban residents' low carbon capability behavior?
5. How will the highly influencing factors towards low carbon capability behavior assist in developing the low carbon capability behavior framework for the urban residential area?

To discover the solutions to the research questions and ultimately obtain the goal of the study, the subsequent objectives have to be achieved:

1.7 Research Objectives

1. To investigate the level of urban residents' climate change awareness in related to low carbon capability behavior.
2. To examine the most preferred low carbon capability behavior among urban residents.
3. To identify the relationship between the variables of factors towards urban resident's low carbon capability behavior.
4. To examine the main factors that highly influences urban resident's low carbon capability behavior.
5. To propose the Low Carbon Capability Behavior Framework for the Putrajaya urban residential area.

1.8 Significance of Study

According to Anand and Seetharam (2011b), although the related institutions in Malaysia are able to address and manage climate change, the room for betterment is always there, especially at the state and local authority levels. This includes increasing awareness and public involvement to encourage essential behavioral responses to climate change. For physical planning towards climate change response in Malaysia, the intention is to encourage sustainability in the built environment and increased public awareness of the environmental matters. Hence, it is convinced that for the effort towards mitigation and adaptation measures against global climate change, awareness among urban community does contribute towards sustainable futures. Whereas, the community roles towards climate change mitigation strategies are well supported by Figueiredo and Perkins, (2013), where he mentioned the characteristic of the bottom-up approach to climate change, an assimilation must start at the community level where these locally based approaches will foster capacity building, community empowerment, social inclusiveness, and participations. Hence, a baseline data are needed on how extensive is the urban community awareness of the climate change issues is in Malaysia, currently. Furthermore, there is also a considerable need to enrich our knowledge of urban community awareness with regards to global climate change issues and their relationships with low-carbon capability behavior. This research can be considered as a pioneering study that can establish a basis for

developing a Low Carbon Capability Behavior Framework for the urban residential area, and as well as point out future research needs. In summary, this research will:

1. Provide baseline data pertaining to urban resident's climate change awareness and the most preferred low carbon capability behavior; specifically among urban residents;
2. Explain the relationship between variable factors and the urban residents low carbon capability behavior;
3. Provide the theory of the main factors that highly influence urban resident's low carbon capability behavior;
4. Proposing a Low Carbon Capability Behavior Framework for the urban residential area.

1.9 Scope of Research

The research starts with a review of global climate change and sustainability concepts, recent international and Malaysia policy towards global climate change, following by an elaboration of the existing low carbon cities framework, nationally and internationally, and finally a review of theory related to environmental awareness and environmental behavior. The preliminary conceptual framework is first verified by the expert and professionals in related fields prior to the focus group discussions. It then will explore the urban resident's awareness towards global climate change, with a case study using an empirical survey that focused on the Malaysia urban residential area, particularly, Putrajaya. The authors then will attempt a synthesis between environmental awareness and low carbon capability behavior change to propose the final Low Carbon Capability Behavior Framework for the urban residential area. Finally, a discussion on the findings and their implication for the individual and urban residents, local authorities, planners, and designers will be concluded, in terms of encouraging the low carbon capability behavior and promoting the low carbon community.

1.10 Research Limitation

Research only covered urban residential area due to current trends in Malaysia; the rapid growth in the urbanization. For instance, in 2008; the urban population in Malaysia grew at a rate of 2.2% per annum versus the rural growth rate of 1.6% from 2000 to 2009. In 2008, the total urban population in Peninsular Malaysia reached 67% and is expected to grow up to 75% by 2020, parallel with the country development. Evidently, more and more people choose to live in the urban areas. For that reason, cities, which consume energy and became the centers of environmental degradation, the result of temperature increased can be most felt. Besides, 50% of total greenhouse gas emission is contributed by urban development which well known by many as primary factors to climate change and global warming (LCCF and Assessment System, KeTTHA, 2011). Hence, studies on community awareness with regard to global climate change and low carbon capability behavior are best to be conducted in an urban residential area.

However, time constraints and resources have made research unable to cover more than one sample areas, which in this study, only the case study of Putrajaya are highlighted. Therefore, a generalization of research is limited because population or the sample could not be more diverse to make a better generalization. Hence this research focuses more on urban residential preferences that represent the layman's interest in adapting to climate change impact. Thus, we cannot conclude that this research covers the professional interest as well, even though the framework is being validated by experts and professionals in the field. However, it is in line with the research objective that concentrating on urban residents as discussed in the previous problem statement. The other research limitation is a self-report survey method. Data collection using this method normally susceptible to poor memory, misinterpretation of questions and purposeful deception, therefore, might contribute towards inaccuracy of the results (Podsakoff et al., 2003).

1.11 Definition of Terms

Below terms are defined to help in clarifying the main concepts of this study.

a. Climate Change

Climate change is an important worldwide problem that influences the perseverance and development of all human beings (IPCC, 2007; United Nations, 2006). Global climate change is said to be affected by rising levels of greenhouse gases such as carbon dioxide (CO_2) and methane, mainly in the industrialized countries due to population growth and lifestyle (Sundblad et al., 2014).

b.Urban Residents/Communities

Individuals' engagement to cut their carbon emissions has the substantial effect on the general community low carbon sustainability for better energy conservation and environment protection, (Jiang et al., 2013). This effort is particularly true for a densely populated community with the substantial utilization of energy consumption and carbon emissions, commonly community that's located within a city. As the most basic unit of a city, urban communities have their own system of construction, culture and economy (Reith and Orova, 2015), and the direct and indirect carbon emission cannot be overlooked, as their emissions provide considerably to the overall carbon emission of cities.

c. Climate Change Awareness

Arlt et al., (2011) define environmental awareness as a purely cognitive construct, demonstrating whether someone is conscious of the threatened environment. However, Lieske et al., (2014) claim that there is still a general lack of public awareness related to climate change, or worse, complete misunderstanding, which weakens the public readiness to collaborate or support mitigation efforts towards climate change.

d. Low Carbon Community

The concept of low carbon community was elevated against the background of the necessity to effectively lessen the carbon emission from urban communities. It specifically concentrates on reducing carbon emissions and enhancing the carbon sink. While, the low carbon communities normally associated with compact special arrangements, convenient and green transportation systems, green and energy efficient architecture, efficient energy consumption, recycling and reclamation of waste materials and public involvement (Wang et al., 2016; Murota, 2014; Fraker, 2013). The low carbon communities also act as a method of cooperation and collaboration that target to reduce the carbon amount of their members' lifestyles by contributing to amenable contexts and mechanisms that encourage behavior change (Heiskanen et al., 2010).

e. Carbon Capability

The carbon capability is a method of understanding the situated meanings of carbon and energy in everyday life. A principal element of being carbon capable is through engagement which is beyond individuals' routines and behaviors; with an extension into engagement with systems of provision and governance (O'Neill et al., 2013). It is also termed as 'the cability to build informed judgments and to take applicable choices through both individual behavior change and collective action for the use and management of carbon'. It is the concepts propose to portray the contextual meanings involved with carbon and individuals' capability and motivation to decrease emissions (Whitmarsh et al., 2011).

1.12 Thesis Structure

Chapter 1 presents the background of the research by showing the detailed explanation of its subject, problem statement and justifications, research gaps, research goal, research questions and research objectives. The significance of studies, research scope, and limitations and some definition of terms are also discussed in this chapter.

Chapter 2 contains the review of literature about the key concepts of global climate change and sustainability and the low carbon community as the aspects of sustainable futures. The in-depth review also includes the International and Malaysia policies towards global climate change, consist of the existing local and international framework of low carbon community and their key aspects. It then explores the theory that relies on the community environmental awareness and environmental behavioral changes. These reviews are essential in order for the study to conclude, simplify and propose the preliminary theoretical framework of low carbon capability behavior in the urban residential area. Through this chapter, a list of key aspect towards low carbon community and the factors that influence towards urban residents' awareness in relation to low carbon capability behavior is highlighted.

Chapter 3 discusses the research methodology. It clarifies the development of the research strategy and the process of carrying out the research, including the pilot study. Explanations of the method selected and the data collection technique is also discussed in this chapter. The discussion on the preliminary conceptual framework and the preference on the method approaches are also pointed out.

Chapter 4 presents the lesson learn and findings of a qualitative study during the expert focus group discussions. The one day program was held at UPM Golf Club Meeting Room, attended by seven respective expert panels. The initial instrument, develop for a Low Carbon Capability Behavior Framework for the urban residential area was briefly discussed during the course. This chapter also discusses the previous initial instrument developments through content analysis and the disparity of findings revealed during the expert focus group discussions.

Chapter 5 analyzed the empirical findings of the urban resident's quantitative survey in the Putrajaya case study. The most preferred low carbon capability behavior and the main highly influencing factors towards low carbon capability behavior are also highlighted in this chapter. This refines the preliminary framework that has been built throughout the literature review process in previous chapter two, and the findings through the expert focus group discussions. These help authors to further refine the framework and validate it to propose the framework at the end of this chapter.

Chapter 6 focuses the most important findings, revisit the goal and research objectives, present a summary of findings, implications of findings, recommendations and limitations and last but not least, the suggestion for future research needs.

The thesis structure is summarized in the Figure 1.6 below:

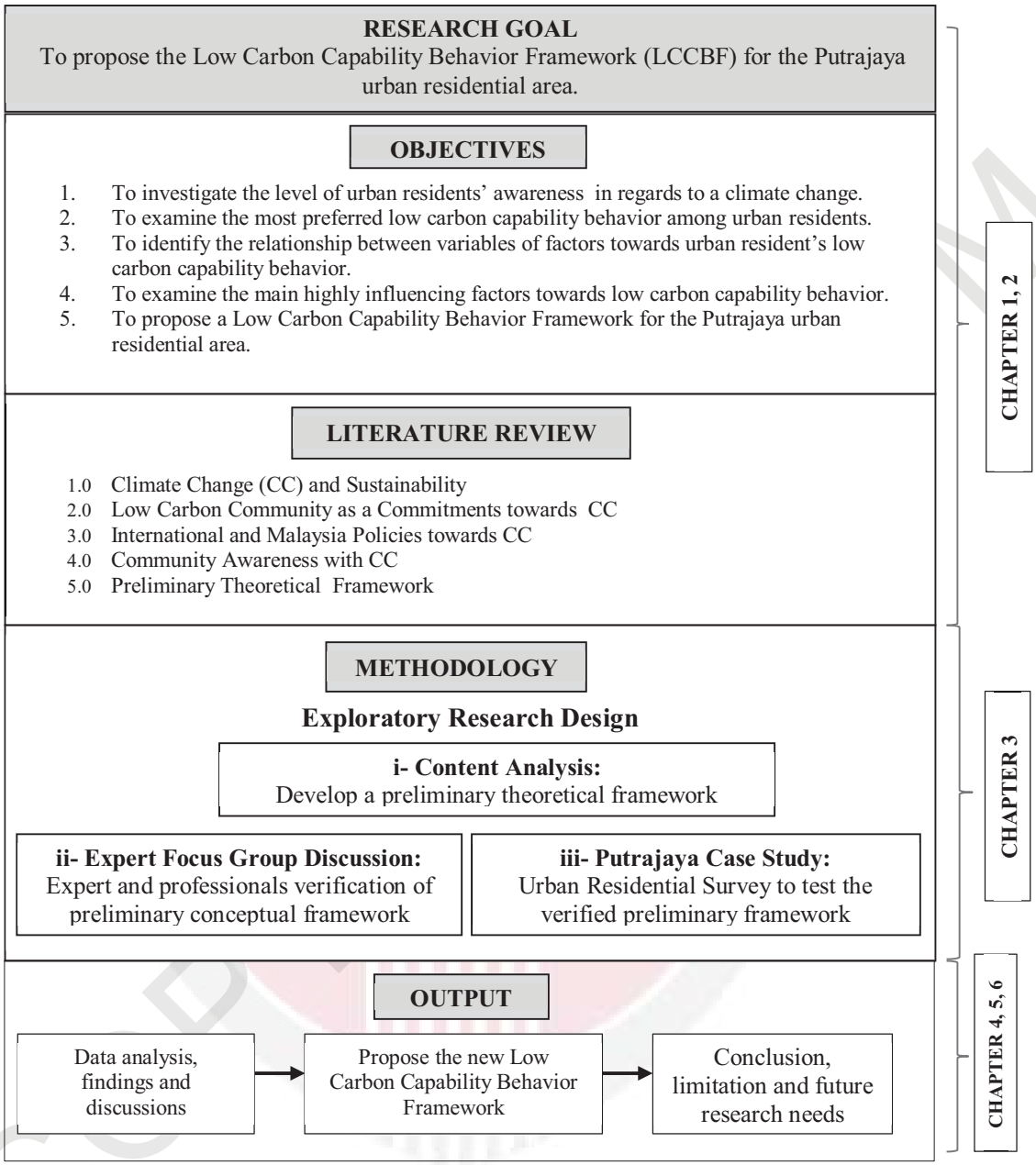

Figure 1.6 : The thesis structure
(Source : Author, 2017)

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