

**THE DEVELOPMENT OF GREEN HOMES IN
MALAYSIA: ASSESSING THE READINESS OF
HOUSING DEVELOPMENT COMPANY**

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**THE DEVELOPMENT OF GREEN HOMES IN
MALAYSIA: ASSESSING THE READINESS OF
HOUSING DEVELOPMENT COMPANY**

by

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LIST OF ABBREVIATIONS

ACWMA	Alameda County Waste Management Authority and Recycle Board
BRE	Building Research Establishment
BREEAM	Building Research Establishment Environmental Assessment Method
CIB	Council for Research and Innovation in Building and Construction
CIDB	Construction Industry Development Board
DANIDA	Danish International Development Agency
EPA	Environmental Protection Agency
EPU	Economic Planning Unit
GSB	Greenbuildingindex Sdn. Bhd.
IEA	International Energy Agency
ISO	International Organization for Standardization
KeTTHA	Kementerian Tenaga, Teknologi Hijau dan Air
LEED	Leadership in Energy and Environmental Design
OECD	Organization for Economic Co-operation and Development
PDC	Portland Development Commission
PTM	Pusat Tenaga Malaysia
REHDA	Real Estate and Housing Developers Association
RICS	Royal Institution of Chartered Surveyors
SBRS	Sustainable Building Rating Systems
UNCED	United Nation Conference for Environment and Development
UNEP	United Nations of Environmental Protection Agency
UNEP-SBCI	United Nations of Environmental Protection Agency - Sustainable Buildings and Climate Initiative
USGBC	United States Green Building Council
WCED	World Commission on Environment and Development

**PEMAJUAN RUMAH HIJAU DI MALAYSIA:
MENILAI KESEDIAAN SYARIKAT PEMAJU PERUMAHAN**

ABSTRAK

Sesebuah syarikat perniagaan akan memastikan kedudukan syarikat terus berkembang di dalam pasaran yang pelbagai dan dinamik. Bagi syarikat pembangunan perumahan, terdapat banyak cabaran daripada faktor-faktor dalaman dan luaran dalam membangunkan rumah hijau di Malaysia. Kajian ini dijalankan untuk mengenalpasti sejauh manakah penerimaan kakitangan syarikat pembangunan perumahan dalam membangunkan rumah hijau di Malaysia. Kajian ini menggunakan borang kaji selidik yang dijalankan secara sendiri berstruktur untuk mendapatkan maklumbalas daripada responden. Dalam kajian selidik ini, terdapat 351 borang kaji selidik yang diedarkan kepada responden yang berada di bandar-bandar utama di Malaysia dan seramai 105 borang kaji selidik yang lengkap dijawab oleh responden telah berjaya diperolehi. Ini mewakili kadar maklumbalas sebanyak 30 peratus. Berdasarkan kajian literatur, terdapat tiga pembolehubah utama iaitu ciri-ciri pekerja, perwatakan syarikat dan faktor luaran syarikat yang mempengaruhi kesediaan syarikat pembangunan utama untuk menerapkan perubahan. Kaedah korelasi Pearson dan regresi berganda lazim telah diguna untuk menyelidiki perhubungan di antara faktor dalaman dan luaran syarikat dengan tahap kesediaan pemaaju perumahan utama dalam membangunkan rumah hijau. Berdasarkan analisis, kajian menunjukkan bahawa tahap kesediaan pemaaju perumahan utama mempunyai perhubungan yang positif dan kuat dengan perwatakan syarikat dan faktor luaran syarikat. Di samping itu, tahap kesediaan pemaaju perumahan juga mempunyai sedikit perhubungan dengan ciri-ciri pekerja. Melalui analisis deskriptif, kajian

mendapati bahawa kesediaan pemaju perumahan berada di tahap pertengahan dan disegmenkan sebagai *adopter*. Akhir sekali, faktor-faktor kajian ini boleh digunakan oleh syarikat pemaju perumahan sebagai panduan untuk mempromosikan tahap kesediaan syarikat pemaju perumahan di dalam membangunkan rumah hijau.

**THE DEVELOPMENT OF GREEN HOMES IN MALAYSIA:
ASSESSING THE READINESS OF HOUSING DEVELOPMENT COMPANY**

ABSTRACT

Any business organisation want to upkeep their position in the diverse and dynamic market. For the housing development company, there are challenges from internal and external factors in developing green homes in Malaysia. This study is primarily to assess the acceptance on green homes development by the employees of the housing developer in Malaysia. The study used a structured survey, which was conducted independently to obtain feedback from respondents. In this study, 351 survey forms were distributed to respondents residing in major cities in Malaysia and a total of 105 completed questionnaires, which answered by respondents, were obtained. This represents a response rate of 30 percent. Based on the literature reviews, there were three main variables, namely the employees' characteristics, company's characteristic and company's external factor that affect an organisation's readiness to adopt changes. Meanwhile, Pearson's correlation and regression analysis was used to investigate the relationship between these variables and the readiness of housing developers in developing green homes. Based on the analysis, the study showed that the level of readiness of housing developers has a strong and positive correlation with the company's characteristic and company's external factors. In addition, the readiness of housing developer also has a slight correlation with the employees' characteristics. Based on descriptive analysis, the study found that the willingness of housing developer is right in the middle and segmented as adopter. Finally, the study lists the factors that can be used as a guide to promote the readiness of the housing developers in developing green homes.

CHAPTER 1

INTRODUCTION

1.1 Research Background

At the beginning of this chapter, the background of study is discussed, which lead to the problem statement of study. Next, the research aims and objectives are established with the set-up of scope and significance of study. Finally, the outline of research is presented.

Housing is known as an important necessity after foods (Oladapo, 2006). Therefore, housing industry is vital in providing the fundamental need for human race. As stated by Agustin (1990), housing is needed to provide a living place, shelter and area for social activities for human being. In addition, Lawrence (2004) highlighted that housing is intended to provide the fundamental human needs for shelter and security. Meanwhile, Sultan Sidi (2010) highlighted that housing offers place for the family gathering and life enrichment.

As projected by United Nation, the world population may reach to a total of 9 billion by the year 2050 (UN, 2014). Consequently, the demand of housing will

increase all over the world because of the growing population. The growth of world population has increased demand for more housing. According to UN-Habitat (2008), an additional of 40% world's population may require more house, which means a housing developer may need to provide at least 96,150 new house per day. Therefore, housing industry plays an important role in providing new housing developments with basic infrastructures and amenities for the mass. The vital gauge to the society development is the demand of the housing are satisfied and accepted at national level (Doman´ski, Ostrowska, Przybysz, Romaniuk, and Krieger, 2003).

According to Ali (2011), housing sector contributes to the social growth and become the main component and catalyst to the nation's economy. Similarly, Xing (2000) acknowledged that housing sector contributes to national economy and urbanisation. UN-Habitat (2008) added that the increase of population in urban area will increase the demand for housing and infrastructure services. In summary, the development of housing has become the main factor for growth of economy and social development.

It is inevitable to conclude that human activities have caused a negative impact on the environment (Jefferson, 2006). Those activities may include the clearing of land for massive development, changing the land use or exploration of mining. Chen, Ganesan and Jia (2005) identified the negative impact to environmental, such as pollution, waste and foul emissions, excessive energy and resources consumption. These have changed the environmental conditions and human comfort. Ibrahim, Mohd Shafiei and Abdullah (2011b) observed these impacts had sparked many debates from the people at large. Most organisations now take initiatives to integrate a concern for environment with business needs. Automotive industry have

developed hybrid car as to decrease the carbon emissions (Nurul Amin, 2009; Tonachel, 2007). Similarly, as recommended by Ibrahim, Mohd Shafiei and Abdullah (2011a), the housing industry needs take similar approach in order to keep its competitiveness in generating the nation's economy and social growth without compromising the needs of current and future generations.

The estimation of Malaysian population is 28 million people, and expected to increase to 32 million people by year 2020 (Department of Statistics, 2011). About 75% of this population is expected to be living in urban areas. In 2011, the available stock of housing is around 4.4 million and new planned supply is 574 thousand units only (NAPIC, 2011). As observed by REHDA (2010a), the housing sector may face a shortage of supply against the demand from the community. As the result, Malaysian government asked the private housing developers to participate in the national housing developments since the 5th Malaysian Plan (1986 - 1990). Since then, the private housing developers have expanded their participant in the national housing development (Ali, 2011).

The Malaysian government agrees with the global communities on creating the sustainable development. Since 8th Malaysian Plan (2001 - 2005), the government emphasised the needs of housing developments integration of sustainable development. In the 10th Malaysia Plan, property industry needs to adopt green building designs and standard (EPU, 2010). Maruani and Amit-Cohen (2011) viewed that housing developers play a dominant role in land use planning decision. In summary, housing developers play a bigger economic role in providing the housing development in Malaysia.

1.2 Problem Statement

It is acknowledged that building construction contributes to environmental depletion, particularly through excessive energy usage and gas emission (Alias, Sin, and Aziz, 2010; CIOB, 2007). Therefore, the effort and responsibility duty to provide more green homes lies with the stakeholders, mainly the private housing developers as the catalyst of change. Landman (1998) and Baker (2006) agreed that most of the construction player were reluctant to build green homes due to lack of support from the industry and costly. On the other hand, Dangelico and Pujari (2010) and Similarly, Zhang, Shen and Wu (2011) observed that the green homes improved image and competitive advantage. It is noted that green homes were constructed as project-basis and there was no evidence on the readiness of the company to adopt green homes. Therefore, it is very crucial to determine the factors that influence the readiness of a housing developer to adopt green homes development in Malaysia. Currently, there was a few assessment of readiness that look into engineering, information technology, knowledge management and housing delivery system (Khalfan, Anumba, Siemieniuch, and Sinclair, 2001; Jaafar, Abdul Aziz, Ramayah, and Saad, 2007; Atrinawati and Surendro, 2009; Yusof, Mohd Shafiei, and Said, 2010). The previously mentioned research may not represent the readiness of the company to adopt green homes development in Malaysia. Nevertheless, selecting a housing developer in Malaysia as one of eminent players in the housing industry is an advantage. There is a possibility of getting the precise information of the readiness of the company to adopt green homes. It is also important to develop a readiness framework that suitable for a housing developer in Malaysia as the previous frameworks were developed by other countries.

1.3 Research Questions

The research questions are as follows:

1. What are the criteria of readiness of developing green homes that the company has put forward?
2. What is the current scenario of readiness of developing green homes by the company in Malaysia?
3. What are the company's internal and external factors that may encourage the readiness of developing green homes by the company?
4. What are the main factors that can be used to assess the readiness of developing green homes by the company in Malaysia?

1.4 Research Aim and Objectives

The aim of this research is to assess the readiness of a housing development company. However, to achieve this aim, the following research objectives are proposed:

1. To determine the criteria that contribute to the company's readiness for change;
2. To assess the state of readiness of the company on developing the green homes in Malaysia;
3. To determine the relationship between the company's internal and external factors that encourage company to implement the green homes; and
4. To determine the main factor of the company's readiness on developing green homes.

1.5 Scope of Research

This study is making an effort by using the available frameworks to assess the Company's readiness in developing green homes in Malaysia. It is important to identify the scope of the study due to the limited resources. Therefore, the respondents are all members of staff of IJM Land Berhad in Malaysia. The data collection for this study shall be conducted according to the company's development in four (4) regions, mainly northern (Penang and Perak), central (Kuala Lumpur, Selangor, Negeri Sembilan and Melaka), southern (Johor) and east Malaysia (Sabah and Sarawak).

1.6 Brief on Research Methodology

The research methodology is divided into two phases: the primary and secondary data. These two sources are as following:

1.6.1 Secondary data

Secondary data will be gathered through literature reviews from references such as books, local and international journals, published proceeding conferences (local or international) reports, online database and etc.

1.6.2 Primary data

A survey will be conducted to gather the needed data. A questionnaire will be used to assess the readiness of a housing development company in Malaysia. The target respondents are the employees of the company, which include the executive, manager, senior manager and top management. This study will focus on a housing development company that have various regional offices, departments and development projects in Malaysia, which is leading the construction industry in the development of green homes in Malaysia.

1.7 Significance of Research

This study is substantial for academic purposes and as part of IJML's strategic planning in adopting the green homes to enhance their product in the marketplace. In the perspective of academic, this study is attempting to explore the concept of organisational readiness for change for specific company, which involved in development of green housing in Malaysia. Therefore, the green technology has become one of the main criteria of change for the developer in adopting the green homes. This study is conducted in order to provide the vital information on building the bridge of knowledge for the academic and practitioner on the assessment of readiness of housing developers on adopting the changes. The proposed framework can be used by the housing developers to examine their current state of readiness towards green homes development for formulating the strategic planning to adopt, practise and lead the green homes development in the marketplace.

The existing framework for assessment of readiness for change was not being used to assess the readiness of housing developers for adopting green homes. Therefore, it is important to establish the assessment of readiness for the green housing development in Malaysia. The study attempts to investigate the organisation's internal and external factors as variables to find out the readiness of change by housing developer in developing green homes.

1.8 Thesis Outline

This thesis is organized into seven (7) chapters. A summary of each chapter of the thesis is shown in the following paragraphs:

Chapter 1: The chapter commences with the introduction and background of the thesis, which encompasses the research problems, the research objectives, the research questions, the scope and significance of the research, and the structure of the research.

Chapter 2: The reviews of literatures for sustainable development and green homes are highlighted in this chapter. In addition, the recognition of sustainable development by the construction industry is briefly explored. At the end of the chapter, the current trends of construction industry in Malaysian and internationally toward green homes development are reviewed.

Chapter 3: In this chapter, the concept of readiness, change management and organizational change are thoroughly reviewed. The factors that influence the

readiness and stage of readiness are underlined. The development of the conceptual framework for this study is presented and the list of hypotheses is developed.

Chapter 4: This chapter underlined the details of the research methodology used in this study. The research design and method of data collection were presented with the relevant instruments that were developed previously. In addition, the usage of analytical techniques for this study is discussed. In brief, the background of IJM Land Berhad is presented, based on the annual report, which is related to the previous and current portfolio in the marketplace. In the last part of the chapter outlines the methodology used in selection of respondents.

Chapter 5: Execution of data analysis, reliability and validity of the studies are discussed in this chapter. The discussion of green homes development readiness amongst the housing developers is presented. The research findings are summarised at the end of this chapter.

Chapter 6: This chapter presents the discussion of the findings. It then compares and argues the current findings with the past studies.

Chapter 7: The end chapter summarises the study by linking the results with the research objectives and the hypotheses of the study. Following this, the recommendations for the future research are outlined.

CHAPTER 2

SUSTAINABLE DEVELOPMENT AND BUILDING

2.1 Introduction

This chapter compiles the literature review of sustainable development, sustainable construction and sustainable building for residential. The definition, background and relationship between the Sustainable Development and Sustainable Construction are discussed. In addition, the guidelines and sustainable building rating system (SBRS) are reviewed, which including the development of green homes in the region. Next, the initiatives by government and housing developers in developing sustainable building in Malaysia are highlighted. Lastly, summary of the chapter is presented.

2.2 Sustainable Development

A unified scientific endeavour in the 2000s has resulted in the emergence of sustainability science as a new interdisciplinary, which has commanded an estimated 37,000 authors based in 174 countries by 2010 (United Nation, 2013). The sustainable development has being improvised since 1970s by all, including cities

and local and regional government, international organization, universities and grassroots movement. As explained by Parkin et al. in 2003, many effort have been spent over the last decade on trying to deepen understanding about sustainable development, both as a concept and, no less importantly, in a practical sense.

However, the term “sustainable development” has become over- and/or misused by various stakeholders in society, as well as by individuals and groups (Robinson, 2004; Du Pisani, 2006). According to Du Pisani (2006), some have (over) used the terms without a true understanding of its original meaning.

2.2.1 Definition of Sustainable Development

Pezzey (1989), Strand and Fossdal (2003) and Parkin et al. (2003) agreed that there were many available definitions of sustainable development, which were disputed and complex. It is difficult to agree on a single definite definition of sustainable development as it had been developed by a variety of authors. This may reflect the struggle on the implementation of sustainable development in any countries.

The conflicts between a healthy environment and the development of a nation were first acknowledged during the Stockholm’s UN Conference on the Human Environment in 1972 (WCED, 1987). According to Kibert (2005), a sustainable society was first defined in 1981 by Lester R. Brown as “...one that is able to satisfy its needs without diminishing the chances of future generation.” Next, the General Assembly of the United Nations had initiated The World Commission

on Environment and Development, which was chaired by the Prime Minister of Norway Gro Harlem Brundtland. In 1987, the Brundtland Commission “Our Common Future” report established and presented the concept of sustainable development.

Thus, the most accepted definition for sustainable development is, “Humanity has the ability to make development sustainable - to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). This definition that has been adopted by various publications to base ideas, claims, and support sustainability related findings (Said, Osman, Mohd Shafiei, Abd Razak and Abdo Rashideh, 2010). Meanwhile, according to Pitt, Tucker, Riley, and Longden (2009), an agreed definition of sustainable development is highly debated among practitioners and academics alike.

The U.S. National Research Council on Sustainable Development have developed the framework of toward sustainability (NRC, 1999), which started the initiation of sustainability in U.S. as shown in Figure (2.1). There are mainly three pillars in sustainable development, which represent the dynamic process between environmental, economic and social. According to Berke and Convoy (2000), this is where the communities anticipate and accommodate the current and future generations’ needs in ways that reproduce and balance local economic, social and ecological systems. Usually, sustainable development illustrated as three overlapped circles (Gidding, Hopwood, and O’Brien, 2002) as shown in Figure (2.2), which the objective to achieve a right balance between three pillars; environmental, economic and social (Parkin et al., 2003; Pitt et al., 2009; Said et al., 2010).

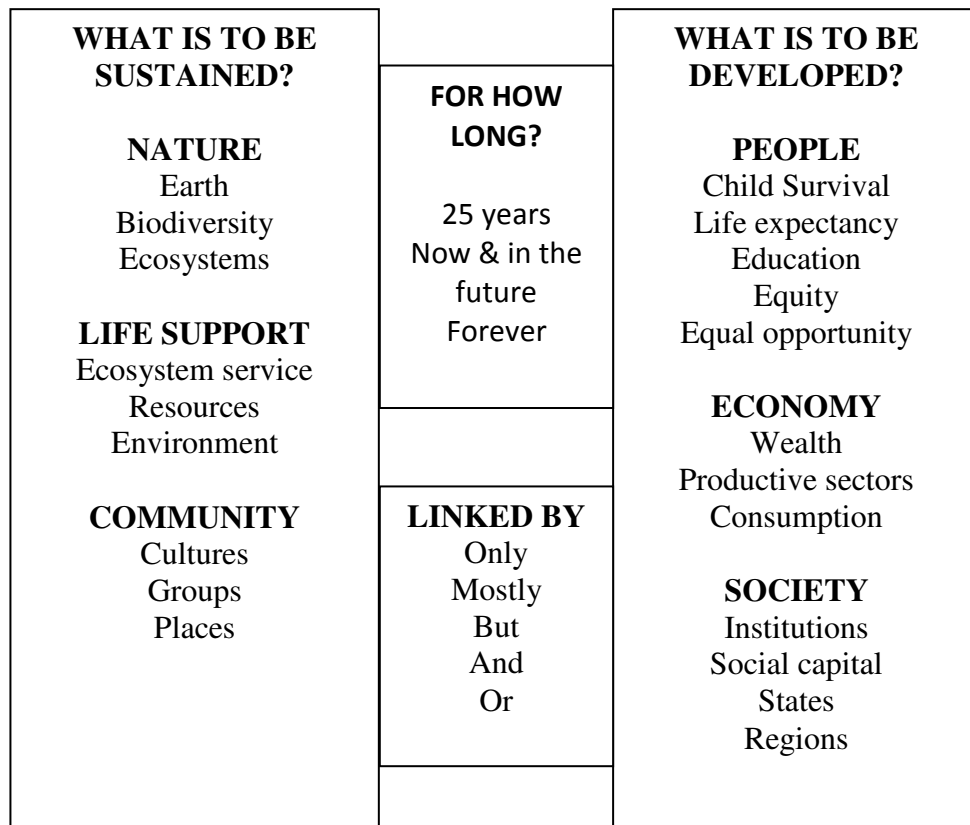


Figure 2.1: Our Common Journey: A Transition toward Sustainability

Source: (NRC, 1999)

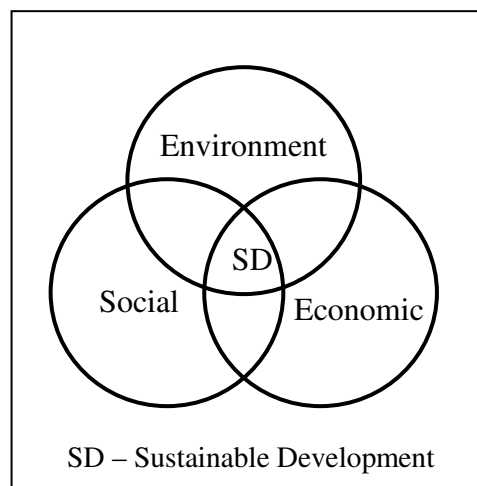


Figure 2.2: The Three Circles of Sustainable Development

Source: (WCED, 1999)

2.2.2 Background of Sustainable Development

The first United Nations (UN) Conference on the Human Environment held in Stockholm in 1972 has increase the environmental awareness amongst the UN's members. Since then, various conferences on sustainable development organized by United Nations (UN). The first agenda of sustainable development was launched in 1987, where the UN General Assembly on the World Commission on Environment and Development had established the Brundtland Report. According to Serageldin (1995), the urban environmental agendas that evolved from this conference were named the "Brown Agenda" by the international development agencies such as the World Bank.

The second United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro, Brazil in 1992. The conference was also known as 'The World Summit', which formulated Agenda 21 and developed the Green Agenda of deforestation, resource depletion, global warming, biodiversity and pollution. The role of human settlements in sustainable development was specified in chapter 7 of Agenda 21 (CIB and UNEP-IETC, 2002).

Subsequently, United Nations' Habitat II Conference held in Istanbul in 1996, developed the concept of "Sustainable cities", leading to setting a number of international directions in making cities sustainable. The concept of Sustainable cities had merged the Brown and Green agendas that initiated the Sustainable Cities Program (SCP) under a joint UNCHS/UNEP program. The Habitat Agenda is the main political document that came out of the conference, which adopted by 171

countries. The document, which was called the City Summit, contained over 100 commitments and 600 recommendations on human settlements issues (United Nation, 1996). According to Sjostrom and Bakens (1999), the agenda is relevance to the construction industry as it had highlighted the roles of the industry in terms of the sustainable development of human settlements (CIB and UNEP-IETC, 2002).

Kyoto Climate Change Protocol (1997) was established in Kyoto, Japan with the commitment to reduce greenhouse gases from 2008 until 2012. Then, the Agenda 21 on Sustainable Construction was published in 1999 (du Plessis, 2001) with the objectives to guide the construction industry on implementing the sustainability principles. The Sustainable Construction coordinates the concepts of sustainable development and sustainable construction, the concern and impacts of construction industry (Sjostrom and Bakens, 1999); and highlighted for locally appropriate approaches to respond to both global and local challenges and opportunities (du Plessis, 2001, 2005).

Figure (2.3) indicated the position of ‘Sustainable Construction in Developing Countries’ in supporting the Habitat Agenda and Agenda 21. This was established in 2002, during the United Nations World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa. The program was commissioned as part of the action plan for the implementation of Agenda 21 on Sustainable Construction by Council for Research and Innovation in Building and Construction (CIB) and supported by United Nations Environment Program (UNEP) (du Plessis, 2002).

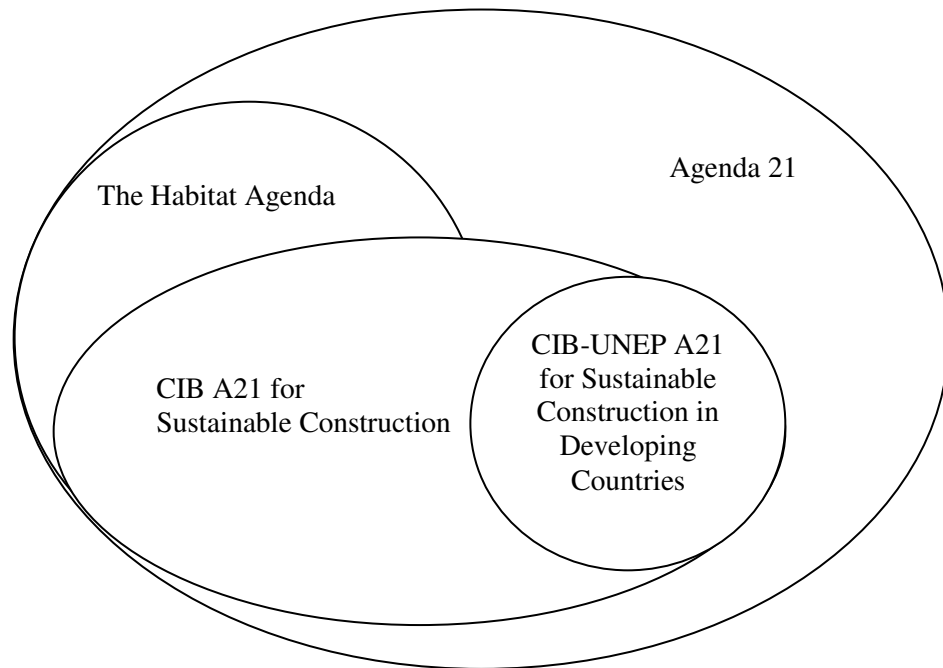


Figure 2.3: Agenda 21 for Sustainable Construction in Developing Countries

Source: CIB (2009)

The developing country may require different approach from the developed country in implementation of sustainable construction, which is related to the country's social, economic and environment. Therefore, the subject matter is not often clearly understood and discussed (du Plessis, 2002) and developing countries face greater differences and more extreme problems with fewer resources (Strand and Fossdal, 2003).

In 2012, the United Nations Conference on Sustainable Development (UNCSD), which is also known as Rio+20 Conference was held in Brazil. In the same year, the Kyoto Protocol is expired. The latest High Level Political Forum on Sustainable Development (HLPF) was promoted in 2013 as to continue the effort of

Sustainable Development. These international events have prompted positive actions and plans by many countries to implement and absorb the concept of sustainable development within their industries (Zainul Abidin, 2009). Table (2.1) indicates the milestone of Sustainable Development at global level.

It is more than 40 years, United Nations have promoting and implementing sustainable development for the benefit of people and environment. The construction industry is responsible for a significant amount of resource use and carbon emissions (Hamid et al., 2014), which contribute to the wealth of the country. According to Mustaffa and Ahmad Baharum (2009), about 40% of the total world energy consumption is initiated from built environment, while the property industry was found to contribute about 20% of CO₂ emissions via energy use, waste and water production. The construction industry is acknowledged as a catalyst to ensure the success of sustainable development for our next generation.

Table 2.1: Sustainable Development Milestones at Global Levels

Year	Milestones
1972	United Nations (UN) Human Environment Conference in Stockholm – Brown Agenda.
1979	US National Academy of Sciences – Landmark Report (Linked greenhouse effect to climate change).
1985	Vienna Convention for the Protection of the Ozone Layer.
1987	UN General Assembly on the World Commission on Environment and Development - Brundtland Report.
1987	Montreal Protocol on Substances that Deplete the Ozone Layer.
1988	World Meteorological Organization and UNEP established the Intergovernmental Panel on Climate Change (IPCC).
1992	UN Conference on Environment and Development (UNCED) – the Earth Summit / Rio Summit / Rio Conference – Agenda 21 in Rio de Janeiro, Brazil. (Call for voluntary to cut in greenhouse gases emission).
1996	UN Habitat II Conference - The Habitat Agenda - Istanbul Declaration on Human Settlements.
1997	Kyoto Climate Change Protocol in Kyoto, Japan. (Commitment to reduce greenhouse gases from 2008 until 2012).
1999	Agenda 21 on Sustainable Construction.
2000	Millennium Summit.
2002	UN World Summit on Sustainable Development (WSSD) - Agenda 21 for Sustainable Development in Developing Country in Johannesburg, South Africa.
2012	United Nations Conference on Sustainable Development (UNCSD) - Rio+20 Conference.
2012	Kyoto Protocol is expired.
2013	High Level Political Forum on Sustainable Development (HLPF).

Source: The Researcher (2014)

2.3 Sustainable Construction

The construction industry plays an important role by significantly contributing to the growth of the economy and the development of any country. According to Bourdeau (1999), it enables communities to live and work in more comfortable environments. It has also been known as a changer of the social environment. Potentially, the construction industry, including building, is one of the largest industries to contribute to the reduction of greenhouse gas emissions. In addition, the construction industry has prospects in terms of implementing sustainable practice (Williams and Dair, 2007). Meanwhile, CIDB (2007b) reported that recent development processes, such as sedimentation and soil erosion, destruction of vegetation, flash floods and pollutions, have had a significant impact on the environment.

2.3.1 Definition of Sustainable Construction

Since the 1960's many authors accepted the triple constraints, namely time, cost and quality as a standard measure of success in a project. According to Vanegas, DuBose, and Pearce (1996) and Vanegas and Pearce (1997); the construction industry focused on triangle objectives, namely cost, time and quality. According to Kibert (1994), the construction industry must also address the additional elements of suitability such as minimization of environmental degradation and resource depletion, and creating a healthy built environment. As suggested by Vanegas and Pearce (1996), sustainable practice in the construction industry may include human satisfaction, environment and energy.

In 1994, Kibert introduced the definition of sustainable construction during the International Conference on Sustainable Construction as “...the creation and responsible maintenance of a healthy built environment based on resource efficient and ecological principles...”. In 1998, more definitions of sustainable construction were introduced in the CIB W82. One of the definitions was “...a way of building which aims at reducing (negative) health and environmental impacts caused by the construction process or by buildings or by the built-up environment...”. Another definition was “...the reduction of the use of natural resources and the conservation of the life support function of the environment by construction processes, buildings and the built-up environment under the premise that the quality of life is maintained...”.

2.3.2 Background of Sustainable Construction

According to Bourdeau (1999) and Hill and Bowen (1997), sustainable construction was first commenced in 1994 during the First International Conference on Sustainable Construction in Tampa, Florida. Zainul Abidin (2010) added that the conference promoted sustainable construction as the balance between, on the one hand, the human need for buildings to live and work in and as infrastructure to increase the quality of life, and on the other hand, protecting and preserving the natural resources and ecosystems on which current and future generations depend.

The CIB W82 Project was launched in 1995 with the collaboration of experts coming from various countries in Europe, North America, South Africa and Asia (CIB W82, 1998). According to Bourdeau (1999), the CIB W82 Project is mainly

focused on investigating the relationship and links between the principles of sustainable development and the construction industry.

2.4 Sustainable Building for Residential

It is estimated that existing buildings are responsible for more than 40% of the world's total primary energy consumption and for 24% of global carbon dioxide emissions (IEA, 2006). A separate report produced by UNEP-SBCI in 2009 titled "Building and Climate Change" indicated that the building industry contributed as much as one third (30%) of total global greenhouse gas emissions and consumes up to 40% of all energy, both in developed and developing countries.

Buildings are identified as the largest consumers of energy in the US. The annual direct impact of all US residential and commercial buildings include 39% of total energy use, 68% of electricity consumption and 30% of greenhouse gas emissions (USGBC, 2007). In 2012, the consumption in residential and commercial buildings accounted for over 40% of primary energy use in the US. As an example the City of Portland (Oregon, USA), reported that its buildings consumed 35% of total USA energy output, consumed more than 60% of the electricity, accounted for at least 35% of all carbon dioxide (CO₂) emissions and generated more than 210 million tons of solid waste annually (PDC and CPGBI, 2002).

According to Edwards and Hyett (2001) the built environment in the United Kingdom (UK) is responsible for 50% of the total UK energy consumption; 45% for heat, light and ventilation of buildings, and 5% to construct them. Further findings

by Pitt, et al. (2009) reported that The Royal Institution of Chartered Surveyors (RICS) estimated that the building industry is responsible for 40% of all UK waste, which includes greenhouse gas emissions. Based on these published reports, it was indicated that the building industry plays important roles in the energy demand and in producing significant carbon emission that could harm our environment.

In 2011, due to rapid growing energy end-use sector in China, energy consumption in residential and commercial buildings accounted for over 25% in China (Khanna et al., 2014). Malaysia is experiencing a rapid increase in energy consumption with the increase of 98% consumption of natural gas since the last decade, mainly due to its high economic growth and increase in the standard of living of households (IEA, 2010).

Cities in development are the growth engines of the future, offering their populations greater opportunities for protection and employment. Yet, the negative effects of their growth can result in environmental pollution, depletion of natural resources, as well as a significant contribution to climate change. As reported by UNEP (1992), activities in the building sector can be a source of environmental damage. This issue has received attention from the industry and experts around the world, with various conferences, research reports and publications emerging.

EPA (1991) highlighted that World Health Organization Committee in 1984 claimed that up to 30% of new and remodelled buildings worldwide may be the subject of excessive complaints related to indoor air quality. ACWMA (2003) reported that the poor indoor air quality is caused by the off-gassing of chemicals

found in many building materials, and poorly designed and maintained heating and cooling systems.

Over the next decade, greenhouse gas emissions from buildings will double unless effective solutions are found to overcome these issues. UNEP SBCI (2009) recommended the construction industry to reduce greenhouse emissions at least by 50% in forty years and to have achieved at least a 25% reduction in eleven years, to avoid worst-case scenario of climate change. In order to reduce the impact of climate change, the construction industry needs to produce future-proof buildings for the benefit of future generations.

For the concept sustainable building, various terms may be in use within the industry and they are often used interchangeably (Kibert, 2005). Zhu and Lin (2004) recommended terms such as “ecological building”, “energy efficient building” and “healthy building”. Du Plessis (2005) used the term “sustainable architecture” and Kibert (2004) and USGBC (2006) promoted the term “high performance building”. In addition, USGBC (2006) highlighted that “Green” stands for the concept of sustainable development as applied to the building sector, with the intention of building environmentally responsible, economically profitable, and healthy places to live and work. According to Kibert (2004), “Green” is viewed as a subset of sustainable construction which represents simply: structure.

These various terms for sustainable building all refer to the shared goals of reducing the impact to environment and increasing the efficiency of building. In addition, OECD (2003) referred to these terms as building practice that has

minimum adverse impacts on built and natural environments, in terms of the buildings themselves, their immediate surroundings and their broader regional and global setting. Roper and Beard (2006) referred to the term as building that strives for integral quality for economic profitability, social need and environmental performance in a broad way.

The following are in brief the characteristics of sustainable building (CIB W82, 1998):

- Consumes a minimum amount of energy and water;
- Efficiently consumes of raw materials;
- Breeds a minimum amount of pollution and waste;
- Utilizes a minimum amount of land;
- Integrates well with the natural environment;
- Meets the needs of current and future user; and
- Crafts a healthy indoor environment.

Strand and Fossdal (2003) emphasized on the elaboration by International Organization for Standardization (ISO) on the green design practice based on three pillars of sustainable development, which include design for environment, social impacts and full-cost accounting procedures.

In 2003, Organization for Economic Co-operation and Development (OECD) has conducted OECD Sustainable Building Project (SBP) with the main