EVALUATION OF GREEN INFRASTRUCTURE IN ISKANDAR MALAYSIA

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DEDICATION

This thesis is dedicated

To my beloved father, mother, wife, brother, and sisters.

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ABSTRACT

Green infrastructure is becoming an intentional development of green and blue networking in corridors and living spaces of cities in developing countries. The services include providing ecological framework for social, economic and conducive environmental health. This encapsulates sequestering and storing excessive CO_2 from atmosphere, serving as regional carbon sink. Nonetheless, urbanization, land-use change and deforestation has led to disappearing of trees and water bodies. This developments causes escalation of high temperature, increase in greenhouse gas emission, flood, flow of strong wind and tsunamis. For this reason, there is a need to ascertain the conservation and integration of green and blue spaces in fast growing cities. However, cities in developing countries are subconsciously overlooking the values and benefit of green infrastructure while undergoing urban development processes. Hence, this study aimed to identify the awareness and understanding regarding the concept of Green infrastructure in Iskandar Malaysia. The study conducted a questionnaire survey by distributing instruments to seven experts, both from public and private sector. Eight green infrastructure where found available in Iskandar Malaysia: (1) parks,playing fields, (2) pocketspaces, (3) bodies of water, (4) Neighborhood open spaces, home gardens and roof top garden, (5) Courtyards, (6) Bioswales, and permeable pavement, (7) hill forests, and (8) Loose-fit places. Notwithstanding, this study attests the decline of green in the city corridor consequent to uncertainty and indecisiveness of identifying the availability hill forests in Iskandar Malaysia. This needs the attention of replantation in line with the policy of reforestation. For this reason, the study profoundly explored ten more green infrastructure needed to be included in Iskandar Malaysia during developmental processes. This include (1) street furniture/road furniture (led/solar), (2) recycle bin, (3) EV charger, (4) rain harvesting system (SPAH), (5) bicycle lane, (6) Fountains in the building complexes, (7) landscape surrounding the undeveloped pocket land, (8) shaded walkway, (9) beautified and multi-functional water detention pond, and (10) electric bus. Lastly, this study affirms regulatory, technical, contextual, structural and culture/behaviour as barriers towards improving green infrastructure in Iskandar Malaysia. Moreover six more barriers were explored as additional barriers from this study including (1) financial/budget allocation, (2) maintenance cost, (3) conflict for determine lead agency/department, (4) enforcement and up keep of the facilities, (5) the problem of financial allocation for agencies and (6) the high cost burden for developers to implement. It is recommended that Malaysian government should keep upholding the reforestation policy in every of its urban development processes. Moreover, it should provide a blueprint for implementation of green infrastructure in Iskandar Malaysia cooperation between the public and private sectors. Moreover, the government need to advance development and changes of GI in Iskandar Malaysia through implementation of related projects as an incentive. Henceforward, for future research it is suggested to explore the aforementioned confirmatory findings interacting with experts and community participation through semi-structured interviews, participatory observations, and Delphi-technique or focus group discussions. The exploratory findings will emerge new criteria and dimensions of improving the GI in Iskandar Malaysia.

ABSTRAK

Infrastruktur hijau menjadi pembangunan yang disengajakan bagi rangkaian hijau dan biru di koridor dan ruang kediaman di bandar-bandar negara membangun. Perkhidmatan tersebut termasuk menyediakan rangka kerja ekologi untuk kesihatan persekitaran sosial, ekonomi dan kondusif. Ini merangkumi pengasingan dan penyimpanan gas karbon dioksida yang berlebihan dari atmosfera, berfungsi sebagai sinki karbon serantau. Namun begitu, pembandaran, perubahan guna tanah dan penebangan hutan telah menyebabkan kehilangan pokok dan badan air. Perkembangan ini menyebabkan peningkatan suhu, peningkatan pelepasan gas rumah hijau, banjir, ribut kencang dan tsunami. Oleh sebab ini, terdapat keperluan untuk memastikan pemuliharaan dan penyepaduan ruang hijau dan biru di bandar yang berkembang pesat. Walau bagaimanapun, bandar-bandar di negara membangun secara tidak sedar mengabaikan nilai dan faedah infrastruktur hijau semasa menjalani proses pembangunan bandar. Justeru, kajian ini bertujuan untuk mengenal pasti kesedaran dan kefahaman mengenai konsep Infrastruktur Hijau di Iskandar Malaysia. Kajian ini menjalankan tinjauan soal selidik dengan mengedarkan instrumen kepada tujuh orang pakar, sama ada dari sektor awam dan swasta. Lapan infrastruktur hijau yang terdapat di Iskandar Malaysia: (1) taman, padang permainan, (2) ruang poket, (3) badan air, (4) Kawasan lapang kejiranan, taman rumah dan taman atas bumbung, (5) Halaman, (6) Bioswales, dan turapan telap, (7) hutan bukit, dan (8) Tempat yang longgar. Walau bagaimanapun, kajian ini membuktikan kemerosotan hijau di koridor bandar akibat ketidakpastian dan ketidakpastian mengenal pasti ketersediaan hutan bukit di Iskandar Malaysia. Ini memerlukan perhatian penanaman semula selaras dengan dasar penanaman semula hutan. Oleh sebab itu, kajian ini meneroka secara mendalam sepuluh lagi infrastruktur hijau yang perlu dimasukkan ke dalam Iskandar Malaysia semasa proses pembangunan. Ini termasuk (1) perabot jalan/perabot jalan (led/solar), (2) tong kitar semula, (3) pengecas EV, (4) sistem penuaian hujan (SPAH), (5) lorong basikal, (6) Air pancut dalam kompleks bangunan, (7) landskap mengelilingi tanah poket yang belum dibangunkan, (8) laluan berlorek, (9) kolam penahan air yang cantik dan pelbagai fungsi, dan (10) bas elektrik. Akhir sekali, kajian ini menegaskan peraturan, teknikal, kontekstual, struktur dan budaya/tingkah laku yang menghalang

ke arah menambah baik infrastruktur hijau di Iskandar Malaysia. Selain itu enam lagi halangan tambahan yang telah diterokai oleh kajian ini termasuk (1) peruntukan kewangan/belanjawan, (2) kos penyelenggaraan, (3) konflik untuk menentukan agensi/jabatan utama, (4) penguatkuasaan dan pemeliharaan kemudahan, (5) masalah peruntukan kewangan untuk agensi dan (6) beban kos yang tinggi untuk dilaksanakan oleh pemaju. Kerajaan Malaysia dicadangkan supaya mengekalkan dasar penghutanan semula dalam setiap proses pembangunan bandarnya. Selain itu, ia Kerajaan Malaysia harus menyediakan rangka tindakan bagi pelaksanaan infrastruktur hijau di Iskandar Malaysia melalui kerjasama antara sektor awam dan swasta. Selain itu, kerajaan perlu memajukan pembangunan dan perubahan GI di Iskandar Malaysia melalui pelaksanaan projek berkaitan sebagai insentif. Setelah itu, penyelidikan masa depan hendaklah dirancang untuk meneroka penemuan pengesahan yang disebutkan di atas, berinteraksi dengan pakar dan penyertaan komuniti melalui temu bual separa berstruktur, pemerhatian penyertaan, dan teknik Delphi atau perbincangan kumpulan fokus. Melalui Penemuan penerokaan akan muncul kriteria dan dimensi baharu untuk menambah baik GI di Iskandar Malaysia.

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LIST OF ABBREVIATIONS

GI	-	Green infrastructure
IM	-	Iskandar Malaysia
ES	-	Ecosystems services
SSA	-	Sub-Saharan Africa
LA	-	Latin America

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CHAPTER 1

INTRODUCTION

1.1 Research Background

The deliberate creation of networks of green and blue spaces that benefit people in many ways is thought to be possible with the help of a concept called "green infrastructure" (Benedict and McMahon 2002). With the European Commission's most recent report of a green infrastructure strategy (EC, 2013) promoting its adoption in European Union countries, green infrastructure has gained popularity since first introduced in the United States in the 1990s as a reaction to the pressures placed on natural systems by urbanisation. It has also gained popularity in Australia and the United Kingdom (UK). An urban and rural, freshwater, coastal, and marine ecosystems' networks of natural and semi-natural spaces is known as "green infrastructure" (GI). Together, these factors maintain the sustainability and health of ecosystems, aid in the preservation of biodiversity, improve ecosystem services, and benefit both humans and the environment. Enhancing GI may be accomplished by taking deliberate, coordinated steps that monitor, maintain, upgrade, and connect existing areas and features as well as create new uses and features (Naumann et al., 2011). By increasing the infrastructure of green areas that can provide effective livability, nature protection, and biodiversity interaction—all of which will benefit the human community by delivering ecosystem services—it is necessary to increase the ecosystem's best service.

As a result, intentional effort is needed to restore and conserve the current environment. To restore ecosystem services, proper network strategy must be employed to connect various existing As a result, significant effort in repairing and protecting the current environment is essential. As suggested by the GI idea, in order to form an integrated network of natural and semi-natural elements, existing patches of landscape and water bodies must be connected using a good network strategy. By

fostering the idea of balance among economic development, social equality, efficiency, and environmental conservation, sustainable urban development resolves the complicated concept of quality of life, economic growth, social cohesion, and environmental preservation (Albu, 2013). Because of the significant influence created by physical growth, the argument of sustainability is widespread primarily in regions that are recognised as urban centres. As a result, GI might be viewed as a catalyst for sustainable urbandevelopment, as both principles encourage the protection of natural resources.

Environmental issues are intertwined; for example, deforestation has an impact on water quality and air pollution (Dessie and Bredemeier, 2013). after a site is selected for urban growth, which necessitates substantial forest reserve clearing, the region in issue, if notcorrectly built, will promote increases in surface run-off, speeding up the pace at which soil erosionoccurs and thereby causing siltation of rivers and lakes (Owens et al., 2005). Acidification of water bodies and changes to soil composition facilitate the loss of forest reserves. Due to these links, environmental management requires a long-term approach. This indicates that if efforts are made to solve the aforementioned difficulties in a coordinated manner, green open spaces will improve soil quality, helping to minimise flash floods, erosion, and other environmental problems that endanger the safe habitation of urban areas (United Nations, 1987).

It has been demonstrated that GI offers a variety of services to urban populations and works to lessen the effects of physical development to achieve green growth (Hammer et al., 2011). Biodiversity is a component of GI which promotes the preservation of living creature such as plants and animals which are living in an interconnected web system. They assist in purifying water through purification and the hydrological cycle influences.

They provide healthy food through adequate supply of soil nutrients. Through evapotranspiration, they function as a carbon sink. They also mitigate and adapt to the effects of climate change by holding surplus water and releasing it gradually to stop soil erosion and pollutant absorption (Lucas et al., 2011). By establishing locations that are more tolerant of climate change and have distinctive local character and scenic

quality that draw people to live, work, and visit them; locations that encourage wellbeing, productivity, educational advantage, and crime reduction; and locations where communities can actively engage their local environment (The Wildlife Trusts, 2012). GI is a framework for planning that supports sustainable urban development.

GI facilities promote social cohesion through recreational services (Hisyam et al., 2012), through the provision of pleasant green open spaces that can attract public users to visit and to recommend the site to family and friends, as well as a well maintained, clean and secured recreation centre within a walking distance which encourages patronage. Therefore, it promotes social wellbeing and community cohesion (Pasaogullari and Doratli, 2004). Green Park as an attribute of GI when designed with diverse facilities, promotes higher adult visits. Green open spaces are also part of GI attributes, and they can serve as a meeting point of urban population and place of recreation that enhance the health status of urban residents. Therefore, this work is designed to systematically analyse planning policies on GI for sustainable urban development.

When properly maintained and incorporated into a development plan, urban green space delivers several benefits to the urban population. Because of its potential to deliver multifunctionalservices, pristine landscape gives greater advantage than single value benefits supplied by other grey infrastructures. In terms of providing recreational services, landscape that is easily accessibleis shown to boost cultural value (De Groot et al., 2010). Recreational facilities must be properly connected and accessible to diverse sections of the urban population, spanning from tiny childrento older people, in order to provide such services. To attract urban residents, they must provide the necessary amenities (Niemelä et al., 2010). The ecological preference is based on the diversity ofthe individuals being studied as well as their educational awareness. As evidenced by the policies examined in this study and other related literatures, the Malaysian people recognise the importance of GI in promoting sustainable development.

A green open space with a variety of plant classes and bird species, as well as a recreationalfacility with supplementary playing places and amenities that are properly

connected to residentialland use, draws the urban population to engage in physical activity and enjoy visual beauty. It hasenormous potential, particularly in a society where most people work in static, computerised environments (James et al., 2009). Because people in today's culture spend so much of their time inside, placing urban green space closer to their homes and offices will encourage them to participate in recreational activities during their free time. This would help them with their psychological and mental wellness.

Human engagement with environment is influenced by biodiversity, which improves their well-being and recreational services while also fostering relaxation and communal cohesiveness (Li et al., 2005). It has been demonstrated that having a green perspective affects job satisfaction and, as a result, increases productivity (Ambrey and Fleming, 2012). In a busy metropolis, the National Park of Athens gives scenic beauty and a calm and peaceful location for the people, whichis a unique property of green spaces in absorbing noise pollution (Brett-crowther, 2011). As a result, implementing GI in Malaysian urban areas will aid sustainability by improving the qualityof urban areas, hence increasing the economic worth of landed properties, and promoting social cohesiveness, both of which are essential stimulants for long-term urban growth.

1.2 Problem Statement

In order to maintain environmental quality, restoring green spaces is becoming more and more crucial as a result of the natural land being gradually replaced by impermeable surfaces as a result of settlement growth. This resulted in climate change, which has a detrimental impact on urbanisation due to rising precipitation levels in cities that result in flooding and the heat island effect. One strategy that might lessen these negative consequences while delivering a variety of environmental, economic, and social advantages is to concentrate on green infrastructure. Global warming, ozone and resource depletion, energy shortages, ecological toxicity, human toxicity, acid rains, and other unfavourable environmental concerns have been affecting the world during the past ten years. Nevertheless, despite these impacts, people perceive the planning, designing, and creation of structures as a means of satisfying their own social

requirements for housing, financial investment needs, and attaining organisational goals. However, comprehensive fulfilment of these requirements typically comes at a hefty cost and causes long-term harm to our ecosystem. This has caused a greater understanding on a worldwide scale of the need to change our conventional methods of building development into far more responsible ones that may effectively meet our construction demands without endangering the environment in which we live.

According to a United Nations Environment Programme report from 2009, the building sector contributes to 40 percent of the world's annual total waste due to building construction and demolition activities, 20 percent of the world's annual water use, 40 percent of the world's annual greenhouse gas (GHG) emissions, and 20 percent of the world's annual total waste consumption. Consequently, it is anticipated that if action is not done due to the growth of the sector globally over the previous several decades, the construction industry would be accountable for the loss of natural ecosystems and species throughout more than 70% of the Earth's geographical area by 2032. [2]. Green building is therefore the cornerstone of the development of sustainable construction. Green building development faces a variety of commercial impediments in developing nations, like Malaysia, despite offering a wide range of social advantages.

As an example, green infrastructure helps the city of Iskandar, Malaysia, capture and store CO2 from the atmosphere, functioning as a regional carbon sink, lowering greenhouse gas emissions, and regulating hot temperatures. Large trees in the mangrove forest and the bodies of water around the city are mostly responsible for promoting them. The mangrove forest in Iskandar Malaysia is a crucial habitat for both aquatic and terrestrial animals, according to Azian and Mubaraq (2012). Additionally, it protects against soil erosion, high winds, waves, and tsunamis. It also aids in flood prevention and CO2 sequestration. Daniel et al. (2011) make the important claim that mangrove forests have greater primary productivity (carbon) leaves than other forests.

Unfortunately, mangroves are decreasing in Iskandar Malaysia as a result of deforestation and land use change, which reduces their ability to store carbon and raises emissions of greenhouse gases (GHGs) globally. For instance, between 1990

and 2010, the area of mangroves in peninsular Malaysia decreased by around 19%. While the area of Johor's mangroves has decreased by about 20% (Hamdan, 2012). Therefore, approximately 4 million Johor inhabitants would be affected by high temperatures, GHG emissions, climate change, and global warming if action plan is not taken into consideration.

The major driver of economic growth in Malaysia, namely in the housing sector, is the building industry. Malaysia's population is growing, which causes a huge increase in housing demand. However, meeting basic human needs typically has a negative influence on the environment. The green residential idea was developed to increase resource efficiency in the use of energy, water, and other natural resources while maintaining an acceptable quality of living and protecting the environment. What are the type of green infrastructure in settlement? What are the benefit of green infrastructure in the settlement? What are the main challenges and enabling factors for green infrastructure in the settlement? The main aims of this study is to identify current level of awareness and understanding regarding the concept of Greeninfrastructure in Iskandar Malaysia.

Since 2006, the land use of Iskandar Malaysia has changed at a rapid rate, making it one of the most innovative and unique development projects ever attempted in Malaysia. Because of rising economic growth, there has been a change in land use that has led to urban growth and a loss of open space. In contrast, the region has a tropical environment with year-round temperatures between 21 and 32 degrees Celsius and yearly precipitation between 2000 and 2500 millimetres. The city of Malaysia is anticipated to become a metropolis by 2025, making this area one of Malaysia's newest economic corridors. From 1.4 million in 2008 to 3 million in 2025, the population is projected to grow. As a result of rapid economic development and population expansion, various changes in land use and land cover are projected.

According to a number of studies, the weighted average statistical approach was also used to estimate the impact of changes (increases and reductions) in each land use/cover (LULC) category on LST and to project the LST of the entire Iskandar Malaysia by 2025. During the day, it was discovered that built-up regions are the

hottest land use, while forest and mangrove areas had the lowest LST. From 1989 to 2013, there was a 3.28 °C rise in LST for urban surfaces. Other land cover classifications showed a similar trend in LST, with increases of 1.96 °C for forest, 2.05 °C for rubber, 2.47 °C for mangrove, 2.6 °C for oil palm, and 2.86 °C for water. Between 1989 and 2013, the mean LST for all of Iskandar Malaysia climbed from 21.88 °C to 24.78 °C (2.85 °C). By the year 2025, it is expected to rise to 25.3 ° C.

Finally, it was learned from a variety of sources that adding green infrastructure can lower the temperature in the study area, most likely due to an increase in transpiration and/or evapotranspiration rates. More green areas and sites, such as along rivers and waterways, should be established as new urban parks, according to studies, since vegetation and water bodies may significantly lower air temperature and enhance relative humidity, providing thermal comfort to people. This also helps to mitigate climate change by reducing the demand for air conditioning.

1.3 Research Questions

The research questions for the study are:

- What are the type of green infrastructure in Iskandar Malaysia?
- What are the benefit of green infrastructure in Iskandar Malaysia?
- What are the main challenges and enabling factors for green infrastructure in IskandarMalaysia?

1.4 Research Aim and Objective of the study

The goal of the study is to determine the existing level of knowledge and awareness in Iskandar Malaysia about the idea of green infrastructure.

- To identify the available types of green infrastructure in Iskandar Malaysia,
- To examine the value and benefits of green infrastructure in the neighbourhood, Iskandar Malaysia,
- To evaluate the main barrier and enabling factors for green infrastructure in IskandarMalaysia.

1.5 Significance of the study

This research is therefore needed to understand available green infrastructure in settlements. In order to improve the existing green infrastructure provision in Iskandar Malaysia, to foresee to which values has been left out and need to be taken into account for future strategies and policies. Moreover, it provides a comprehensive information about the main barriers and enabling factors for green infrastructure in Iskandar Malaysia, finally, this work will serve as a resource for future researchers.

1.6 Research Flow

This research contains the preliminary understanding such as, literature review, data collection and data analysis, result and finding, conclusion and recommendation figure 3.1 illustrates the study flow chart.

The background of the green infrastructure in the settlements is identified in the preliminary understanding stage of this research. Following that, the problem statement was developed, and the relevance of the study was acknowledged based on the problem statement. Finally, the research, aim, objective, and researchs cope were determined.

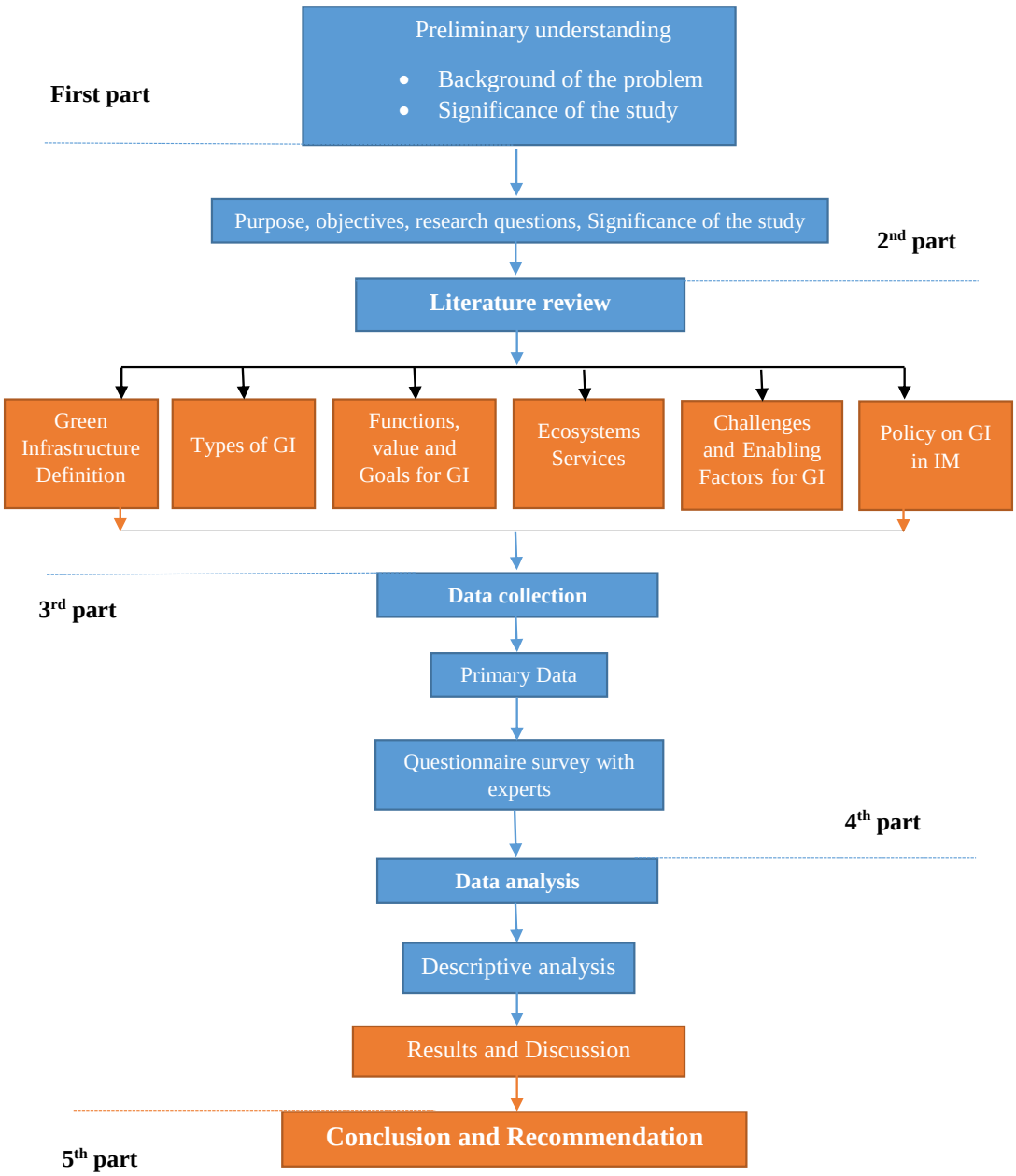

Figure 0.1 Research Flow chart

The literature review is the second part of this study, and it includes all of the knowledge and information obtained from various textual sources. The literature study was carried out in order tobecome acquainted with the present level of knowledge about research challenges and to learn how other researchers have approached comparable issues. The concept of green infrastructure, kinds of green infrastructure,

advantages of green infrastructure in settlements, and difficulties and enabling factors for green infrastructure in settlements are all covered in the literature study.

The third step of this study is data collecting; the approach for this research is quantitative data collection based on primary data. Expert perception has been the method in primarydata collection. The fourth stage of this research is data analysis; after obtaining the data, the excel programme was utilised to evaluate the questionnaire results. And moreover outcome andfinding, which is presented in the form of tables by using Likert scale mean score for proper understanding. The fifth part of this research is conclusion and recommendation, in which a framework of solution and recommendation based on the findings and results has been proposed for enhancing green infrastructure in Iskandar Malaysia.

1.7 Summary

This chapter contains the background of green infrastructure, problem statement. And moreover this chapter covers the aim, objective and scope of this study, as well as the significant of the study, apart from that this chapter contains the research flow.

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