Development of a Sustainability Assessment Framework for Malaysian Office Buildings Using a Mixed-Methods Approach

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Chapter 1: Introduction

1.1 Background of the Study

One-tenth of the global economy is dedicated to constructing, operating and equipping buildings (Roodman & Lenssen, 1994). By contrast, the construction sector consumes 25% of the virgin wood and 40% of the raw stone, gravel and sand worldwide each year (Dimson, 1996). In addition, the sector is responsible for huge solid waste generation, environmental damage and approximately a third of global greenhouse gas emissions (Barrett, *et al.*, 1999; Confederation of International Contractors' Association [CICA], 2002; de la Rue du Can & Price, 2008; Scheuer, *et al.*, 2003; Spence & Mulligan, 1995; Zimmerman, *et al.*, 2005). Therefore, actions are needed to make the built environment and construction activities minimise the environmental damage and greenhouse gas emissions they create. Addressing environmental issues alone however, is insufficient because the construction industry also has the responsibility to ensure economic and social development (IUCN, *et al.*, 1980; UN, 1992a; UNDP, 1996).

From the early 1990s, “sustainable development” has gradually become a new important agenda at both national and global levels. The Brundtland Report has defined sustainable development as a development that “meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987, p.8). In 1992, *Agenda 21*, the key outcome of the Rio Summit, highlights that the protection of the environment, social equity, and economic development are the key components of sustainable development (UN, 1992a). Later in 2002, the report of the World Summit on Sustainable Development (WSSD) put a strong emphasis on participation by all members of society by emphasizing that sustainable development should have the overall aims of eradicating poverty, changing unsustainable patterns of consumption and production, and protecting and managing the natural resources, and that decision-making should take a long-term perspective and involve a broad-based stakeholder participation (UN, 2002). The WSSD report explains that the three sustainability components are interdependent and mutually supportive elements of long-term development (UN, 2002). This means, decision makings to support sustainable development involve a balanced and holistic approach to these three dimensions (Barton, 2000; International Council for Local Environmental Initiatives [ICLEI], 1996; ISO/FDIS 15392, 2008; Lutzkendorf & Lorenz, 2007).

Within the construction industry, “sustainable construction” is seen as a way for the industry to respond to achieve sustainable development as part of an integrated whole (Du Plessis, 2001) and to depict the industry’s accountability towards protecting the environment (Bourdeau*, et al.*, 1998; Hill & Bowen, 1997; Ofori*, et al.*, 2000; Spence & Mulligan, 1995). The concept of sustainable construction also transcends environmental sustainability (Green Agenda) to embrace economic and social sustainability (Brown Agenda), which emphasizes possible value addition to the quality of life of individuals and communities (Du Plessis, 2002; United Nations Development Programme [UNDP], 1996). Further, cultural and heritage implications of the built environment are also given attention as other important aspects in sustainable construction (Sjostrom & Bakens, 1999).

The implementation of sustainable construction however, requires different approaches between developed and emerging/developing[1] countries due to the difference in priorities (Bourdeau*, et al.*, 1998). Based on a global report on *Sustainable Development and the Future of Construction* (Bourdeau*, et al.*, 1998), developed countries are in the position to place an emphasis on environmental issues to progress to a more advanced stage in the path towards sustainability. Emerging/developing countries on the other hand, need to focus more on social and economic sustainability which are not necessarily technical issues (Bourdeau*, et al.*, 1998). The key sustainable development priority in emerging/developing countries is to ensure that the basic needs of its citizen, such as food, health, safety and employment, are met (UN, 1992a; UNESCO, 1992). It is also important that development designed to meet these needs involves educating and empowering people in order to ensure that impact can be multiplied, and is sustainable (UN, 1992a, 2002). From the perspective of sustainable construction, emerging/ developing countries need to address and prioritize public awareness; efficiency, safety of processes and quality of products; environmental and human health impacts; affordability; social equity; semi-skilled labour; and participation of affected community (Du Plessis, 2002; Larsson, 2005; Ofori, 1998).

In responding to sustainable construction, there have, over the past decade, been a plethora of building performance assessment systems (BPASs) emerging as one of the strategies in, and perceived as tools for, promoting and contributing to sustainable construction (Cole, 1998, 2001; Cooper, 1999; Crawley & Aho, 1999; Ding, 2008; Holmes & Hudson, 2000; Kaatz*, et al.*, 2002; Todd*, et al.*, 2001). Many such BPASs have been developed in the form of rating systems that measure how well or poorly a building is performing, or is likely to

[1] The term “emerging/developing” is used in this thesis to describe countries whose economies have not reached advanced or developed status. For further explanation, refer to Section 2.3 in the next chapter.

perform, against a declared set of sustainability criteria. Examples of such BPASs include BREEAM in the U.K. (BRE, 2008b), LEED in the U.S. (USGBC, 2010), GreenStar in Australia (GBCA, 2008a), SBTool (formerly known as GBTool) initiated in Canada (iiSBE, 2009), and many more.

Although these BPASs are largely different from each other and designed around different indicators, many scholars assert that they have the potential to reduce the negative environmental impact of buildings and the building sector as their application provides significant theoretical and practical experience in pursuing environmentally responsible design, construction, and operation practices (Aotake*, et al.*, 2005; Brochner*, et al.*, 1999; Cole, 1999a, 2000). Due to the broad range of issues incorporated in a BPAS, a number of researchers also believe that it can also act as an educational and empowerment medium that produces and transfers knowledge, and enhances communication between, as well as promotes collaboration among, building stakeholders (Bordass & Leaman, 2005; Cole, 1999a; Gann*, et al.*, 2003; Kaatz*, et al.*, 2006). BPASs, can also be seen as a means to enhance the quality of decision-making in the building and construction processes (Cole, 2003; Kaatz*, et al.*, 2005). All in all, BPASs are viewed as one of the most effective methods of market transformation (Aotake*, et al.*, 2005; Cole, 2000; Larsson & Cole, 2001); therefore, BPASs are important agents of change in building practices and providing significant educational opportunities to their users, which is the subject of this research.

In line with this realisation, many other countries, particularly emerging/developing countries have begun to realize that the development and implementation of BPASs have the potential to contribute towards achieving a sustainable built environment. Some early established BPASs listed earlier have been widely accepted in the world and customized for different countries and regions. However, many such customizations have been criticized as inappropriate to cope with the specific regional conditions in many ways, none the least is the lack of appropriate data to be used in the system (Strand & Fossdal, 2003). It is also not an easy task to select the right type or adopt established BPASs for the specific tasks in hand, because they are developed with different approaches, issues, functions and underlying assumptions, as well as with limitations relating to the specific conditions in their country of origin. Furthermore, the conditions and requirements of BPASs in any specific region are significantly diverse and complex. Without a proper understanding of the regionally specific context for sustainable building development, it is difficult to say what types of BPASs are indeed needed and appropriate in a region.

Most of the existing BPASs from developed countries have long been criticized for following a single-dimensional approach or being restricted to the environmental dimension of sustainability only, with limited ability to assess the broader social and economic dimensions of sustainability (Cole, 2006b; Cooper, 1999; Curwell & Cooper, 1998; Du Plessis, 2005; Guy & Kibert, 1998; Kaatz*, et al.*, 2005; Kohler, 1999; Theaker & Cole, 2001; Todd*, et al.*, 2001). Hence, they are inadequate in addressing the complex concept of sustainability as well as many of the non-environmental priorities of emerging/developing countries.

1.2 Statement of the Problem

Economically, Malaysia has one of the fastest growing construction industries in the world (Australian Business Council for Sustainable Energy [ABCSE], 2007); and currently categorized as a "newly industrialized country" (Mankiw, 2008) or an "emerging market/economy" (Dow Jones Indexes, 2011; Independent Evaluation Office of the IMF, 2009). However, the industry activities have contributed crucial environmental and social impacts in the country. The exploitation of resources, uncontrolled, and improperly planned development has resulted in the deterioration of the environment (Aiken*, et al.*, 1982; Begum*, et al.*, 2006; Department of Environment Malaysia, 1997; Economic Planning Unit of Malaysia, 2005; Mohd Yunus, 2007; Sani, 1999). On top of this, the industry's reliance on foreign labour has resulted in low level of productivity and quality (Chan, 2009; CIDB Malaysia, 2007b), as well as higher rate of work-related accidents (Abdul-Aziz, 2001; CIDB Malaysia, 2005, 2007b).

These predicaments reflect the imbalance between environmental and socio-economic development; thus the benefits of development may be negated by the costs of environmental and social impacts. If this is the case, then the current Malaysian construction and building practices can be deemed as not sustainable. In addition, the formation of new development corridors in the southern, northern, and eastern regions of Peninsular Malaysia will further add huge pressure to the environment if not approached in a sustainable manner. The adoption of sustainable development (i.e. balancing economic development with environmental protection and social development) in Malaysian construction industry is therefore very timely and crucial.

Accordingly, Malaysia has one of the best sets of environmental legislations, comparable even with those of some developed countries (Sani & Mohd Sham, 2007), and a plethora of sustainable development frameworks, policies or various enabling legislations and regulatory frameworks deployed to reduce and overcome sustainability issues. As such, one might wish to question why there are continuous presence of, and increasing problems related to, the environment in Malaysia. Arguably, moving towards the path of sustainability requires education, information dissemination, communication and participation across disciplines (Girardet, 2003; Holdren*, et al.*, 1995), which are still lacking in the context of emerging/developing countries (Du Plessis, 2002). The level of knowledge on environment issues and sustainability among Malaysians, including building stakeholders, has generally remained low (CIDB Malaysia, 2007d; Haron*, et al.*, 2005; Ibrahim & Abbas, 2001; Shari*, et al.*, 2006, 2008; Zainul Abidin, 2010). Unless there is willingness among the public to align their attitude with the requirements of sustainability, no legislation and no conservation programme, however well designed, will be successful or have the desired impact (Sani & Mohd Sham, 2007). People's motivation to change indeed comes from knowledge (Du Plessis, 2005; Fiedler & Deegan, 2007).

Since the lack of knowledge and awareness in sustainability is paramount among the building key players, specific means and programs need to be developed for raising their awareness in order to promote sustainability in the Malaysian building sector. It was argued that benchmarking, assessment and knowledge sharing should be the immediate work that needs to be focused on in emerging/developing countries (South-east Asia in general, and Malaysia in particular) and considered as one of the technology enablers for sustainable development and construction (CIDB Malaysia, 2007d; Du Plessis, 2002; Shafii & Othman, 2005; Yeoh, 2005).

In line with this realisation, Malaysia has recently developed and implemented its BPAS i.e. the Green Building Index (GBI) system (GSB, 2009a). GBI, however, still reflects those of developed countries and its scope focuses particularly on the Green Agendas, or rating the environmental impact of the building design itself with limited capacity to assess the social and economic impact of new developments on the existing community (Soebarto & Ness, 2010). This is despite the fact that there are differences in priorities between developed and emerging/developing countries in implementing sustainable development and construction, which lead to the need for different models of BPAS (Kunszt, 1998; Sha*, et al.*, 2000). Therefore, an effort to formulate an appropriate assessment framework that takes relevant priorities into account as a means to create a sustainable construction industry in emerging/developing countries, particularly Malaysia, is deemed necessary and is the subject pursued in this study.

1.3 Research Focus

This research concentrates on office buildings in Malaysia as the research vehicle to examine the issues, considering that this building type has been identified to be 'intensive' (Yeang, 1998) and 'extravagant' (Smith, 2001) users of energy. Statistics show that in Malaysia, commercial buildings consume 29% of the country's electricity and domestic consumption accounts for less than 20% (Energy Commission, 2005). Based on the preliminary study conducted by Ahmad and Kasbani (2003), the average Building Energy Index (BEI)[2] of office buildings in Malaysia is 166 kWh/m^2/yr, which is more than 136 kWh/m^2/yr as recommended value in the Malaysian Guidelines for Energy Efficiency in Buildings by the Ministry of Energy, Telecommunications and Posts 1989. Furthermore, there is an increasing demand for offices in Malaysia generated by the rapid developing economy. Based on official records from the Ministry of Finance's Commercial Property Market Report for the first half of 2007, the total incoming supply of office space in the country stood at 1.62 million square metres. The market had another 2.23 million square metres in the planned supply. In terms of value, the commercial sub-sector recorded the highest increase of 28%, followed by industrial (15%) and residential (10.5%). Therefore, there is a potential in improving the energy performance of office buildings especially in designing and operating new efficient buildings.

1.4 Research Aim and Objectives

The study aims to develop an appropriate assessment framework that enables sustainability to be addressed and incorporated in office building development, relevant to emerging/developing countries, particularly the Malaysian context. The fact that such development should take into account local building sector requirements and expectations as well as national and international research findings, the following objectives have been derived:

1. To evaluate the key aspects of sustainable development and the key priorities of emerging/developing countries in pursuing sustainable development in general, and sustainable construction in particular;
2. To investigate the current status of building sector within the Malaysian construction industry in addressing sustainable development issues;
3. To investigate the applicability of existing BPASs in generating sustainable building design outcomes as well as in educating building stakeholders;

[2] BEI measures a building's operational energy efficiency, calculated by dividing the global yearly energy consumption of the entire building with the air conditioned floor area (Kannan, 2007).

4. To develop an assessment framework that enables sustainability to be addressed and incorporated in office building development relevant to the Malaysian context; and
5. To validate the appropriateness and test the applicability of the new framework in the Malaysian context.

1.5 Research Questions

The Overarching Questions:

How can office buildings in Malaysia (existing or proposed) be meaningfully assessed by stakeholders as sustainable? What would be the nature and form of an assessment framework, relevant to emerging/developing countries, particularly the Malaysian context, taking into account possible shortcomings in its implementation such as unavailability of data?

Sub-questions:

1. What are the key concepts of, and the current international consensus position on, sustainable development that are useful in understanding how the construction industry can move towards sustainable development?
2. What are the key differences in priorities between developed and emerging/developing countries in responding to sustainable development?
3. What are the Malaysian conditions, constraints, and priorities in promoting and practicing sustainable development in the country?
4. How is the built environment (at building scale) currently being assessed for sustainability, and are the current BPASs able to support sustainable design and address priorities of emerging/developing countries in general, and Malaysia in particular?
5. To what extend is sustainable development being practiced in Malaysia?
6. How do stakeholders of Malaysian construction industry view sustainability?
7. How could a new assessment framework be made an acceptable and integral part of the local building practice, specifically for office building?
8. What do experts believe as the appropriate benchmarks for their selected assessment criteria?
9. What are the most important sustainability criteria for assessing Malaysian office buildings, and what are their relative weightings?
10. How do the data together gathered reveal the relevant form for the assessment framework?

11. Will there be any criteria that would suffer missing data when applied to a case study office building in Malaysia? If so, to what extent is the sensitivity of those criteria to be an integral component of the assessment framework?

1.6 Significance of Research

It is anticipated that the framework developed in this study will provide a better understanding of the stakeholders' roles and responsibilities in supporting sustainability throughout the life cycle of their project. The quality of their decision-makings in the building and construction processes will potentially be enhanced by taking into account the interrelationship of environmental, social and economic components of sustainable development.

In terms of impacts on the community, the framework can potentially act as an educational medium that encourages a continuous learning process, enhances communication between, and participation among, building stakeholders in a community such as architects, engineers, developers, builders and building operators/managers. In this way, it would enable the development of new knowledge by helping to close the loop between initial design intent and longer-term changes in use throughout the building's life-cycle; and hence, stimulating needed changes in the Malaysian construction industry. On the government side, the framework could potentially be used as a guide to planning or policy system to promote sustainable buildings in Malaysia. Further, the framework could also serve as a reference when BPASs need to be developed for other part/state of Malaysia than those focused in this research (i.e. Kuala Lumpur, Selangor and Putrajaya).

This research aims to make a contribution to knowledge within the fields of sustainable development, and to building and construction in Malaysia in particular, as well as to the development of an appropriate building sustainability assessment framework for this context. More broadly, it contributes to the development of a new model or approach particularly appropriate for the emerging/developing countries, through which a country-specific building sustainability assessment framework may be established. In doing so, emerging/developing countries will ultimately have an appropriate basis relevant to their countries to create sustainable construction industries, alongside efforts in developed countries to achieve global changes necessary for the future.

1.7 Research Methodology

Since sustainability and the framework to assess building sustainability must be context specific and involve stakeholders' participation, this study adopted a mixed-methods approach, particularly using the exploratory sequential design i.e. a qualitative followed by a quantitative phase. The goal of the qualitative phase was to identify the most essential sustainability criteria, to be incorporated in the framework. This entailed a synthesis of results from research conducted in three stages: 1) wide-ranging literature review; 2) in-depth, semi-structured, open-ended interviews; and 3) focus groups discussion. The literature review findings from the first stage were synthesized to reveal the relevant criteria and to formulate the requirements for developing the assessment framework. These criteria were further refined in the second and third stages conducted with more than thirty experts from various backgrounds of the Malaysian construction industry.

The criteria identified from, and refined in, the qualitative phase were then brought into the quantitative phase by developing an instrument for the purpose of assigning their relative importance. This phase involved a cross-sectional questionnaire survey in which more than 200 local office building stakeholders participated. Detail explanations on the overall mixed methods research methodology are provided in Chapter Five; whereas details of the data collection and data analysis for qualitative and quantitative phases are discussed separately in Chapters Six and Seven, and Chapter Eight respectively.

Upon the validation of the proposed framework by local experts, the framework was applied on a local case study office building to test its applicability; hence, forming the basis for further refining the framework empirically and identifying any criteria with missing input data. Detail explanations on the method of validating and applying the framework are provided in Chapter Nine and Ten respectively.

1.8 Thesis Structure

The thesis structure is presented in Figure 1.1 and the specific chapter descriptions are as follows:

<u>PART I: Chapter Two</u>

This chapter builds a theoretical foundation for the research by reviewing literature on the key aspects of sustainable development and sustainable construction. It reviews the international context of sustainable development to discover important aspects and differences in the outlook and approaches of developed and emerging/developing countries to sustainable development. It then explores the differences in priorities between developed and emerging/developing countries in pursing sustainable construction. Overall, this chapter assists in defining the goal of sustainable development that buildings and construction in emerging/developing countries should aim for.

PART I: Chapter Three

This chapter concentrates on the progress made in Malaysia to date in terms of promoting and practicing sustainable development. It does this by examining the environmental and social impacts of the construction industry in relation to its economic performance. Barriers that have hindered the implementation of sustainable development are investigated. Arguments are also established not only to provide the justification for the study, but also to inform the ideal nature of the assessment framework that suits the Malaysian context. Overall, the chapter highlights the Malaysian conditions, constraints and priorities that inform the specific criteria that should be incorporated in the assessment framework.

PART I: Chapter Four

This chapter comparatively reviews and critiques nine BPASs currently used in developed and emerging/developing countries, including Malaysia's GBI, in terms of their characteristics and limitations in assessing building sustainability and supporting sustainable development. This review informs how the Malaysian assessment framework should be developed. Justification for developing another assessment framework for Malaysia is established, followed by an outline of specific requirements for developing the framework based on a synthesis of research outcomes from all literature review chapters. This synthesis also forms the basis for the proposal of tentative Malaysian Office Building Sustainability Assessment (MOBSA) framework at the end this chapter.

PART II: Chapter Five

This chapter discusses in detail the methodology of the study to ensure that views from Malaysian building stakeholders are incorporated in all stages of refining the tentative MOBSA framework. The methods of collecting and analysing the data for exploratory sequential design are explained.

PART II: Chapter Six

This chapter qualitatively explores the extent of sustainable development practices in Malaysia, different views of sustainability among building stakeholders, and their primary concerns in pursuing sustainable office building development. This was done by collecting semi-structured-interview data from a sample of thirty stakeholders from various backgrounds in the Malaysian construction industry. It first details the selection of participants, interview protocol, and data analysis, followed by results and discussions. These findings substantiated and fine-tuned the criteria identified in the tentative MOBSA framework, resulting in the proposal of Stage-1 MOBSA framework at the end of this chapter.

PART II: Chapter Seven

This chapter sets out to refine the Stage-1 MOBSA framework further by means of a focus groups discussion, which can be described as the second stage of the qualitative phase. The focus groups involved 38 experts from various backgrounds of the local construction industry. The specific objectives of this stage are to discuss, identify, clarify and define the assessment criteria relevant to the Malaysian context; and to establish the performance benchmarks for the derived criteria. The procedure and results are presented and discussed and a Stage-2 MOBSA framework is proposed at the end of this chapter.

PART II: Chapter Eight

The outcome of the qualitative phase earlier provides a foundation for the subsequent quantitative phase which involves a development/refinement of a questionnaire survey, which is the subject of this chapter. It details the instrumentation, the target population, sampling methods, questionnaire administration, followed by results and discussions. The outcomes of this chapter are an identification of the most important criteria and their relative weightings and these are presented as the Stage-3 MOBSA framework.

PART III: Chapter Nine

This part of the thesis aims to integrate both qualitative and quantitative results to reveal the relevant form of the MOBSA framework. It aims to bring the Stage-3 MOBSA framework into a validating process involving nine experts in the local construction industry. In doing so, the chapter first proposes tentative performance benchmarks for the criteria in the framework based on results from qualitative phase earlier; and additional review of literature. Following the validation process, the *Validated Comprehensive MOBSA Framework*, applicable to all phases of project assessment and building stakeholders, is proposed at the end of this chapter.

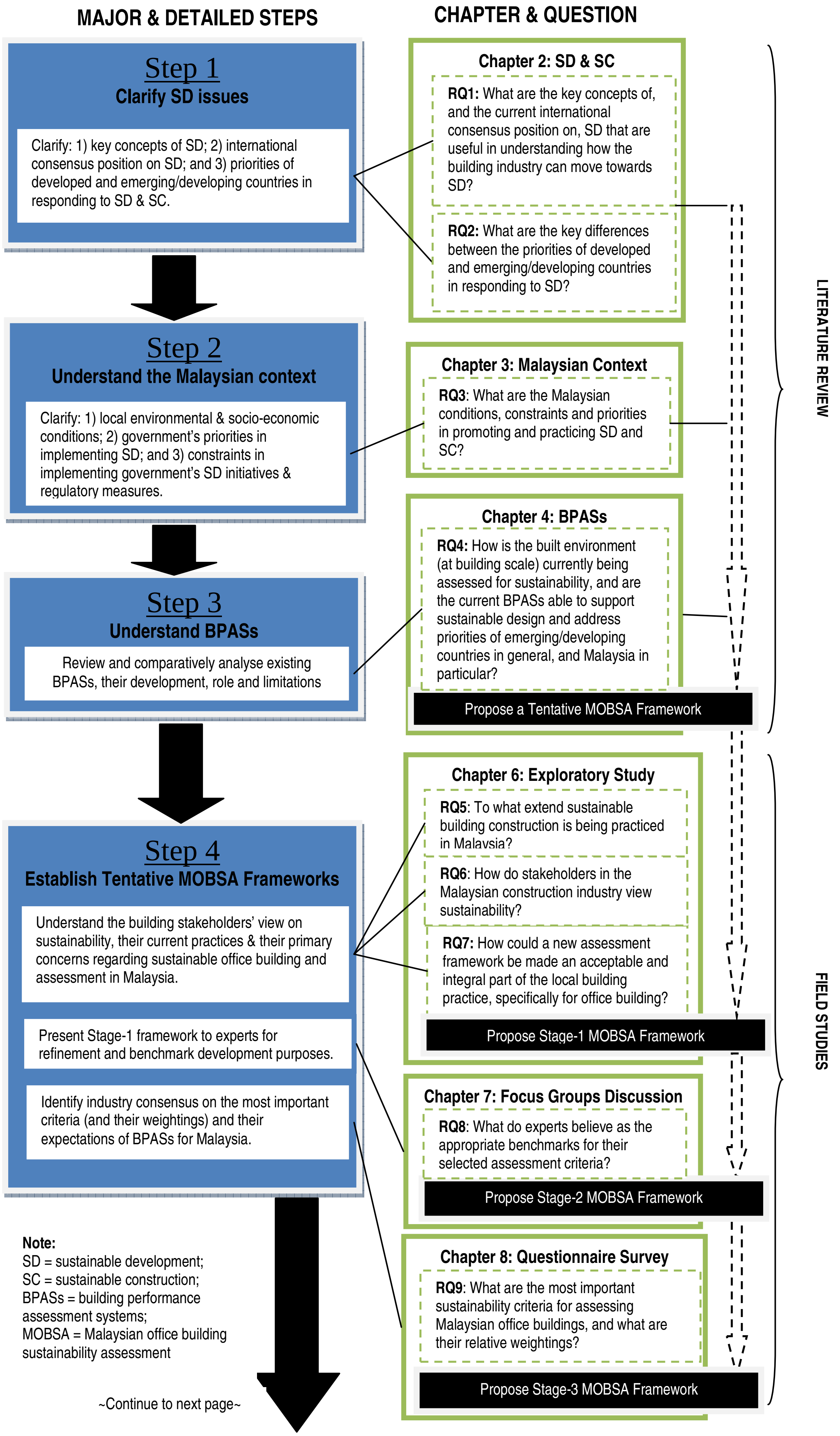
PART III: Chapter Ten

This chapter aims to show how the Validated Comprehensive MOBSA Framework may be applied in real life by proposing a scoring system to enable its application or testing. The application however, focuses on criteria applicable to the design phase. These criteria (and their appropriate benchmarks) therefore, were extracted from the comprehensive framework and referred to as Validated MOBSA Framework for the Design Phase. This framework was subsequently applied on a real life case study project for the purpose of refining the benchmarks based on empirical data and identifying any criteria with missing input data. Additionally, the case study building's assessment results between Validated MOBSA Framework for the Design Phase and existing environmental-focused BPAS are compared and discussed.

PART III: Chapter Eleven

This chapter summarises the research and states the conclusions. Conditional statements are made with respect to the application of the proposed assessment framework in the construction industry. The possibilities of further research are suggested at the end of the chapter.

The flow steps of the research and structure of the research are presented in Figure 1.1.


MAJOR & DETAILED STEPS
CHAPTER & QUESTION
Step 1
Clarify SD issues
Clarify: 1) key concepts of SD; 2) international consensus position on SD; and 3) priorities of developed and emerging/developing countries in responding to SD & SC.
Chapter 2: SD & SC
RQ1: What are the key concepts of, and the current international consensus position on, SD that are useful in understanding how the building industry can move towards SD?
RQ2: What are the key differences between the priorities of developed and emerging/developing countries in responding to SD?
Step 2
Understand the Malaysian context
Clarify: 1) local environmental & socio-economic conditions; 2) government's priorities in implementing SD; and 3) constraints in implementing government's SD initiatives & regulatory measures.
Chapter 3: Malaysian Context
RQ3: What are the Malaysian conditions, constraints and priorities in promoting and practicing SD and SC?
Step 3
Understand BPASs
Review and comparatively analyse existing BPASs, their development, role and limitations
Chapter 4: BPASs
RQ4: How is the built environment (at building scale) currently being assessed for sustainability, and are the current BPASs able to support sustainable design and address priorities of emerging/developing countries in general, and Malaysia in particular?
Propose a Tentative MOBSA Framework
LITERATURE REVIEW
Step 4
Establish Tentative MOBSA Frameworks
Understand the building stakeholders' view on sustainability, their current practices & their primary concerns regarding sustainable office building and assessment in Malaysia.
Present Stage-1 framework to experts for refinement and benchmark development purposes.
Identify industry consensus on the most important criteria (and their weightings) and their expectations of BPASs for Malaysia.
Chapter 6: Exploratory Study
RQ5: To what extend sustainable building construction is being practiced in Malaysia?
RQ6: How do stakeholders in the Malaysian construction industry view sustainability?
RQ7: How could a new assessment framework be made an acceptable and integral part of the local building practice, specifically for office building?
Propose Stage-1 MOBSA Framework
Chapter 7: Focus Groups Discussion
RQ8: What do experts believe as the appropriate benchmarks for their selected assessment criteria?
Propose Stage-2 MOBSA Framework
Chapter 8: Questionnaire Survey
RQ9: What are the most important sustainability criteria for assessing Malaysian office buildings, and what are their relative weightings?
Propose Stage-3 MOBSA Framework
FIELD STUDIES
Note:
SD = sustainable development;
SC = sustainable construction;
BPASs = building performance assessment systems;
MOBSA = Malaysian office building sustainability assessment
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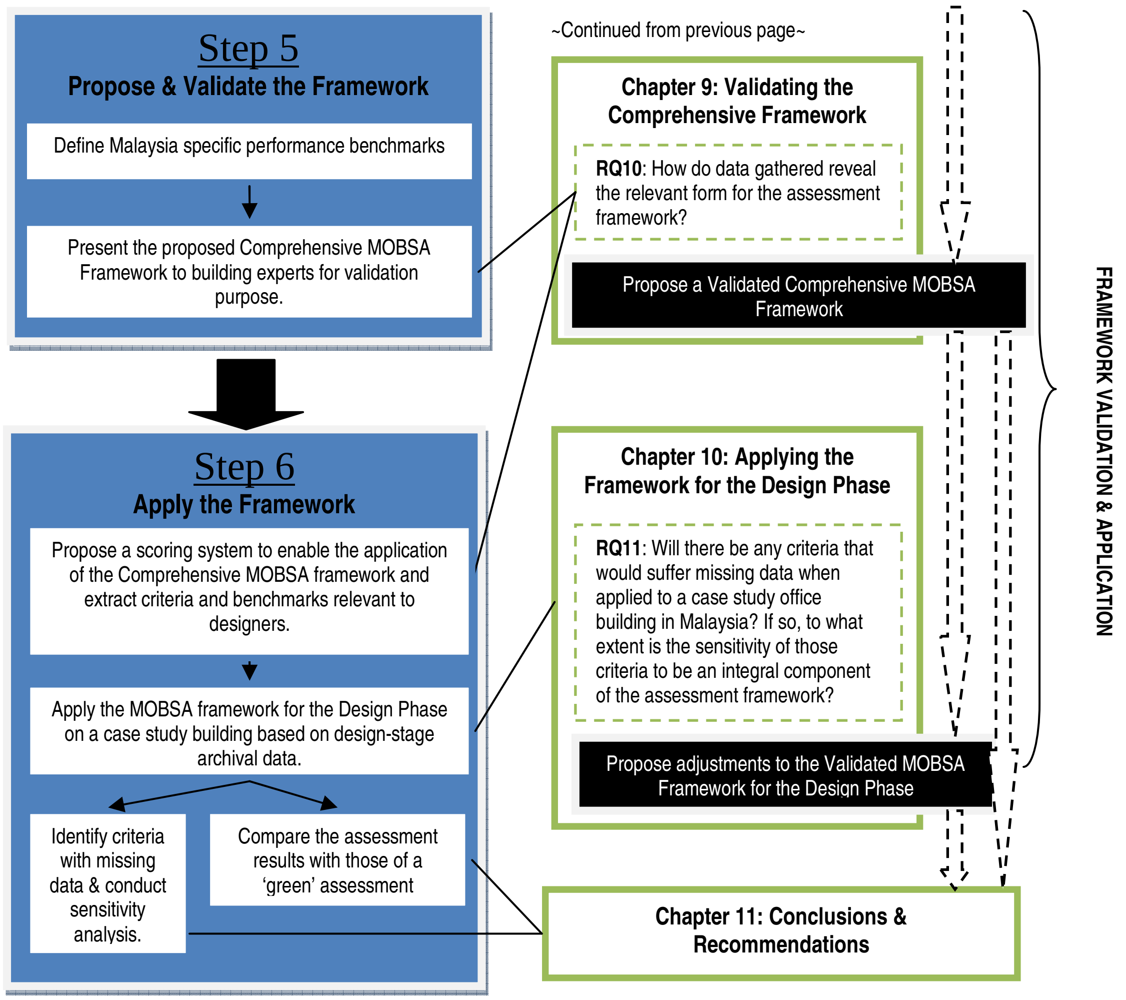

Note:
SD = sustainable development; SC = sustainable construction; BPASs = building performance assessment systems;
MOBSA = Malaysian office building sustainability assessment

Figure 1.1: Structure of thesis

Chapter 2: Key Aspects of Sustainable Development and Sustainable Construction

2.1 Introduction

This chapter aims to evaluate the sustainable development concept, its relationship to the construction industry, and the key priorities of emerging/developing countries in its implementation. This is important to enable the study to be informed by theory in this field, which shall inform the development of the tentative Malaysian Office Building Sustainability Assessment (MOBSA) framework in Chapter Four.

This chapter is divided into two sections. The first section reviews the evolution of the sustainable development concept, covering the panorama of definitions of the terms and their components in order to understand their key concepts. It then outlines the variety of approaches in the implementation of the concept and reviews the international context of sustainable development. This review enables identifying important aspects and differences in the outlook and approaches of developed and emerging/developing countries to sustainable development.

The second section highlights the global environmental, social and economic impacts of the construction industry, and discusses the concept of ‘sustainable construction’. It then discusses the differences in priorities between developed and emerging/developing countries in pursuing sustainable construction. Finally, the specific requirements of sustainable construction in the emerging/developing countries are highlighted.

2.2 Sustainable Development

2.2.1 Evolution of the Concept

In the 18th and 19th centuries, the Industrial Revolution, and the resulting changes in social value systems and advances in science and technology, as well as the population explosion and rapid urbanization, exacerbated the process of consumption of natural resources and pollution. However, sustainability was not seen as an issue, as the planet apparently had plentiful resources to offer.

One of the first responses calling on local environmental awareness only took place in 1962 with the publication of *Silent Spring* (Carson, 1962), a book which highlighted the earth's limited capacity to absorb pollutants. Then in 1968, the first photographs of the Earth were taken from the Moon during the Apollo 8 mission perfectly visualized the metaphor 'Spaceship Earth' that not only implied limits to human activities but also the need for human management of the environment (Dresner, 2002). In fact, within two years of these photographs being taken, the modern environmental movement was born (Gore, 2006). Following the oil crisis of the 1970s the dependence of human existence on natural resources was widely recognized, and that their availability forever could not be taken for granted (Williamson*, et al.*, 2003).

Around the same time as the oil crisis, a group, later known as the Club of Rome published *The Limits to Growth* (Meadows*, et al.*, 1972), a document which emphasized that concerns about pollution, environmental degradation and natural resource depletion were crucial to the long-term future of humanity. They argued that economic growth is the cause of environmental destruction and concluded that, if present trends in population growth, food production, resource use and pollution continued, the carrying capacity of the planet would be exceeded within the next 100 years. The 'limits to growth' argument was supported by Daly (1977) in his *Steady State Economics* who recognised the limits to economic growth and believed that environmental protection and economic development are conflicting and non-compatible. Therefore, this initial concern led to calls for zero-growth strategies.

It was the 1972 United Nations Conference on the Human Environment, held in Stockholm that first explored the links between environment and development on a global scale (Dresner, 2002; Mebratu, 1998). In the Stockholm Conference, the idea of an urgent need to respond to the problem of environmental deterioration was accepted and was included in the *Stockholm Declaration on Human Environment* (UN, 1972). Even if the link between environmental and development issues did not emerge strongly, there were indications that the form of economic development would have to be altered. The limits-to-growth perspective in the 1970s challenged the pro-growth perspective of the previous decades, and, because this threatened important ideas and interests, the reaction was intense. A synthesis of these conflicting perspectives eventually emerged in the perspective of 'sustainable development' i.e. a middle ground between both extremes (Stockdale, 1989).

The practice of nature conservation in the 1970s however, was still largely embraced a preservationist philosophy, which held that nature could and should be conserved within the nearly demarcated boundaries of conservation areas. Development and conservation were seen as two ideals which were in direct conflict with one another. In 1980, the International Union for the Conservation of Nature (IUCN) formulated the *World Conservation Strategy* (WCS) (IUCN*, et al.*, 1980) and since then, there has been a growing global acceptance that conservation is not necessarily the opposite of development. This Strategy marked a significant shift in conservation, from focusing solely on the practice of fencing off nature reserves to viewing conservation and development as an integrated concept. Conservation cannot be achieved without development to alleviate poverty and misery of hundreds of millions of people. On the other hand, development that does not conserve nature will lead to numerous problems for the world's people and fragile ecosystem. The Strategy defined development as "modification to the biosphere to satisfy human needs", and conservation as "the management of human use of the biosphere to yield the greatest sustainable benefit to present and future generations" (IUCN*, et al.*, 1980). Although the term 'sustainable development' did not appear in the text, the Strategy's subtitle "Living Resource Conservation for Sustainable Development," certainly highlighting the concept of sustainability (Khosla, 1995). According to Khosla (1995), by bringing the element of time directly into the environment and development debate, the Strategy discovered a truly synthesizing factor in sustainability and was able to focus what earlier had been a rather diffuse idea. However, the report concerned with human needs only, concentrated entirely on addressing environmental sustainability, as opposed to linking sustainability to wider social and economic issues.

It was not until 1987, when the World Commission on Environment and Development (WCED) produced a publication entitled *Our Common Future* (WCED, 1987), which is referred to as the 'Brundtland Report', that the links between the social, economic and environmental dimensions of development were explicitly addressed. In making the links, the Brundtland Report puts 'development', a traditional economic and social goal, and 'sustainability', an ecological goal, together to devise a new development model, that of sustainable development. Sustainable development is a model of societal change that has both the objectives of traditional development and maintaining ecological sustainability (Lele, 1991). This differs from the previous IUCN approach in 1980 which linked the environment with conservation, not with development. Therefore, it could be argued that environment and development issues are inextricably linked and therefore worrying about either environment or development on its own was inappropriate.

The Commission stated that the essential needs of vast numbers of people were not being met, and warned that a world where poverty and inequity were endemic would be prone to ecological and other crises. The Brundtland Report holds the key statement of sustainable development, which defined it as: “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987, p.8). In contrast to the limits-to-growth perspective in the 1970s, sustainable development placed more emphasis on the social and economic goals of society, particularly in the emerging/developing countries, but stressed that the attainment of these goals was interconnected with the achievement of environmental goals. The Brundtland Report underlines the strong linkage between poverty alleviation, environmental improvement, and social equitability through sustainable economic growth. It also recognizes the dependency of humans on the environment to meet needs and well-being in a much wider sense than merely exploiting resources: “ecology and economy are becoming ever more interwoven – locally, regionally, nationally and globally” (WCED, 1987, p.5). However, limits are still imposed “by the ability of the biosphere to absorb the effects of human activities” (WCED, 1987, p.8) and by the need to “adopt life-styles within the planet’s ecological means” (WCED, 1987, p.9). Thus, sustainable development does not assume that growth is both possible and desirable in all circumstances.

The Brundtland’s definition has raised the question as to what is defined as ‘needs’. This clearly will be defined differently by different societies, and will differ widely between developed and emerging/developing countries. Mebratu (1998) for example, has identified several institutional definitions of sustainable development; all focused on need satisfactions that interpret needs very differently. The interpretation largely depends on the group that the institution represents, whether nation states, communities or corporations. The varying interpretations support advocacy of very different policies and practices. Numerous authors have argued, convincingly, that needs vary with context and values (e.g. Douglas*, et al.*, 1998; Maslow, 1987; Max-Neef, 1991). If this is the case, then any concepts of sustainable development based on needs simply encourages individuals and organizations to project their own values onto the concept. The looseness of the concept and its theoretical underpinnings have enabled the use of the phrases ‘sustainable development’ and ‘sustainability’ to become popular among politicians and business leaders (Wackernagel & Rees, 1996).

After the publication of the *Brundtland Report*, the IUCN produced another report, titled *Caring for the Earth* (IUCN*, et al.*, 1991) in addition to the WCS produced in 1980. Compared to the 1980 report, which concentrated entirely on environmental changes, the 1991 report, although still concentrating on environmental issues, shows a greater recognition of social issues proposing changes in socio-economic structures, increasing participation in decisions, improving the quality of life and modifications to the world economy (Hopwood*, et al.*, 2005). *Caring for the Earth* defined 'sustainable development' as development which "improves the quality of human life while living within the carrying capacity of supporting ecosystem" while 'sustainability' is "a characteristic of a process or state that can be maintained indefinitely" (IUCN*, et al.*, 1991, p.211).

In this definition, the required state for sustainability is to improve the quality of human life. This must happen within limits, in this case the carrying capacity of the supporting ecosystem. This definition remains contentious because of difficulties in defining the 'quality of human life', difficulties in determining the 'carrying capacity of supporting ecosystems', and difficulties in identifying the actions undermining ecosystems. Accusations between the nations of the North and the South over who is overextending the carrying capacity of local and global systems have become habitual, and formed the topic of heated debate at the 1992 United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, which is also known as the 'Rio Conference' or the 'Earth Summit.' In this event, the sustainable development concept was given currency. 154 countries signed the *Rio Declaration on Environment and Development* and reaffirmed the *Stockholm Declaration*. Of particular strategic importance to the international community are the official agreements on five specific areas, namely: *The Rio Declaration* (UNESCO, 1992), *Agenda 21* (UN, 1992a), the *Statement of Principles on Forests* (UN, 1992b), the *Convention on Biological Diversity* (UN, 1992c), and the *Framework Convention on Climate Change* (UNFCCC, 1992). Therefore, the emergence of the concerns for development and environment in the late 1980s and early 1990s, when compared to the movement in the 1970s, show at least three changes in emphasis: 1) the depletion of the stratospheric ozone layer and atmospheric warming; 2) concern about the depletion of non-renewable mineral resources which has to some extent receded; and 3) the wider acceptance that economic growth which seeks to minimize ecological damage needs to be met (Hardoy*, et al.*, 1992; IUCN*, et al.*, 1991; World Bank, 1992).

The *Agenda 21* mentions the economic disparities between, and within nations, worsening poverty, hunger, illiteracy and the continuing deterioration of ecosystems (UN, 1992a). Two issues prevailed in the UNCED: 1) Link between environment and development and 2) practical interpretation of the rather theoretical concept of sustainable development, seeking to balance the modalities of environment protection with social and economical concerns. This Agenda points to the fact that the protection of the environment, social equity and economic development are the key pillars of sustainable development (UN, 1992a).

In addition to these three pillars, the *Habitat II Agenda* (United Nations Development Programme [UNDP], 1996), which was the outcome of the United Nations International Conference on Human Settlement in Istanbul in 1996, introduced the term 'sustainable politic'. Thus, sustainability was reinforced as having multiple dimensions. Later in 2002, the concept of sustainable development was further reinforced at the World Summit on Sustainable Development (WSSD), held in Johannesburg. The WSSD was the biggest conference of its kind organized by the UN to date (Hens & Nath, 2005). The WSSD published the *Johannesburg Plan of Implementation* (JPI) (UN, 2002) in which clearer definition from Brundtland Report is provided and an additional component to sustainable development is suggested. In particular, the report put a strong emphasis on 'participation' by all members of society by emphasizing that sustainable development should have the overall aims of eradicating poverty, changing unsustainable patterns of consumption and production, and protecting and managing the natural resources, and that decision-making should take a long-term perspective and involve a broad-based stakeholder participation (UN, 2002). Arguably, sustainability of any initiative or project can be meaningfully fostered only if it is based on effective participation. Moreover, the JPI also explains that the sustainability components or pillars are interdependent and mutually supportive elements of long-term development (UN, 2002).

It is now clear that the term 'sustainable development' was used differently in the 1960s and 1970s, as compared to 1980s and beyond, in the argument against economic and population growth. The main concern in 1960s and 1970s was about conserving natural resources for continuous economic growth because the world's natural resources were perceived to be limited and may be depleted at a rate that could be detrimental to economic growth. In contrast, advocates of sustainable development in the 1980s sought to find ways of making economic growth sustainable, mainly through technological change (Commonwealth Government, 1990; Pearce*, et al.*, 1989). In 1982, the British government began using the term 'sustainability' to refer to sustainable economic expansion rather than the sustainable use of resources (Beder, 1994). The clarification of the WCED in 1987 has emphasized the need for continued economic development, including economic growth "[because] development is seen as …desirable for the entire world,…most particular for those nations which are currently 'underdeveloped'" (Eichler, 1999, p.185). The *Brundtland Report* rejected the idea that there were environmental limits to growth (Kirkby*, et al.*, 1995) and saw a different, less environmentally damaging form of economic growth in future as possible and indeed essential (Rees, 1990). A more recent study by Dresner (2002) attempted to address this controversial issue by arguing that the sustainable development concept carefully balanced environmental concern with endorsement of economic growth.

Rather than challenging the idea of growth directly, it sought to modify the kind of growth strategies that were pursued (Dresner, 2002).

The lack of an accepted definition of sustainable development has had at least two important consequences. Firstly, it has enabled the concept of sustainable development to be defined by various interest groups in a manner which suits their own goals and agenda (Beder, 1996). The relevance of this can be appreciated at all levels: from project to local, regional, national and global (vanPelt, 1993). It is embraced by big business, governments, social reformers and environmental activists, all of which put their own interpretation on what sustainable development means. Not surprisingly, Pezzoli (1997) demonstrates that there is an abundance of literature available on the subject, but no consensus on the meaning of the term. Even within the same disciplines there have been disagreements among the experts. This could be the reason for the lack of progress in solving many real problems that exist universally today. In line with this realization, Tim O'Riordan (1988) argued in his essay *Politics of Sustainability* that the reason for the popularity of the term 'sustainable development' lay in the way that it could be used both by environmentalists, emphasizing the sustainable part, and by developers, emphasizing the development part. Some people would see 'development' as the kind of economic growth that has been claimed to be thoroughly unsustainable because it is the actual cause of the ecological predicament which we now face. Indeed, for many environmentally inclined people, 'development' is almost a dirty word, calling to mind wanton destruction of natural places for the building of ever more luxury residences and factories.

Secondly, the vagueness of the definition would allow people to claim almost anything as part of sustainable development, reducing the term to meaninglessness (O'Riordan, 1988). However, Daly (1996) argued that having a consensus on a vague concept, rather than disagreement over a sharply defined one, was a good political strategy. By 1995, however, this initial vagueness was no longer a basis for consensus, but later become a breeding ground for disagreement. For example, according to Fowke and Prasad (1996), there were at least 80 different, often competing and sometimes contradictory, definitions and interpretations of sustainable development in circulation. Similarly, Mawhinney (2002) demonstrated that 'sustainable development' appears to be an over-used and misunderstood phrase. There are common threads between these definitions, but also problematic differences, such as differing priorities, ambiguity in meaning, and questions of appropriate scale of application. Reflecting the same apprehension, Goldin and Winters (1995) described the concept as being "elusive," while Tryzna (1995), Dresner (2002) and

Doughty and Hammond (2004) presented the growing frustration around the concept, underlying by it being branded as “oxymoron” by its own protagonists.

The term between ‘sustainability’ and ‘sustainable development’ is also an area of debate. Both of these terms were used interchangeably in *Agenda 21*. However, Dovers and Handmer (1992) drew a distinction between the terms. They claimed that ‘sustainability’ is the long-term and difficult goal of reaching an ecologically sustainable state. The variable process by which we might move somewhat nearer to this goal is ‘sustainable development’ (Dovers & Handmer, 1992). Similarly, the International Organization for Standardization (ISO CD 15392, 2004) asserted that ‘sustainability’ is the result of applying the concept of ‘sustainable development’, ensuring the maintenance of ecosystem components and functions for future generations. Therefore, these arguments imply that ‘sustainability’ is a goal while ‘sustainable development’ is a process. Surprisingly, according to McNeill (McNeill, 2000, p.18), ‘sustainable development’ must be a goal and not a process as it is “unambiguously concerned with the normative, what ought to be done not with describing the actual experience of one or more countries”.

Clearly, there is no common philosophy on sustainable development and reaching a consensus is complicated and difficult. The divergence of opinions relating to the term proves that ‘sustainability’ is so broad an idea that a single definition cannot adequately capture all the nuances of the concept. Whatever view is taken, it is clearly an area of contention. Nevertheless, it is probably true that the dichotomy of the development/environment debate in the 1970s and the 1980s has been replaced by a sustainable development synthesis, in that there is general agreement that uncontrolled exploitation of natural resources is not beneficial to humankind in the long term. Hence, the term ‘sustainable development’ has been used today as it attempts to embrace the relation between the socio-economic and environment and has gained widespread recognition. This term is therefore used throughout this thesis to describe attempts to combine the environment, social and economic issues.

2.2.2 The Interrelationships of the Three Dimensions

The previous section showed that sustainable development has these three dimensions – the environmental, social and economic. As buildings have both human and environmental aspects, this section will therefore concentrate on developing an understanding of the interrelationships of these dimensions in order to grasp the different approaches in implementing the sustainable development concept.

Due to the complexity of the concept of sustainable development, with wide-ranging aims and scope, it is difficult to make the concept precise for implementation purposes. There is considerable divergence in opinion regarding which approaches, priorities and drivers should take precedence. At the root of most of this lies the debate about which is most important: the environment or human needs, including such needs as maximizing shareholder value and achieving a high standard of living. This dualistic tension can be found in the debates around weak versus strong sustainability (Pearce & Barbier, 2000; Pearce*, et al.*, 1989; Turner & Pearce, 1993), Brown and Green Agenda (International Institute for Environment and Development [IIED], 2001; McGranahan & Satterthwaite, 2000), and Shallow versus Deep Ecology (Naess, 1989).

Despite this tension, the expression of the so-called 'Triple Bottom Line' (TBL)[1] approach to sustainable development has evolved (Elkington, 1994) in order to operationalize the sustainable development concept in the corporate community. TBL, attempts to rationalize development that promotes economic growth, but maintains social inclusion and minimizes environmental impact. Nevertheless, there are discrepancies on the interpretation of sustainable development. The three dimensions can be considered equal or the environment can be viewed dominant dimension that sets the preconditions for the others (Rydin, 2003). These two approaches are discussed below.

In the first approach, the three dimensions are presented as three interconnected rings (Barton, 2000; International Council for Local Environmental Initiatives [ICLEI], 1996; ISO/FDIS 15392, 2008; Lutzkendorf & Lorenz, 2007) (see Model 1 on Figure 2.1). The model has a conceptual simplicity in which the environment was seen as equal to society and the economy. The model usually shows equal sized rings in a symmetrical interconnection, although there is no reason why this should be the case. Often sustainable development is presented as aiming to bring the three together in a balanced way, reconciling conflicts. For example, the International Organization for Standardization (ISO/FDIS 15392, 2008, p.8) explained that:

> The three components are inextricably linked to each other, are interdependent and to be balanced. They must be considered equally. These aspects should be listed in no particular order…The overlapping areas represent aspects of mutual influence. The overlapping may lead to positive impact in one sphere resulting in adverse impact in the other(s).

[1] It is a term that is increasingly accepted worldwide within the corporate community, and a framework for corporate reporting practices.

Consequently, every plan or activity should take into account these interrelationships. As Robinson (2004, p.378) noted: "solutions that address only environmental, only social or only economic concerns are radically insufficient."

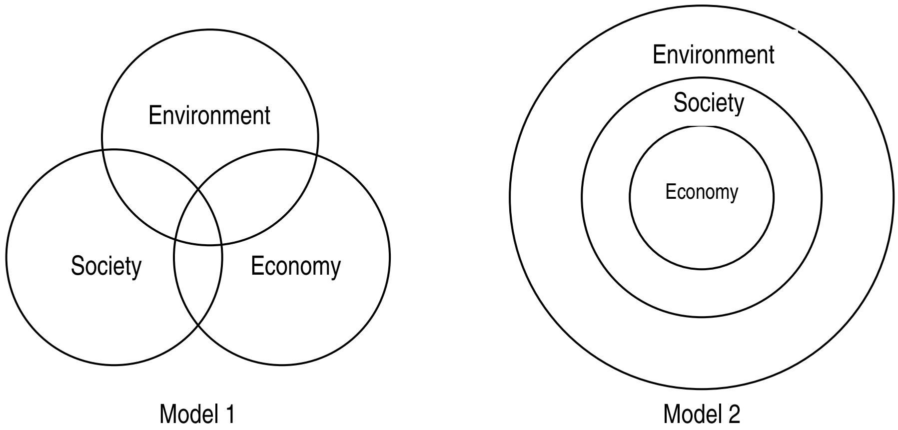

Figure 2.1: Three-ring models of sustainable development

However, if they are seen as separate, as the model implies, different perspectives can, and often do, give a greater priority to one or the other. Numerous authors pointed out the weaknesses and limitations of this model by arguing that it assumes the separation and even independence of the economy, society and environment from each other (Giddings*, et al.*, 2002; McGregor, 2003; Neumayer, 1999; Wackernagel & Rees, 1996). This view risks approaching and tackling issues of sustainable development in a compartmentalized manner i.e. concentration on a part, rather than the whole. According to Neumayer (1999) and IUCN (2006), this separation leads to assumptions that trade-offs can be made between the three dimensions, in line with the views of 'weak' sustainability that built capital can replace or substitute for natural resources and systems. Similarly, McGregor (2003) argued that this model does not implicitly recognise the environmental limits of growth because the basis is a balancing mechanism, which effectively trades off economic growth against the two other dimensions. IUCN (2006) further argued that the dimensions cannot be treated as if equivalent. Consequently, a distinction is often drawn between 'strong' sustainability (where such trade-offs are not allowed or are restricted) and 'weak' sustainability (where they are permissible) (IUCN, 2006).

Another approach of viewing the interrelationship of the three components was given by Daly (1992), Rees (1995), Wackernagel and Rees (1996), and Giddings *et al.* (2002), who argued that in reality, economy is dependent on society and the environment, and without society, there can be no economy. They also noted that human activity takes place within the environment. This view implies that the economy is a subset of society, which in turn is a subset of environment[2] (see Model 2 on Figure 2.1). Put differently, economic capital is placed at the centre as the basis of wealth creation, which drives the development engine, but at the same time is constrained by environmental and social considerations. McGregor (2003) seemed to favour this model as he argued that this model implies that environmental limits are an important constraining influence on economic growth, which is in contrast with his view on the first model. Giddings *et al.* (2002) noted that placing the economy in the centre does not mean that it should be seen as the focus which the other dimensions and activities revolve. Rather it is a subset of the others and is dependent upon them. Human society depends on environment although in contrast the environment would continue without society (Lovelock, 1991). The economy depends on society and the environment although society for many people did and still does exist without the economy.

Conclusively, the pursuit of sustainable development depends on the capacity to guarantee a complete interaction among economy, society and environment. It seems, nevertheless, essential to highlight the many close interconnections that these dimensions share. They should therefore not to be perceived as independent, but rather as a systematic frame of elements that equally contribute to reach the same goal. Consequently, it is noted in this research that every building planning and construction should take into account these interrelations. A planning or construction favouring just one or two of these dimensions, will not contribute to sustainable development. However, despite the fact that this research ensures the inclusion and equitability of the three dimensions of sustainable development within the assessment framework, trade-offs or putting greater emphasis on one dimension above the others is not impossible in building stakeholders' practical decisions.

2.2.3 The International Context

This section explores the current international context of sustainable development by reviewing five key documents (in chronological order), namely: 1) *Agenda 21* (UN, 1992a); 2) the *Rio Declaration on the Environment and Development* (UNESCO, 1992); 3) the *Framework Convention on Climate Change* (UNFCCC, 1992) and the *Kyoto Protocol* (UN, 1998); 4) the *Millennium Declaration* (UN, 2000); and 5) the *Johannesburg Plan of Implementation (JPI)* (UN, 2002).

[2] Lutzkendorf and Lorenz (2005) argue perhaps surprisingly that the construction industry participants who strive for sustainable development have been strongly focused on environmental considerations rather than economic considerations, and therefore they place environment at the centre with economic capital at the margin. This is used to justify the rationale for their research that the construction and development industry has frequently ignored the impact of environmental and social issues on property values and returns.

2.2.3.1 Agenda 21 (1992)

Among the ‘products’ coming out of UNCED or 1992 Earth Summit, *Agenda 21* (UN, 1992a) and the *Rio Declaration* (UNESCO, 1992) were arguably the most important international agreements for advancing understanding of sustainable development. These documents have been adopted by 178 governments and each UN member country was expected to produce a national report covering current national environmental and developmental aspects and drawing up an action plan for promoting sustainable development within the national context. In order to monitor progress of implementing *Agenda 21*, the Commission on Sustainable Development (CSD) was established in 1992. The CSD reviewed the implementation of *Agenda 21* in 1997 and endorsed its ongoing implementation.

Agenda 21 is a policy document that outlines the global response to the global ecological crisis and sets out in broad terms plans for implementation in all areas of sustainable development. It calls for “integration of environment and development concerns,…the fulfilment of basic needs, improved living standards for all, better protected and managed ecosystems and a safer, more prosperous future” (UN, 1992a, Article 1.1). Developed through an international consensus-building process, involving representatives of national governments from around the world, *Agenda 21* provides a strong foundation for a shared understanding of sustainable development.

Responsibility for the implementation of *Agenda 21* is placed with national governments, which are required to ensure that implementation occurs through national strategies, plans and policies. The preamble of Agenda states that the document is a framework outlining actions, which will be implemented differently, by different countries, depending on local situations, capacities and priorities. Developing countries, it declares, should be given particular attention because of the state of transition that these are in. These countries suffer particular challenges in transforming their economies as a result of social and political tension. In bringing about sustainable development, *Agenda 21* puts emphasis on the bottom-up approach by highlighting the role of citizens, communities and non-governmental organizations (NGOs). The entire tone of *Agenda 21* is about participation and open government.

The agenda consists of 40 chapters of specific objectives and activities. A list of these chapters is provided in Appendix A-1. Each of these chapters provides the reasoning behind why change is required, a description of the objectives of the program and a list of activities that will help achieve the objectives described. In some cases these lists are highly detailed and include suggested actions for a wide range of stakeholders including local government and communities. Detail is also provided of the estimated costs and capacity requirements of implementing the program.

However, while *Agenda 21* outlined many specific objectives and actions, it did not establish any binding targets or commitments. Instead, it provided a conceptual framework under which international, national, regional and local organizations could develop their own detailed implementation plans. Consequently, the progress in the practical implementation of *Agenda 21* has been varied. At the national level, implementation has generally been poor (UN Economic and Social Council, 2001) due to three main factors: vagueness of how to measure sustainable development; unrealistic expectations placed on the creation of the CSD; and the lack of funds for the implementation (Hens & Nath, 2005). On the other hand, numerous local authorities have developed their own *Local Agenda 21* action plans. As of 2002, "6,416 local authorities in 113 countries [had] either made a formal commitment to *Local Agenda 21* or [were] actively undertaking the process" (International Council for Local Environmental Initiatives [ICLEI], 2002, p.3).

The *Agenda 21* acknowledges the diversity of countries by suggesting that the implementation of the program may vary from country to country, depending on local circumstances. It declares however, that implementation should be aligned to a set of principles developed alongside *Agenda 21*. These are referred to as the *Rio Declaration on Environmental Development*.

2.2.3.2 Rio Declaration on Environment and Development (1992)

The *Rio Declaration on Environment and Development* (UNESCO, 1992), often shortened to *Rio Declaration*, provides a set of principles that countries should use in implementing *Agenda 21*. The declaration consists on 27 broad principles that were put forward as a blueprint for achieving global sustainability. These are listed in Appendix A-2. These principles provide a useful guide for how sustainable development should be implemented. They are however too abstract to be easily applied to the building and construction sector. For example, the principles had nothing specific to say about energy which is relevant to sustainable development in general and of paramount importance to the building sector in particular. While a number of the principles articulated in the Declaration could be construed to have bearing on energy, none deals with the issue directly.

Although the climate convention was not the direct product of the Rio process, it is of direct relevance to the energy issue. Indeed, *UN Framework Convention on Climate Change* (UNFCCC) is the nearest thing to a global convention dealing directly with energy concerns.

2.2.3.3 UN Framework Convention on Climate Change (1992) and Kyoto Protocol (1997)

Energy issues are related to sustainable development in three important ways: 1) energy as a source of environmental stress at global, regional as well as local levels; 2) energy as a principal motor of macroeconomic growth; and 3) energy as a prerequisite for meeting basic human needs (Najam & Cleveland, 2005). These correspond to the three dimensions of sustainable development: environmental, economic and social. In line with this realisation, this section concentrates on the *UN Framework Convention on Climate Change* (UNFCCC) which has a direct link to energy concerns.

The establishment and adoption of the UNFCCC, which is the global pact to reduce dangerous anthropogenic impacts on the climate, was influenced by the *First Assessment Report 1990* (IPCC, 1990), published by the Intergovernmental Panel on Climate Change (IPCC). UNFCCC was signed in 1992 at Rio de Janeiro, and came into force in 1994. The IPCC, established in 1988, aims to provide the world with a clear scientific view on the current state of climate change and including its environmental and socio-economic implications. The IPCC stressed that global consumption of fossil fuels, hence, carbon dioxide emissions are growing faster than at any time since 1970 with world economic growth getting stronger, thus causing global warming and ultimately contributing towards climate change problems (IPCC, 2007c). To date, IPCC has already issued four series of assessment reports on climate change (IPCC, 1990, 1995, 2001, 2007a, 2007b, 2007c) and the *Fifth Assessment Report: Climate Change 2013* is currently undergoing. The fourth report highlighted that it is more than 90% certain that GHG emissions by human activities, especially energy use, are raising global temperatures. Even if mitigation actions are taken now, the warming will continue during many decades, and thus contribute to increased energy use for space cooling in warm regions (IPCC, 2007c).

The UNFCCC sets off a string of negotiations, culminating in the adoption of the *Kyoto Protocol* (UN, 1998) at the third Conference of Parties (COP 3)[3] in 1997 in Kyoto, Japan to commit industrialized nations to specifically legal-binding GHG emission reduction. The

[3] In the period of 1995-2005, ten meetings of the parties that signed the UNFCCC were held. These meetings are known as Conferences of the Parties (CoPs) meetings and aimed at putting flesh on the general agreements outlined in the UNFCCC (Baker, 2006).

Kyoto Protocol came into force in 2005, once the requisite number of countries had become signatories. As a result of Kyoto, legally binding targets and timetables have now become an integral part of the implementation of the UNFCCC with the years between 2008 and 2012 be defined as the first GHG emissions commitment period. The comprehensive global climate agreement for the period after 2012, when the first commitment period of the *Kyoto Protocol* expires, was established at the fifteenth UN Climate Conference (COP 15) held in 2009 in Copenhagen, Denmark.

In responding to UNFCCC and the Kyoto Protocol, various measures are being implemented to reduce GHG emissions. These measures are oriented towards a transition from our current economic model to one known as the “low carbon economy” (LCE) (Stern, 2006). LCE is defined as “an economy that has a minimal output of GHGs into the biosphere, aiming to combine the highly efficient use of existing energy resources with the exploitation of new clean energy supplies” (Chen & Taylor, 2011, p.54). The goal is to develop a system which is capable of including the potential deterioration caused to the environment by GHG emissions throughout the production process as a cost of that activity. The two measures available to achieve this are the creation of taxes on emissions and the development of market of tradable emission rights (Brohe*, et al.*, 2009).

LCE makes a direct link with the need to promote sustainable development. The *Fourth Assessment Report 2007* (IPCC, 2007b) pinpoints buildings as a major contributor to global warming. Therefore, the global impacts of the construction industry as well as the need to promote sustainable development in the industry will be further discussed later in the chapter.

Apart from the protection of the atmosphere, the implementation of sustainable development also involves commitment to a number of poverty-related goals which can be traced back to one of the internationally agreed documents, which is *Millennium Declaration*.

2.2.3.4 Millennium Declaration (2000)

The *Millennium Declaration* of the UN (UN, 2000), agreed by all 189 member states of the UN at the Millennium Summit in New York on the 8th of September 2000 (UN, 2001), summarized the agreements and resolutions of the UN world conferences held during the last ten years to establish the *Millennium Development Goals* (MDGs) (UNDP, 2000). The MDGs emerged as the principal means of implementing the Declaration, intended for 'improving the lot of humanity in the new century' (UN, 2001, p.7) and generally accepted as benchmarks for measuring actual development (UNDP, 2000).

The eight MDGs and their targets are summarized in Appendix A-3. The first seven goals are directed at poverty reduction. The eighth, global partnership for development is about the means to achieve the first seven. The appendix also shows the specific quantified targets for each goal that need to be realized within a defined timeframe. For each target, these quantified indicators allow to monitor progress.

The environment is an essential component of the MDGs. Of particular importance is goal (7) for ensuring environmental sustainability. The targets of that goal refer to mainstreaming the environment in policy and programs, reversing loss of environmental resources, and improving access to environmental services (UN, 2001). The other goals, in particular (1), (4)-(6) for reducing poverty and improving health, directly linked to sustainable development. The goals and targets of poverty, environment and sustainable development in the *Millennium Declaration* are recalled in the *Johannesburg Plan of Implementation*.

2.2.3.5 Johannesburg Plan of Implementation (2002)

The Johannesburg Plan of Implementation (JPI) (UN, 2002), is the most important document to emerge from the WSSD in 2002. As a whole, the JPI is designed as a framework for action to implement commitments originally agreed to at the UNCED held in Rio de Janeiro in 1992. In addition, it reaffirms the international community's commitments to the Rio principles, the full implementation of *Agenda 21*, the *Programme for Further Implementation of Agenda 21,* and the *Millennium Declaration*.

The JPI contains an impressive list of recommendations i.e. 170 paragraphs in 11 chapters for accelerating the implementation of *Agenda 21* to support sustainable development. A list of these chapters is given in Appendix A-4, together with the core ideas underlying them. The Plan suggests that the followings are the key objectives and essential requirements for sustainable development:

- poverty eradication;
- changing unsustainable patterns of production and consumption; and
- protecting and managing the natural resource base of economic and social development.

A detailed review of the JPI reveals however that the number and complexity of the statements make it difficult for their relevance and application to buildings and construction to be easily ascertained. The study therefore proposes to extract and summarize the most relevant statements for buildings and construction. These statements are then interpreted into environmental, economic and social sustainable development objectives in order to prepare the ground for exploring their relationship with buildings and construction. The results of this analysis are shown in Appendix A-5.

2.2.3.6 Review of the International Context of Sustainable Development

Through the review of the international context of sustainable development, a number of patterns and characteristics can be detected that are relevant to this study. These are described below.

2.2.3.6.1 The shift from 'environmental' to 'sustainable development' focus

Firstly, it is argued that there has been a shift in emphasis from a purely 'environmental' to a broader 'sustainable development' focus during the ten years between the Rio Summit and the Johannesburg. This is reflected in the structure and content of the declarations from these summits. For instance, in *Agenda 21*, social and economic issues are described separately (under Social and Economic Dimensions) from environmental issues (which are described under Conservation and Management of Resources), whereas in the JPI, the distinction between these aspects is not made. Another example is the emphasis on environmental impact assessment and internalization of environmental costs, placed in the *Rio Declaration* (UNESCO, 1992, Principle 15 and 16). In the JPI, this emphasis has changed to suggesting that countries should develop and use indicators of sustainable development (UN, 2002, Article 130).

This shift can also be described as a move from Green Agenda issues of the *Agenda 21* to the Brown Agenda, as highlighted by the IIED (2001). According to McGranahan and Satterthwaite (2000), Green Agenda was a response to the impact of ecologically detrimental development, such as deforestation, climate change, pollution, and the over-consumption of non-renewable resources, on the earth's life-support systems, whereas the Brown Agenda focuses on the problems of poverty and underdevelopment. Table 2.1 describes the difference in approach between these two Agendas. This shows that decision-makings to achieve sustainable development must take into account the long-term systemic views of Green Agenda as well as the short-term focus of Brown Agenda.

Table 2.1: Difference between the Brown and Green Agendas
Source: McGranahan and Satterthwaite (2000)

	Brown	**Green**
Key concern	Human well-being	Eco-systemic well-being
Timeframe	Immediate	Delayed
Scale	Local	Think global, act local
Concerned about	Low-income groups	Future generations
View of nature	Manipulate and use	Protect and work with
Environmental services	Provide more	Use less

The shift can also be described as a move from a focus on the environmental and economic dimensions to the addition of social dimension, hence invoking together all the three dimensions of sustainable development. This shift is revealed in the difference between how the *Agenda 21* and the JPI have dealt with energy issues. For instance, in Chapters 4, 7 and 14 of the *Agenda 21,* the vast bulk of the discussion on energy issues is contextualized in the need to balance the environmental and economic dimensions of the sustainable development. These chapters highlighted the need for decreasing consumption, increasing efficiency and transitioning to cleaner sources due to monitoring evidence of global climate change. In doing so, *Agenda 21* broadened the focus from merely environmental concerns to the balance between environmental and economic concerns. However, the third dimension of the sustainable development, the social dimension still remained in the shadow.

In the JPI, the concerns about energy in terms of environmental stress and economic growth show up very similarly to how they had surfaced in the *Agenda 21.* For instance, Article 20 of the JPI relates various environment and economic aspects of energy in relation to sustainable development. What is new in the JPI are the repeated references to 'energy and sustainable development.' The document goes beyond *Agenda 21* by focusing more on the social dimension of energy and sustainable development and by concentrating on the role energy plays as a prerequisite for basic human needs including those defined in the UN's MDGs. This new ground is covered in the Article 9 and sub-clase 9.a of the JPI. Here, then, is an example of all three dimensions of the sustainable development being invoked together in a way that was not seen in any of the Rio documents. It deals with energy fully in the context of sustainable development by seeking policy that responds to the environment, economy as well as social impulses of the concept.

The understanding of social and economic aspects of sustainable development however still appears to be developing. For instance, in the JPI, there are detailed descriptions of actions required to address environmental problems whereas these tend to be vague when it comes in addressing social issues. An example of this is the very limited guidance as to how emerging/developing countries should create employment (UN, 2002, Chapter X).

Additionally, both *Agenda 21* and the JPI place a strong emphasis on the collection and use of data and information to support the design and implementation of programs. These documents suggest that a difficulty in many emerging/developing countries is that relevant, current data are not available (UN, 1992a, Chapter 40; 2002, Articles 110, 129 and 133). This makes it difficult to plan effectively or make informed decisions concerning environmental and development, as indicated in the *Agenda 21*:

> ...There is a general lack of capacity, particularly in developing countries...for the collection and assessment of data, for their transformation into useful information and for their dissemination. There is also a need for improved coordination among environmental, demographic, social and developmental data and information activities (UN, 1992a, paragraph 40.3).

It appears that an important requirement in emerging/developing countries in terms of this study will be capturing and making available information on building performance in relation to sustainable development.

2.2.3.6.2 The difference between developed and emerging/developing countries

Explicit in documents from both summits, is the realization that different approaches are required for countries in differing stages of development. This is recognized in the proposed flexible application of *Agenda 21* and through the inclusion of separate chapters for small island developing states and Africa (UN, 2002, Chapter VII and VIII) in the JPI. Here, both documents clearly recognise that there are special challenges to planning for, and implementing sustainable development, in emerging/developing countries.

One of the issues highlighted in the JPI which requires different approaches to be addressed by emerging/developing world is related to sustainable development assessment mechanisms. For example, Chapter III of the JPI calls for actions to:

> Identify specific activities, tools, policies, measures and monitoring and assessment mechanisms, including, where appropriate, life-cycle analysis and national indicators for measuring progress, being in mind that standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries, in particular developing countries (UN, 2002, Article 15.a).

The difference in approach is also reflected in the principle of ‘common but differentiated responsibilities’ of the *Rio Declaration* (UNESCO, 1992, Principle 7). This principle focuses specific attention on the imbalances in global patterns of consumption and production and the need for governments to specify their role and responsibility in establishing the proper balance. Chapter 4 of the *Agenda 21* then points out the need for the developed countries to ‘take the lead’ and developing countries to include sustainable consumption in their development process. The chapter further highlights the need for strategies to address unsustainability ranging from the excessive demands and lifestyles of the rich to the lack of access to food, clean water, healthcare, shelter and education by the poor.

On top of this, the principle of ‘common but differentiated responsibilities’ was also applied in the UNFCCC by categorizing countries based on their economic development status (Baker, 2006): 1) industrialized or developed countries; 2) the most prosperous of the industrialized countries; and 3) most emerging/developing countries, e.g. Malaysia. In applying this principle, the convention text assigns different obligations to the different parties. This is due to the recognition given in the convention that while all nations must play their rightful roles in addressing global warming, developed nations are largely, through inadvertently, responsible for the largest share of emissions and are obligated to take the lead in mitigation efforts (Baker, 2006). Therefore, under the *Kyoto Protocol*, developed nations were given emission reduction targets to result in an overall reduction of GHG emissions of 5% below the 1990 levels. The targeted reduction is to be achieved in the First Commitment period, 2008-2012. The second group of developed countries have the additional obligation of assisting emerging/developing countries to adjust to climate change and to meet their convention obligations.

Emerging/developing countries generally argued that their per capita emission rates are only a tiny fraction of those in the developed world; hence, have no GHG restrictions (Baker, 2006). However, emerging/developing countries may be motivated to participate as IPCC emphasized that those who would feel the worst effects of climate change would be the poorest, who had contributed least to causing it. It is also in emerging/developing countries, with limited technology, financing and information, that barriers against efficient mitigation are highest. Many of these countries now experience economic development and raised living standards, which in turn result in increased energy use, since improved thermal comfort becomes a high priority for people, especially in warm climates, where most emerging/developing countries are located. In line with this realization, Meadowcroft (2002) argued that emerging/developing countries still need to commit themselves to sustainable development and look into energy efficiency and renewable energy resources.

According to UN Economic and Social Council (2001), in its report on *Implementing Agenda 21*, there has been substantial progress by Asian emerging/developing countries in the reduction of poverty level through rapid economic growth and significant offset of deforestation with new forest plantations. Nonetheless, a concerning aspect that emerges from the report is the trend for many emerging/developing countries to perform poorly in the following areas:

- improving human health, partly due to contaminated water, inadequate sanitation and poor hygiene;
- reducing energy consumption and carbon dioxide emissions, hence air pollution;
- promoting solid waste reduction, recycling and safe disposal;
- improving environmental and social product standards and certification for eco-labels, and promoting awareness of "green products" to address the more fundamental issue of changing consumption patterns; and
- access to public transportation.

The evidence would appear to suggest that these areas are a particular priority and should be addressed within the building and construction where possible.

2.2.3.6.3 <u>Participation and empowerment</u>

In both Agenda 21 and the JPI, there is a strong emphasis on ensuring that people are encouraged to participate in the implementation of the programmes. In fact, "one of the fundamental prerequisites for the achievement of sustainable development is broad public participation in decision-making (UN, 1992a, Chapter 23) through communication and dialogue, commitment and cooperation (UN, 2002). Participation, as stated in *Agenda 21*, must involve women, youth, indigenous peoples, non-governmental organisations, business and industry, workers and trade unions, the science and technology industry, farmers and local authorities (UN, 1992a, 9 Chapters of Section III). It is also suggested that there is an increasing awareness that an emphasis on participation is not enough and vulnerable groups, especially the poor, must be more actively empowered by being provided with access to finance, information, information technology, education and infrastructure (UN, 1992a, 2002).

The JPI also demonstrated a departure from conventional environmental and sustainability wisdom by suggesting two things. The first is that infrastructure development is required and should be undertaken. The second is that poor people should dictate the type of development that happens around them. The JPI also make suggestions on how decisions on global public interest issues should be made. It suggests that these should be discussed in open, transparent and inclusive workshops (UN, 2002, Article 114).

In fact, this idea can be linked with the first principle of the *Rio Declaration* (UNESCO, 1992) which states that human beings are at the centre of concerns for sustainable development, and that they are entitled to a healthy and productive life, in harmony with nature. This principle is reiterated in Article 53 of JPI (UN, 2002). This means seeing development, the environment, the economy and society from the perspective of citizens and understanding the needs of people. This must be understood from the perspective of a wide range of people including elderly people, youth and disabled and uneducated people. This aspect is important to note in the study because it suggests that 'placing people at the centre' is an important concept to address in ensuring that buildings and construction support sustainable development. It also provides some guidance on how this concept could be included in building and construction processes.

2.2.3.6.4 Education and awareness

Both *Agenda 21* and the JPI emphasize the importance of education for, and awareness of, sustainable development. For instance, *Agenda 21* states: "Education is critical for promoting sustainable development and improving the capacity of people to address environment and development issues" (UN, 1992a, Chapter 36).

By the same token, the section on education in the JPI reaffirms the *Millennium Declaration* goal to ensure that by 2015 all children would be able to complete full primary schooling (UN, 2002, Article 116). More importantly, it calls for general education for sustainable development, and a decade of education for sustainable development starting in 2005. It would appear that, for at the very least, education would raise public awareness of the need to achieve sustainable development and inform people about what they ought to do individually, collectively and institutionally for the practical realisation of *Agenda 21* objectives; hence, education at all levels is a key to sustainable development in emerging/developing countries.

2.3 Sustainable Development and the Construction Industry

Having looked at the key aspects of, and the key differences between, developed and emerging/developing countries in implementing, sustainable development, it is useful to review and analyse the concept of sustainable development as it relates to the construction industry. This section therefore aims to discover the priorities of emerging/developing countries in fostering sustainable construction.

Prior to that, the terminologies “developed” and “emerging/developing” countries used throughout the thesis should firstly be clarified. The word pair “developed/developing” countries became in the 1960s the more common way to characterize countries, especially in the context of policy discussions on transferring real resources from richer (developed) to poorer (developing) countries (Pearson, 1969). Since then, the literature is replete with competing terminologies; examples include “rich/poor”, “developed/underdeveloped”, “North/South”, “First World/Third World”, and “industrialized/developing”. For the purpose of this thesis, any terminology is as good as any other. But where exactly to draw the line between developed and developing countries is not obvious, and this may explain the absence of a generally agreed criterion. According to the United Nations Statistics Division (2011), “there is no established convention for the designation of “developed” and “developing” countries or areas in the United Nations system.”

Further, different international organisations use different country classification systems but their systems are quite similar in terms of designating countries as being either ‘developed’ or ‘developing’. Table 2.2, modified from Nielsen (2011), provides an overview of the terminologies and country classifications used in the United Nations Development Programme (UNDP), the World Bank, and the International Monetary Fund (IMF)[4]. As the institutions reach broadly similar conclusions as to the membership of the developed country grouping, the compositions of the developing country group are, of course, equally similar. Given the large and diverse group of developing countries, all three organizations have identified subgroups among developing countries. However, it is important to note that these subgroups of developing countries seldom appear in literature within the field of sustainable development and construction, as discussed in the previous section.

[4] The UNDP is a subsidiary body of the UN established pursuant to a UN General Assembly resolution. The World Bank and IMF are UN specialized agencies.

Table 2.2: Terminologies and country classifications used in selected international organisations. Modified from Nielsen (2011).

NOTE:
This table is included on page 38 of the print copy of the thesis held in the University of Adelaide Library.

It is also worth noting that since 1970s and 80s, the term "emerging" and "newly industrialized" have emerged to denote countries whose economies have not yet reached advanced or developed status but have outpaced their developing counterparts (Bozyk, 2006; Mankiw, 2008). These are countries that are experiencing industrialization and rapid economic growth and considered to be in a transitional phase between developing and developed status. Depending on authors/experts, the current list of countries includes China, India, Brazil, Malaysia, Philippines, South Africa, Indonesia, Turkey, Mexico, and Thailand (Bozyk, 2006; Mankiw, 2008).

Therefore, in order to maintain consistency, the terminology "developed countries" is used to mean high-income countries or advanced economies; whereas "emerging/developing" is used to describe the remaining countries whose economies have not reached advanced status, irrespective of whether the literature refers to it as "developing" only or other terms or terminologies.

2.3.1 Global Impacts of the Construction Industry

The improving social, economic and environmental indicators of sustainable development are drawing attention to the construction industry, which is a globally emerging sector, and a highly active industry in both developed and emerging/developing countries (Du Plessis, 2002). Socially and economically, *World Watch* stated that one-tenth of the global economy is dedicated to constructing, operating and equipping homes and offices (Roodman & Lenssen, 1994). These activities account for roughly 40% of the materials flow entering the world economy, with much of the rest destined for roads, bridges and vehicles to connect the buildings (Roodman & Lenssen, 1994). According to the European Commission (2006), 11.8 million employees are directly employed in the sector and it is Europe's largest industrial employer, accounting for 7% of total employment and 28% of industrial employment in the EU-15. About 910 billion Euros was invested in construction in 2003, representing 10% of the gross domestic product (GDP) of the EU-15 (European Commission, 2006).

By contrast, the construction sector is responsible for high-energy consumption, solid waste generation, global greenhouse gas emissions, external and internal pollution, environmental damage and resource depletion (Barrett*, et al.*, 1999; Confederation of International Contractors' Association [CICA], 2002; Scheuer*, et al.*, 2003; Spence & Mulligan, 1995; Zimmerman*, et al.*, 2005). According to Dimson (1996), building construction accounts for 25% of the virgin wood and 40% of the raw stone, gravel and sand used worldwide each year. The built environment also responsible for approximately a third of global anthropogenic GHG emissions, leading to climate change (de Ia Rue du Can & Price, 2008). In fact, global GHG emissions are still increasing despite international climate change protocols and initiatives. Building sector carbon emissions, including those from energy generation used to power buildings have increased by 3% annually since 1970 for example, while emissions from commercial buildings have also increased by 3% annually since 2002 (IPCC, 2007b).

Therefore, construction sector has a potential contribution to progress in sustainable development and actions are needed to make the built environment and construction activities more sustainable. Hence the construction industry has significant direct and indirect links with the various aspects of sustainable development.

2.3.2 Fostering Sustainable Construction

Sustainable construction is seen as a way for the construction industry to respond to achieve sustainable development as part of an integrated whole (Du Plessis, 2001). It is also a way to depict the accountability of the construction industry towards protecting the environment (Bourdeau*, et al.*, 1998; Hill & Bowen, 1997; Ofori*, et al.*, 2000; Spence & Mulligan, 1995). Figure 2.2, based on Du Plessis (2001), illustrates the position of sustainable construction towards achieving sustainable development. In explaining this position, Du Plessis (2001, p.10) noted that,

> Sustainable construction contributes to the achievement of urban sustainability and as one of the integral processes of sustainable development... Urban sustainability is the wider process of creating human settlements and includes areas such as governance. Sustainable building concerns itself solely with the process of creating buildings, while construction[5] includes infrastructure such as roads and bridges.

The first definition of sustainable construction was proposed by Charles Kibert (1994): "Sustainable construction is the creation and responsible maintenance of a healthy built environment based on resource efficient and ecological principles". It identifies the central objectives of sustainable construction, which provides a high building performance for the occupiers. In addition to the Kibert's definition, the European Union also provides its version of the definition: "the use and/or promotion of a) environmentally friendly materials, b) energy efficiency in buildings, and c) management of construction and demolition waste" (United Nations Environmental Programme [UNEP], 2003, p.7). However, both of these early definitions of sustainable construction have an almost exclusive focus on environmental impact.

NOTE:
This figure is included on page 40 of the print copy of the thesis held in the University of Adelaide Library.

Figure 2.2: Sustainable construction as the component of sustainable development.
Source: Du Plessis (2001)

A more holistic definition was highlighted in the *Habitat Agenda II* (United Nations Development Programme [UNDP], 1996, p.13) as participants committed their countries to the goal of sustainable human settlements by developing societies which:

> ...will make efficient use of resources within the carrying capacity of ecosystems and take into consideration the precautionary principle approach, and by providing the people... with equal

[5] The *Agenda 21 on Sustainable Construction for Developing Countries* (2002, p.4) defined construction as "the broad process/mechanism for the realisation of human settlements and the creation of infrastructure that supports development. This includes the extraction and beneficiation of raw materials, the manufacturing of construction materials and components, the construction project cycle from feasibility to deconstruction, and the management and operation of the built environment.

> opportunities for a healthy, safe and productive life in harmony with nature and their cultural heritage and spiritual and cultural values and which ensures economic and social development and environmental protection...

Agenda 21 on Sustainable Construction for Developing Countries (A21 SCDC) defined sustainable construction as "a holistic process aiming to restore and maintain harmony between the natural and the built environments, and create settlements that affirm human dignity and encourage economic equity" (Du Plessis, 2002, p.8). These definitions bring in the social and economic aspects of sustainability rather than merely addressing the reduction of negative impact to the environment, as implied in the earlier definitions. However, all the definitions of sustainable construction stated so far outline three important aspects (Du Plessis, 2007, p.69):

- It requires a broad interpretation of construction as a cradle to grave process, involving many more role players than just those traditionally identified as making up the construction industry;
- It emphasises both environmental protection and value addition to the quality of life of individuals and communities; and
- It embraces not just technological responses, but also the nontechnical aspects related to social and economic sustainability.

Similarly, since sustainable building could be described as a ''subset of sustainable development'', it requires a continuous process of balancing all three systems, environmental, social and economic sustainability (Du Plessis, 1999). These three aspects, according to the International Organization for Standardization (ISO or ISO/TC59/SC17 in particular) in its final draft on *Sustainability in Building Construction – General Principles* (ISO/FDIS 15392, 2008, p.8-9), are defined as follows:

> **Economic:** Besides direct and short-term economic considerations, economic aspects of sustainability must incorporate life cycle considerations that measure the long-term costs of construction works. Costs may be direct and indirect both in short and long term perspective;
>
> **Environmental:** Environmental aspects of sustainability must balance current use of the earth's renewable, non-renewable, and perpetual resources in order to preserve these resources for future use of the human species and other species. Consideration must be provided for impacts on the quantity as well as quality of the resources. Consideration must be provided for impacts on local, regional and global ecosystems; and
>
> **Social:** Social aspects of sustainability are founded upon intergenerational ethics (impact upon future generations) and recognize the inherent value of ecosystems, traditions and cultures. Consideration must be provided for impacts on local culture. Consideration must be provided for basic human rights and human needs. Consideration must be provided for quality of life.

2.3.3 Recognition of Difference in Priorities Between Developed and Emerging/Developing Countries

In 1998, the International Council for Research and Innovation in Building and Construction (particularly CIB Working Commission W082) started to approach pro-actively to sustainable construction following their completion of a global report on *Sustainable Development and the Future of Construction* (Bourdeau*, et al.*, 1998). The study aimed to compare the visions and perceptions of sustainable development and the future of construction as they were held in fourteen different countries, including Malaysia (Malaysia's specific response to this study will be discussed in the next chapter). The report based its enquiry on the earlier stated definition for sustainable construction as provided by Kibert (1994), and focused on investigating the relationship, and clearly defining the links, between the principles of sustainable development and the construction sector.

The report revealed that, not only was the state of the sector different in each country but, interpretations of sustainable development, remedies and approaches were also very different between developed market economies, transition economies and developing countries. Whilst the Kibert's definition used as the point of reference in the project was inherently 'environmental', many social and economic issues were raised in the country reports and considered as part of the sustainable construction agenda. Among the issues raised include "public participation, consumer participation, interdisciplinarity, co-engineering and re-engineering of the building process as means to a better incorporation of sustainability issues in decision-making" (Bourdeau*, et al.*, 1998, p.48).

The study also discovered that the developed countries are in the position to place emphasis to the creating of a more sustainable building stock by upgrading, new developments or the invention and use of new technologies, while the emerging/developing countries need to focus more on social equity and economic sustainability. Clearly the significance of nontechnical issues is growing and crucial for a sustainable development in construction; hence, economic and social sustainability must be explicitly stated in any definition (Sjostrom & Bakens, 1999). Sjostrom and Bakens (1999) commented that cultural issues and the cultural heritage implications of the built environment have also recently given attention as other important aspects in sustainable construction.

An understanding of the social-political and cultural context of a country is also necessary in order to identify the most appropriate sustainable development strategy in its built environment. This necessity can be witnessed from the attitudes of the Romanians towards recycling and reusing materials which are still seen as signs of poverty (Bourdeau*, et al.*, 1998). Also, because many cities in emerging/developing countries are very rapidly urbanizing, the pressures of buildings on the environment are even more intense than in developed countries, where the rate of construction is less rapid. As Du Plessis (2005, p.409) notes, "In a needs-driven environment, there is a real danger that development initiatives will focus on quantitative delivery, without due consideration of sustainability issues." Clearly, for the construction industry to achieve sustainable development it must not only reduce its impact on the environment, but also address the social-political, cultural and heritage issues as well as economic sustainability.

2.3.4 Requirements for Sustainable Construction in Emerging/Developing Countries

Following the publication of the CIB report noted above, the CIB produced the *Agenda 21 on Sustainable Construction* (A21SC) (CIB, 1999; Sjostrom & Bakens, 1999). The document attempted to create a conceptual framework that defined the links between the global concept of sustainable development and the construction sector (Du Plessis, 2002). However, the A21SC suffers from understandable bias towards the issues, challenges and solutions of the developed world. Creating a sustainable built environment in the emerging/developing world requires a different approach to that taken by the developed world. One of the differences lies in the approach to satisfying sustainable construction requirements that are appropriate to the specific contextual conditions and the resources that are available to pursue them. While these requirements are the main focus of sustainable construction in developed countries, in emerging/developing countries they merely constitute another layer in an already complex problem.

To address these issues, and as part of the action plan for the implementation of A21SC, the CIB, in collaboration with the United Nations Environmental Programme – International Environmental Technology Centre (UNEP-IETC), commissioned the preparation of an *Agenda 21 for Sustainable Construction in Developing Countries* (A21 SCDC) (Du Plessis, 2002). The relationship between A21 SCDC and other aforementioned Agendas is shown in Figure 2.3, adopted from Du Plessis (2002). The A21 SCDC report was subsequently launched in 2002 at the WSSD in Johannesburg. This is a substantive report which sets out a comprehensive agenda of issues associated with the achievement of sustainable construction in developing countries.

NOTE:
This figure is included on page 44 of the print copy of the thesis held in the University of Adelaide Library.

Figure 2.3: The scope of A21 SCDC in relation to other Agendas. Source: (Du Plessis, 2002)

One of the important points mentioned in the AG21 SCDC is the possibility for emerging/developing countries to offer sustainable development opportunities that are not common in the developed world. Through their cultural heritage, innovative local solutions and adaptability, emerging/developing countries might have one of the keys to sustainability. In the developed world, solutions are traditionally sought in new technologies, while in emerging/developing countries tradition represents a more people-centred development.

The essential requirements for sustainable construction particular to emerging/developing countries, which are addressed as the 'challenges to sustainable construction' outlined in the A21 SCDC, are as follows (Du Plessis, 2002, p.17-20):

1. Internalising sustainability to be an integral part of decision-makings and business practices;
2. Capitalising on the benefits of sustainability (i.e. savings from efficient resource use, higher productivity and reduced risk) to increase profitability
3. Managing the resources efficiently;
4. Improving public awareness on the impacts of their behaviour and their use and misuse of resources;
5. Improving the efficiency and safety of the construction process and the quality of its products;
6. Reducing resource use by direct and indirect means including:
    a. Reducing building material wastages using, if possible, nature's reuse and degradation technologies or new and innovative methods of waste disposal and reuse;
    b. Increasing the use of recycled waste as building materials;

c. Improving energy efficiency in buildings by reducing both consumption and embodied energy;
d. conserving water; and
e. Improving physical and functional durability of buildings; optimizing the service life in all phases of the building process; upgrading building flexibility and capacity; and considering maintenance during design, and using life-cycle costs to select more competitive technologies.

7. Innovating building materials and methods;
8. Eliminating or reducing environmental and human health impacts of building materials and finishes, as well as impacts presented by activities on building sites; and
9. Including sustainability criteria into procurement policies and procedures.

These requirements offer some support to the findings by the Economic and Social Council (2001) who reported, among others, issues that have yet been successfully addressed by emerging/developing countries in the implementation of *Agenda 21* (see section 2.2.3.6.2). However, one might wish to argue that these requirements seem to also applicable to developed countries or not totally specific to emerging/developing countries with the exception of items 4, 5 and 8.

Another relevant and important factor that should be given emphasis in emerging/developing countries is ‘community sustainability’ (Ofori, 1998). This is to avoid loss of livelihood and disruption of social links due to resettlement, particularly in contexts where major development projects are planned and constructed without consulting, or attending to the needs of, the affected community. This point is consistent with statements in *Agenda 21* and the JPI as discussed in section 2.2.3.6.3.

The lack of capacity of the construction sector to actually implement sustainable practices was also highlighted in the A21 SCDC as the most critical barrier to sustainable construction in emerging/developing countries. Du Plessis (2002) noted that there simply are not enough professionals, tradesmen and labourer who have been trained to support sustainable development. This has been addressed in the ongoing series of sustainable building (SB) conferences since 2004 where priority issues for emerging/developing countries e.g. social equity in general, or housing affordability and semi-skilled labour in particular, were included as part of its agenda (Larsson, 2005).

2.4 Conclusions

This chapter has reviewed the key aspects, and the international context of, sustainable development, and important priorities of emerging/developing country in implementing sustainable development in general, and sustainable construction in particular. It was revealed that the sustainable development concept has been debated for decades in an attempt to reconcile conflicts between the economy, environment and the goal of equity within the present population and between present and future generations. Given the discussion and debate on full definitions and implications of sustainable development, it should be noted that no attempt is made in this study to 'reinvent the wheel'. Instead, an attempt has been made to synthesise and adapt the concept in the contents of the assessment framework.

More importantly, it has been realised that decision makings to support sustainable development and sustainable construction involve a balanced and holistic approach to the three dimensions of sustainable development i.e. social equity, environmental protection, and economic development. It would appear then that it is necessary to ensure that the assessment framework is based on, and promotes, these three dimensions. In this way, the framework can become holistic, more comprehensive, and incisive in terms of the range of issues addressed. This holistic approach may also mean that not only must the design performance of new developments be addressed, it is also important to ensure that the eventual management and maintenance processes of infrastructure are considered at an early stage of a development.

Based on the review of five key documents that reflect the current international context of sustainable development (Section 2.2.3.6), it was found that there are important and useful points which need to be addressed in developing the assessment framework. These points are listed below:

1- Inclusion of Social Sustainable Development Objectives:

- **Education and awareness**: Ensure that development enhances levels of education and awareness on sustainable development;
- **Social cohesion**: Ensure that development supports collaboration and social interaction, and promotes active involvement and participation, of the people that it affects;
- **Accessibility**: Ensure that development supports equality of access for all, in all areas of life whether social, economic, or cultural, where this is needed;

- **Inclusiveness of opportunities**: Ensure that development supports equal opportunities and conditions for every individual;
- **Human health and well-being**: Ensure that development respects human rights and supports improved health, safety and security;
- **Local people and employment**: Ensure that development supports increased access to employment for local people and the development of small ventures;
- **Indigenous knowledge & technology, and local culture & heritage**: Ensure that development makes use of, where appropriate, indigenous knowledge and technology; and maintains or enhances local cultural and heritage values.

2- Inclusion of Environmental Sustainable Development Objectives:

- **Land Use and Biodiversity:** Ensure that development maintains or enhances the biodiversity of the biophysical environment;
- **Resource Management**: Ensure that development supports the management of the biophysical environment and discourages environmentally damaging resource extraction and processing practices;
- **Atmospheric Emissions**: Ensure that development limits the emissions of pollutants to the atmosphere;
- **Waste production**: Ensure that development manages the production of solid waste to ensure that this does not negatively affect the biophysical environment;
- **Water consumption and disposal**: Ensure that development manages the extraction, consumption and disposal of water in order not to negatively affect the bio-physical environment;
- **Energy production and consumption**: Ensure that development manages the production and consumption of energy in order not to negatively affect the biophysical environment.

3- Inclusion of Economic Sustainable Development Objectives:

- **Efficiency and effectiveness:** Ensure that development (including technology specified) is designed and managed to be highly efficient and effective, achieving high productivity levels with few resources and limited waste and pollution;
- **Triple Bottom Line accounting:** Ensure that development is based on, and guided by, a scientific method which measures and monitors social and environmental factors alongside those of economic;

- **Facilitating environment**: Develop a facilitating environment for sustainable development through the development of transparent, equitable and supportive policies, processes, and forward planning;
- **Local economies**: Ensure that development supports the development of small scale, local and diverse economies.

4- Recognition of Differences Between Developed and Emerging/Developing Countries

It has been demonstrated that sustainable construction is seen as a way for the sector to respond to achieve sustainable development. Its implementation however, requires different approach between developed and emerging/developing countries due to the difference in priorities which in turn depends on the economic situation, level of urbanization, historic and cultural context, climate and national policies. The implication of this area for this study is that the priorities for the construction and buildings need to address in order to support sustainable development in emerging/developing countries are different from those in developed countries. This implies that building sustainability assessment frameworks may also be different.

Another important issue in many emerging/developing countries is the unavailability and inaccessibility of relevant, current data (see Section 2.2.3.6.1). As a result, it is sensible to suggest that the study requires capturing and making available information on building performance in relation to sustainable development. This finding also has implications on the methodology of this study.

5- Recognition of Differences in Priorities Between Developed and Emerging/Developing Countries

While developed countries can emphasise on environmental issues to progress to a more advanced stage in the path towards sustainability, emerging/developing countries need to focus more on social and economic sustainability which are nontechnical issues. These attributes owe much to the fact that emerging/developing countries are likely not to have addressed the basic needs of their populations. On top of this, emerging/developing countries may also not have developed highly wasteful infrastructure. Therefore, in order for these countries to move to a more advanced stage of sustainability, the basic needs of their populations must be addressed as a priority.

The specific priorities of emerging/developing countries in implementing sustainable development in general and sustainable construction in particular have been identified in

Sections 2.2.3.6 and 2.3.4 respectively. Although it is noted that the latter is an integral part of the former, discussing both for the same purpose is useful to ensure more compelling and robust findings. For instance, the former section noted that the key sustainable development priority in emerging/developing countries is to ensure that the basic needs of its citizen such as food, health, safety and employment, are met. Emerging/developing countries are also found to perform poorly in reducing air pollution and solid waste generation, and access to public transportation, to name a few. It is also important that development designed to meet these priorities involves, educates, and empowers, people in order to ensure that impact can be multiplied, and is sustainable. These priorities were either reiterated or further detailed in the latter by highlighting the important requirements for sustainable construction in emerging/developing countries. These requirements include addressing and prioritizing the following aspects: public awareness; efficiency, safety of processes and quality of products; environmental and human health impacts; affordability; social equity; semi-skilled labour; and participation of affected community.

Having discovered these priorities, the question remained unanswered is whether these priorities have successfully been addressed in emerging/developing countries, particularly the Malaysian construction industry. The environmental and socio-economic conditions, constraints and priorities in practicing sustainable development in Malaysia will therefore be explored in the next chapter.

Chapter 3: The Malaysian Conditions, Constraints and Priorities

3.1 Introduction

The previous chapter has examined the priorities of emerging/developing countries in implementing sustainable development and construction. Attention is now turned to consider, within the Malaysian context, the progress made to date in terms of promoting and practicing sustainable development. This chapter sets to explore whether or not it is a priority of the country in general, and of the construction industry in particular, to strike a balance between the environmental and socio-economic dimensions of sustainable development. It seeks to further explore whether this balance has been achieved. All in all, this chapter tries to understand the Malaysian conditions, constraints, and priorities in addressing sustainable development issues. It aims not only to justify the need for this study but also to inform the relevant criteria to be included in the assessment framework.

This chapter is divided into five parts. The first part outlines the general characteristics of Malaysia – people, land, and climate. This background is important as it partly contributes to the economic performance of the construction industry and subsequently the social and environmental impacts, which are the subjects of the second and third parts. In the fourth part, the emphasis shifts to the commitment and priorities of the government of Malaysia in the sustainability agenda by looking at its involvement in the international arena and its federal policies and development plans. The last part seeks to understand the reasons for continuous presence of, and increasing environmental problems in the country. It does this by examining the barriers that have hindered the implementation of a few government-driven initiatives. In light of these analyses, it assesses the necessity of bottom up approaches in Malaysia or building performance assessment systems in particular, in order to show that this area is particularly relevant for research.

3.2 Malaysia in General

3.2.1 Population Distribution, Demography, Density and Land Availability

Malaysia is a country in Southern Asia, separated into two regions by the South China Sea; with Peninsular Malaysia bordering Thailand and Singapore while East Malaysia bordering Indonesia and Brunei (see Figure 3.1 and Figure 3.2). Within thirty years, the population of Malaysia increased by 123%, from 10.44 million in 1970 to 23.27 million in 2000 (Bruton, 2007). In 2010, the estimated population has further increased to 28 million (Central Intelligence Agency, 2010). In terms of population distribution by state in Census 2000 (Department of Statistics Malaysia, 2001), Selangor was the most populous state among thirteen states in Malaysia, representing 18% of the total population of Malaysia.

NOTE:
This figure is included on page 51 of the print copy of the thesis held in the University of Adelaide Library.

Figure 3.1: Map of Malaysia and the South East Asian Region. Source: International Opportunities Organization (2001)

NOTE:
This figure is included on page 52
of the print copy of the thesis held in
the University of Adelaide Library.

Figure 3.2: Map of Malaysia. Source: Central Intelligence Agency (2010)

The distribution of ethnic groups and religions in Malaysia are shown in Figure 3.3. It can be seen that Malaysia's population comprises many ethnic groups while Malays make up the majority of the population at 50.4% (Department of Statistics Malaysia, 2001). Overall, Malaysia is a multi-racial, multi-cultural and multi-religion country, though the 60% of the populations are Malays or Muslims.

NOTE:
This figure is included on page 52
of the print copy of the thesis held in
the University of Adelaide Library.

Figure 3.3: Left – Distribution of Malaysian ethnic groups (2004 est.); Right – Distribution of Malaysian religions (2000 census). Source: Department of Statistics Malaysia (2001)

The total Peninsula land area is 13,181,640 hectares and urban areas or built-up lands are accounted for only 3.3% of Peninsula land. Of these, nearly 45% are in the Central Region, where Kuala Lumpur and the municipalities of Selangor, Seremban and Melaka are located. More than half of the land is used for agriculture (50.6%), followed by forests (44.4%) and the remaining are water bodies (1.7%) (Federal Department of Town & Country Planning Malaysia, 2005).

The pattern for the country as a whole shows 62% residing in urban areas which represents an increment of 11.3% from the 1991 figure, while for the Peninsular alone, this has risen to 65.4% or 12.1 million people. States with very high proportions of urban population are Kuala Lumpur Federal Territory (100%), Selangor (87.6%) and Penang (80.1%). This pattern of urbanisation of the population is expected to continue up to 2020 when it is anticipated at least 75% of the Peninsula population will reside in urban areas (World Resource Institute, 1997). Hence, it has been projected that a further 331,520 hectares of land will be required for urban uses. Given this projected urban population, 32% or 8.46 million will accommodate within the Kuala Lumpur Conurbation. The present gross density of Kuala Lumpur is higher than 25 persons per hectare (Federal Department of Town & Country Planning Malaysia, 2005).

Increase in population and urbanisation in Malaysia has had a good side effect as a result of which Malaysian economy has undergone a tremendous transformation in the last three decades. It has shifted from an economy that was once dominated by agriculture and mining to one that is led by manufacturing industry. As a result, the level of poverty in Malaysia has been steadily reduced from 49.3% of the total population in 1970 to 8.1% in 1999, and further reduced to 5.1% in 2010 (Bruton, 2007; Central Intelligence Agency, 2010).

3.2.2 Climate and Predicted Change

According to the Koppen-Geiger climate classification, Malaysia is a tropical humid country with category Af (hot and rainy all seasons) (Ahrens, 1994). Situated at the maritime equatorial doldrums area, the climate is generally the same throughout the year with uniform temperature, high humidity and heavy rainfall. Winds are generally light. It is extremely rare to have a full day with completely clear sky even in periods of severe drought. On the other hand, it is also rare to have a stretch of a few days with completely no sunshine except during the northeast monsoon seasons.

Temperature distribution: Overall, published data show that Malaysia has an annual mean minimum temperature of 22°C to 24°C and annual mean maximum temperature of 29°C to 32°C, thus an annual mean of 26.75°C (Malaysian Meteorological Department, 2009).

Diurnal temperature range: Two thirds of the twenty-four hour period, the ambient temperature is above the ASHRAE (ASHRAE, 2004) thermal comfort upper limits of 26°C for air-conditioned buildings. Throughout the normal working day (8.30 am to 5.30 am), the ambient temperature is above the thermal comfort range of 23°C to 26°C by ASHRAE 2004 Standard.

Relative humidity: Malaysia has high relative humidity with the mean monthly relative humidity of 70 to 90%. For the whole Peninsular Malaysia, the mean relative humidity varies from a low 84% in February to a high of only 88% in November.

Daylight and sunlight: On average, Malaysia receives about 6 hours of sunshine per day (Malaysian Meteorological Department, 2007).

Wind: The wind over the country is generally light and variable; however, there are some uniform periodic changes in the wind flow patterns which distinguish four monsoon seasons in Peninsular Malaysia; south-west monsoon, north-east monsoon and two shorter inter-monsoon seasons. The south-west monsoon is usually established in the second half of May or early June and ends in September. The prevailing wind flow is generally south-westerly and light, below 28 km/h. The north-east monsoon usually commences in early November and ends in March. During this season, steady north-easterly winds of 19 to 37 km/h prevail. The winds during the two inter-monsoon seasons are generally light and variable (Malaysian Meteorological Department, 2007).

Rainfall: Due to seasonal uniformity, rainfall is continuous throughout the year. All months of the year have a mean rainfall of over 130mm.

Predicted climate change: Based on the assessment by the National Hydraulic Research Institute of Malaysia (NAHRIM) (Shaaban*, et al.*, 2008), it was predicted that there will be an extreme change on rainfall, river flow, and surface air temperature patterns over Peninsular Malaysia in the future periods of 2025-2034 and 2041-2050. For instance, the minimum monthly rainfall is expected to decrease from 32% to 61% for all over Peninsular Malaysia. Consequently, an extreme decrease of up to 93% of mean monthly flows of watersheds is predicted to occur in Selangor and Johor. Contrastingly, increased hydrologic extremes (higher high flows, and lower low flows) are expected in Kelantan, Pahang, Terengganu and Kedah watersheds in the future. The whole Peninsular Malaysia will also experience a higher monthly mean temperature of 1.4 degree Celsius with an increase maximum monthly temperature of up to 2 degree Celsius (Shaaban*, et al.*, 2008).

To summarize, Peninsular Malaysia is projected to be hotter, with more extreme draughts in certain parts, but flooding in other parts. The implications of the climate characteristics to the building sector are discussed in Section "Buildings and Emissions to Air" in this chapter.

3.3 Construction Industry and Socio-economic Issues

3.3.1 Economic Performance

The construction industry is one of the productive sectors that constantly contribute to the economy in Malaysia. It has been reported that Malaysia has one of the fastest growing construction industries in the world (Australian Business Council for Sustainable Energy [ABCSE], 2007); and currently described as "upper-middle-income economy" (World Bank, 2011), "large emerging economy" (Independent Evaluation Office of the IMF, 2009) and a country with "high human development" (UNDP, 2010). However, based on the historical statistics, the Malaysian construction industry has consistently been the smallest contributing sector of the economy and it contributes an average of 3% to the total GDP. Due to economic downturns, the construction sector steadily shrank as a share of GDP, from 3.3% in 2000 to 2.5% in 2007 (CIDB Malaysia, 2007b) but it was forecasted to regain to 3% in 2008 (Malaysian Ministry of Finance, 2007). A sum of RM200 billion (AUS$66.7 billion) has been allocated in the *Ninth Malaysia Plan* amounting to approximately RM40 billion per year in construction project value (Government of Malaysia, 2006). Ambitiously, the Construction Industry Development Board (CIDB) envisaged to contribute 5% of GDP by 2015 (CIDB Malaysia, 2007b).

Regardless of economic booming or downturn, according to the CIDB Malaysia (2007b), the construction industry has been emphasizing on providing buildings with the best possible (lowest) cost often at the expense of quality due to two reasons, namely: budget constraints imposed by clients and the use of many levels of subcontracting. Further, clients' ignorance on life cycle costing and value management is evident when CIDB stated, "Malaysian clients do not award projects to contractors based on their technical capabilities" and "A shift in mindset towards the longer term benefits of higher quality, such as lower operating and maintenance costs, higher resale value, and improved safety and environmental profiles, need to be initiated" (CIDB Malaysia, 2007b, p.40).

The current trend of considering minimal possible initial costs alone has taken its toll on certain social and environmental issues in the country. These impacts are discussed in the next few sections.

3.3.2 Construction Workers: Productivity, Quality, and Safety Issues

The construction industry employs approximately 9% (or 900,000, as of 2005) of the total workforce in Malaysia (CIDB Malaysia, 2007b). However, the industry is heavily depending on foreign labour, especially from Indonesia and the ASEAN region, and proved to be the most active sector in utilizing these labourers (Abdul-Aziz, 2001). According to official statistics, as of June 2005, around 250,000 of approximately 800,000 construction personnel are foreigners (CIDB Malaysia, 2007b). It is worth noting that this number was approximately five times higher (1.2 million) in 1991 (Pillai, 1992), or nearly ten times higher (2.4 million) in 1998 (Abdul-Aziz, 2001). These unprecedented proportions of labour flows from abroad owed much to the rapid economic expansion in Malaysia during the 1986-1997 period (Kassim, 1996).

The abundance of cheap foreign labour, on top of the industry's emphasis on low cost as noted earlier, has led to a chain effect as shown in Figure 3.4. The first effect is that the industry tends to favour labour-intensive construction methods over the use of more expensive and productive technology and equipment. This, in turn leads to several effects on the image of the industry. For example, much criticism has been levelled at the construction industry for low quality end-products and low level of productivity i.e. lower output per person and lower incentive to invest in more productive and modern technology (Chan, 2009; CIDB Malaysia, 2007b).

Also, since foreign workers are usually unskilled[1], occupational safety is normally compromised (CIDB Malaysia, 2007b). Abdul-Aziz (2001) noted that foreign workers have a higher rate of work-related accidents than locals. In 2003, the provisional number of reported accidents was 4,134, of which 1.7% and 10.6% resulted in death and permanent disabilities respectively (CIDB Malaysia, 2005). Then in 2004, the construction industry had the third highest fatality rate compared to other sectors in Malaysia (Malaysian Ministry of Finance, 2006). With the rate of 17 reported fatalities per 100,000 workers in 2004 in Malaysia, Abdul-Aziz (2005) contended that this contrasts significantly with 2.4 per 100,000 (2001-2002) in developed European countries.
It is important to note that these occurred despite the existence and enforcement of various safety legislations e.g. *Occupational Safety and Health Act 1994*. Officers of the Department of Occupational Safety and Health (DOSH) complained that main contractors were slow in upgrading their safety standards (Abdul-Aziz, 2001). This is unsurprised as there are only six

[1] Overall, unskilled (general) workers make up almost half of the total workers registered with CIDB and outnumber semi-skilled and skilled workers by more than two-to-one (CIDB Malaysia, 2007).

(as of end 2007) out of thousands construction companies in Malaysia have OSHMS/OHSAS certification (CIDB Malaysia, 2007a). The main reason for the lack of safety and healthy culture within the Malaysian construction industry is the cost involved to abide by safety requirements (Misnan & Mohemmed, 2007; Misnan, *et al.*, 2003).

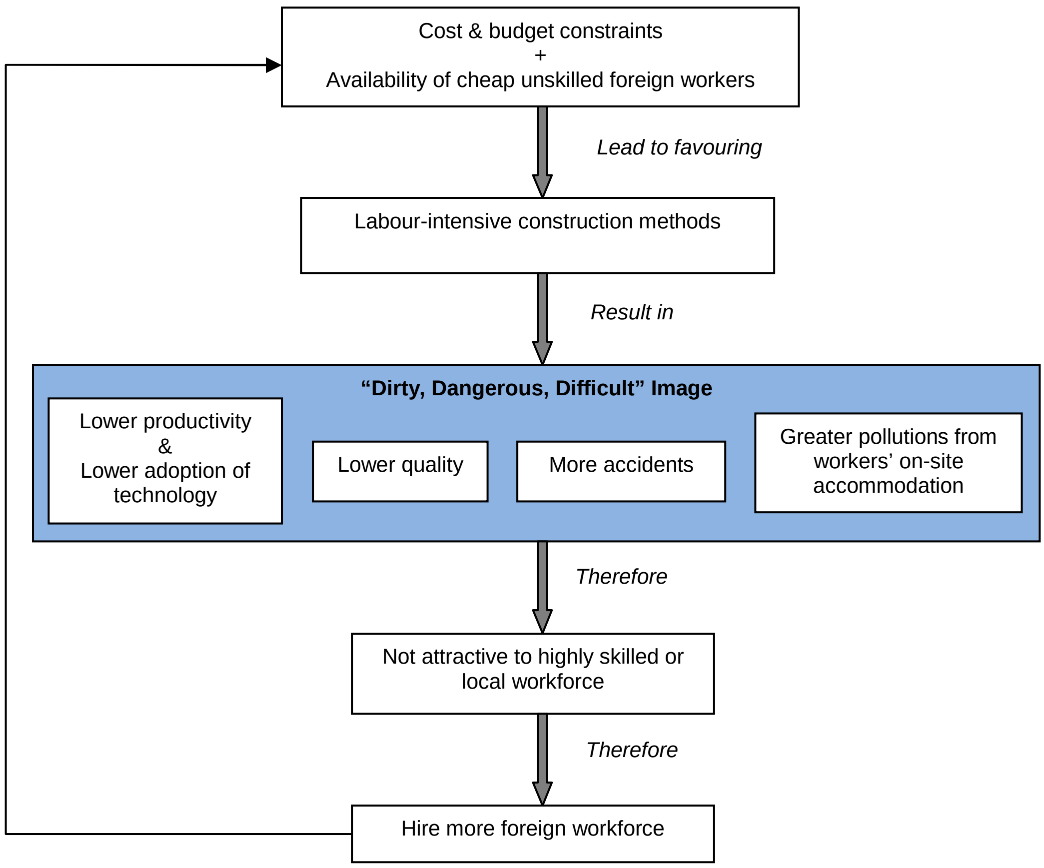

Figure 3.4: The chain effect of dependency on foreign workforce

Apart from social problems, reliance on foreign labourers also creates environmental problems especially from their on-site accommodations which are normally self-built using materials provided by the main contractors. Since they are built without being charged by the main contractor, facilities are made of the cheapest materials without proper sewage system, domestic waste collection, and other basic facilities (Abdul-Aziz, 2001). Inevitably, these lead to air, water and land pollutions. Overall, it is then understandable why CIDB Malaysia (2007b) conceded that the industry's image of "Dirty, Dangerous, Difficult" has been the main reason for the reluctance of local or highly skilled workforce to join the industry. Unavoidably, more foreign workers need to be employed and round and round it goes.

Apart from socio-economic issues highlighted here, others are realised by understanding the current barriers in introducing and implementing government measures to ensure sustainable development principles are incorporated into stakeholders' decision-makings. These are examined later in the chapter.

3.4 Construction Industry and Environmental Issues

As previously mentioned, the growth of population and urbanization has been increasing in Malaysia and this has led to greater economic growth in the construction industry. This increasing growth has however created pressure on the environment, especially the urban environment. Further, the climate characteristics and the current and predicted future climate change have an influence on the development of the built environment. As such, the environmental impacts related to the construction industry are discussed next.

3.4.1 Buildings and Emissions to Air

The rapid growth of the construction industry has led to an increase in the demand for building materials; hence, resulting in both incapacity of the supply to meet the demand and greater greenhouse gas emissions resulted from the energy use in producing the materials, particularly cement and steel. As Shafii *et al.* (2006) noted, the local productions of building materials in countries of South-East Asia, including Malaysia, mostly are not sufficient to meet the demand for the construction sectors due to demand fluctuations and lack of capital for the build-up of supplies, or inputs. They went further to highlight that concrete and steel are the biggest contributor to greenhouse gas emissions.

In Malaysia, buildings consume about 12.85% of the total energy consumption and 47.5% of the country's electricity consumption (Department of Electricity and Gas Supply Malaysia, 2001). The energy consumption in buildings is normally given in terms of the Building Energy Index or BEI. The South East Average BEI is 233 kWh/m2/yr whereby the Malaysian and Singaporean average are 269 kWh/m2/yr and 230 kWh/m2/yr respectively (Zain-Ahmed, 2008). Commercial buildings consume more than 50% of energy for lighting and air-conditioning (Ramatha, 1994).

Malaysia's total energy demand in 2003 is 33.9 megatonne of oil equivalent (Mtoe). Meanwhile, Asia-Pacific Economic Cooperation (APEC) projected the Malaysia's primary energy demand will increase at 3.5% per annum from 56 Mtoe in 2002 to 147 Mtoe in 2030 (APEC, 2006). In parallel with Malaysia's rapid economic development and growing energy demand, more alternative energy sources are needed to fulfil the demand. Although Malaysia is the third largest oil preserver in the Asia Pacific region in 2006, it has already realized that it cannot be totally dependent on its oil resources since, based on the production levels in 2005, it is estimated that the oil reserves is yet to last only another 15 years, while gas reserves is estimated to last for just another 29 years (APEC, 2006).

Apart from the depletion of non-renewable fossil fuel, the current rate of energy consumption has also affected the Malaysian air quality. Malaysia is ranked 25th in the global list of human-made carbon dioxide emissions (Mohd Yunus, 2007), second highest in Asia after Japan, and the highest in South-east Asia (Praveena*, et al.*, 2008). In terms of global electricity consumption, Malaysia is ranked 33rd (Mohd Yunus, 2007). According to the Energy and Environment Data Reference Bank (International Atomic Energy Agency [IAEA], 2006), in Malaysia, each person generates 5.81 tonnes of carbon dioxide per year compared to 3.11, 1.45 and 0.89 tonnes generated by each person in Thailand, Indonesia and Philippines respectively. These are unfavourable positions for a country of only 26 million people. This phenomenon is explained by Ang (2007) and Yoo (2006) whose studies reveal that there is a bi-directional causality between energy consumption and economic development in Malaysia.

The huge amount of electricity consumption in Malaysian buildings is partly due to the climate characteristics as described earlier. Specifically, these climate characteristics cause an adoption of main strategies, such as dehumidification and refrigerated cooling, to keep the indoor conditions thermally comfortable. In Malaysia, most buildings have resorted to mechanical cooling technologies that inevitably consume fossil fuel energy *vis-a-vis* electricity, which in turn contributes to the issue of greenhouse gas emissions, and ultimately global warming and climate change. Although it is realized that measures shall be taken to reduce cooling energy in buildings, the energy cost saving that can be realised is often an insufficient incentive to investments in the enhancement measures, particularly when the energy cost is outweighed by the rental and salary costs, which is the case in Malaysia. Consequently, improving energy efficiency will remain a low priority issue, if the decision of whether or not to improve is based solely on considerations of the direct return on the investment.

3.4.2 Buildings and Emissions to Land and Water

Malaysia is confronted with several crucial environmental impacts and sustainability issues. In fact, Malaysia has a poor environmental image by exhibiting most of the environmental problems that are typical of many emerging/developing economies (Consumers' Association of Penang [CAP], 1998; Perry & Singh, 2001). Soil erosion and silting of water course were among the earliest environmental problems recorded (Aiken, *et al.*, 1982). In fact to date, suspended solids still remain the main water pollutant in most Malaysian rivers and coastal waters. Previously, water pollution was due to mining activities, but presently the problem is mainly contributed to logging, land clearing for infrastructure development, and construction (Department of Environment Malaysia, 1997).

Clearly, activities related to the construction industry are among the contributing factors to the environmental degradation in the country. One of such activities is the careless opening of high land or vegetated areas for construction purposes, which are not managed based on environmental concerns. In Kuala Lumpur, Penang and Johor, the clearing of vegetation and the levelling of sites is driven by the demand for housing. The potential sites for housing are cleared of vegetation by heavy, earth-moving equipment, long before the development is scheduled to take place. In the heavy rains, which are typical of the area, the cleared land is subject to erosion and land slips and contributes to the silting of rivers, which in turn causes pollution, flooding in low-lying areas and flash floods in urban areas (Economic Planning Unit of Malaysia, 2005). Whilst the authorities deny that flash floods problems in Malaysia are in any way related to deforestation and the silting of rivers and drainage facilities, it is difficult not to believe that this is a factor contributing to the problem (Hor, 2006).

Another factor that accounts much of the negative image of the country is the depletion of Malaysia rainforest which has resulted in loss of biodiversity and marginalization of indigenous populations due to poor resource management decisions. As the other resources, those of minerals are also being exploited to sustain the current rate of development (Sani, 1999).

The unsustainable state of local construction industry has been raised to the public's attention by the government. The former Minister of Natural Resources and Environment in his opening speech for a conference on Climate Change held in Kuala Lumpur in 2007, declared that project proposals and developments suffer inadequate environmental input due to lack of knowledge on environmental issues among government officials and their persistence on following the old ways of working which contributes to the practice of cutting corners when emerging/developing projects (Khalid, 2007). Moreover, awareness among contractors and developers on the impacts of their work activities on the environment needs to be enhanced. Developers and contractors should be made aware that good environmental practices can be achieved without adversely affecting their contractual performance and profits (CIDB Malaysia, 2007d). There is also very little appreciation of the fact that good environmental practice in the construction industry is a collective moral responsibility. As a result, only certain parties, particularly contractors, are perceived to be the cause of poor environmental practices, when in reality all stakeholders are similarly responsible (CIDB Malaysia, 2007d). Further barriers to mitigate further environmental degradation are discussed in detail later in this chapter.

Further problems are created by construction wastes which form a significant proportion of total solid waste generation in the country (Begum*, et al.*, 2006) that is eventually disposed off in landfills. A study by Mohd Nasir *et al.* (1998) reveals that 28.34% of national wastes come from industrial and construction waste in the Central and Southern regions of Malaysia. This is unsurprising because waste reduction during the planning and design stage to minimize the generation of waste is rarely considered (Begum*, et al.*, 2007b). Furthermore, majority of contractors surveyed in the Klang Valley do not sort waste at construction sites and dispose their construction wastes at landfills (Begum*, et al.*, 2009). Those who do are limited to large contractors who are more willing to pay more for improved waste collection and disposal services than medium and small contractors (Begum*, et al.*, 2007a). Since these landfills mainly are open dumps with no secure or comprehensive environmental system, the solid waste, and in particularly its content of hazardous waste causes unwanted pollution of rivers, groundwater and sea, while at the same time contaminating the soil (Gatke, 2003). Construction wastes also create greater problems, such as illegal dumping. The number of detected cases related to this problem has generally increased in the last five years, although the country has a state-of-the-art integrated hazardous waste treatment and disposal facility (Keng, 2006). The possible reasons could be “lack of awareness, accountability, responsibility and sheer wanton disregard for the environment and public safety, as well as greed for maximum profit” (Keng, 2006, p.13).

Based on data from *Living Planet Report 2004* (World-Wide Fund for Nature International [WWF], 2004), Malaysia’s ecological footprint (EF), i.e. 3.0 gha/cap, appears to be smaller than that of the developed countries (e.g. 9.5 gha/cap for the U.S. and 7.7 for Australia), but larger than that of other ASEAN countries (e.g. 1.6 and 1.2 gha/cap for Thailand and Indonesia respectively). This means each Malaysian requires 3.0 global hectares to support their lifestyle, when the actual capacity for each individual is 1.9 global hectares. Put differently, more than one and a half planets are needed if the rest of the world was to live as Malaysians (McCoy, 2006). The largest contributor to the EF for each Malaysian is energy consumption but the major difference between Malaysia and ASEAN countries is the use of energy land (World-Wide Fund for Nature International [WWF], 2004). Therefore, any reduction of energy consumption will contribute to the reduction of EF of the country.

Another noteworthy issue is the number of construction companies with ISO14001 certification of environmental management systems. Despite the provision of assistance by the government for companies to obtain ISO14001 (Zarsky & Tay, 2000), there were only 598 certified organisations in Malaysia, as compared to 716 in the small city-state of Singapore (as of January 2007) (Tsujii, 2007), with only one-fifth of the total Malaysian populations. Further, as of end 2007, only two of the abovementioned ISO14001 accredited organisations in Malaysia are construction companies (CIDB Malaysia, 2007a). This number compares rather unfavourably with the total of 3751 Grade 7 construction companies in Malaysia (i.e. the highest grade of contractors registered with the CIDB Malaysia).

To summarize, it is clear that the exploitation of resources, uncontrolled, and improperly planned development has resulted in the deterioration of the environment. The incidence of environmental problems highlighted earlier has changed with Malaysia’s economic progress, but generally increased incomes have yet to be translated into improved environmental conditions (Rasiah, 1999; Sani, 1999). These predicaments reflect the imbalance between environmental and socio-economic development; thus the benefits of development may be negated by the costs of environmental impact. In other words, environmental degradation may be caused by human negligence on the one hand, but on the other hand, it is more often than not is the individual intentionals or collective actions that have put economic gains as of utmost importance. As such, in the process of economic and infrastructural development, environment has not been given its due respect and has often been sidelined which leads to further degradation of the environment. If this were the case, then the current Malaysian construction and building practices can be deemed as not sustainable.

In addition, efforts to form three development corridors in the southern, northern and eastern regions of Peninsular Malaysia (i.e. Iskandar Malaysia (IM), Northern Corridor Economic Region (NCER), and East Coast Economic Region (ECER) respectively) will further add huge pressure to the environment if not approached in a sustainable manner. Therefore, the adoption of sustainable development in the Malaysian construction industry is very timely and crucial. The next section then seeks to find out whether this path has been chosen as the priority by the Malaysian government.

3.5 Commitment of the Government in the Sustainability Agenda

3.5.1 International Treaties

Malaysia, being part of the global community, has been active in environmental issues internationally and has signed various international agreements. In 1987, Malaysia signed the *Montreal Protocol*, which commits the nation to phasing out ozone-depleting substances (ODS). When Malaysia ratified the *Montreal Protocol* agreement in 1989, its ODS consumption was 0.29 kilograms per capita and further dropped to 0.10 in 1997. It was expected that CFCs and halon will be completely phased out by the year 2010 (Ali, 2007).

Malaysia also became Party to several other international environmental conventions including those promulgated at the Rio Summit, and played an important role in promoting partnership between the North and the South in combating global environmental deterioration (Government of Malaysia, 1996). For example, as noted in Chapter Two, Malaysia became a Party to the *UN Framework Convention on Climate Change* (UNFCCC) in 1994 and *Kyoto Protocol* in 2005, under the third mechanism, the Clean Development Mechanism (CDM)[2]. During the Copenhagen Climate Change Summit, on December 2009 in Copenhagen, Malaysia conditionally agreed to commit in reducing the carbon emissions to 40% in terms of emissions intensity of gross domestic product (GDP) by the year 2020 compared to 2005 and preserve the forest land area (Ahmad*, et al.*, 2011). Accordingly, Malaysia has recently launched the National Policy on Climate Change which aims to "ensure climate-resilient development to fulfil national aspirations for sustainability" (Malaysian Ministry of Natural Resources and Environment, 2010, p.1). The policy was set to mainstream national responses that consolidate economic, social and environmental development goals. Besides, several sectors have also instituted their own policies and measures to address climate change. For example, for decades, Malaysia has had clear policies, rules and regulations for the conservation of forests and reforestation mainly because it is well aware that forests act as carbon sinks (Kee, 2007). However, it is worth noting that unlike European countries, Malaysia has not established the target of achieving zero carbon emission for buildings and carbon trading is still relatively new in the country. Further information on Malaysia's carbon trading potential can be found in Oh and Chua (2010).

[2] As a non-Annex 1 country, the CDM is thus the only mechanism provided by the Kyoto Protocol that is relevant to Malaysia. CDM allows countries in Annex 1 (industrialized or developed countries) to finance emission reduction projects in the developing countries and the credit obtained can be used for compliance with its commitment.

Other environment and sustainable development related conventions that Malaysia has been involved in are conventions on biological diversity, basel convention on the control of trans-boundary movements of hazardous wastes and their disposal, endangered species, wetlands, to name a few (Central Intelligence Agency, 2010).

3.5.2 Policies and Legislations Relating to the Construction Industry

Malaysia has a plethora of policies and legislations relating to environmental, social and economic sustainability of the construction industry. In fact, it was noted that Malaysia has one of the best sets of environmental legislations, comparable even with those of some developed countries (Sani & Mohd Sham, 2007). A table showing the hierarchy and classification of these policies and legislations is provided in Appendix B. It provides a reference to various policies and legislations mentioned in general or reviewed in particular in this chapter. It is however important to note that the content of this table is non-exhaustive. How important all of these policies and legislations may be, only a small portion of these references are included in this analysis, since they are not relevant to the issue that is being dealt with in this chapter.

At the national level, aspects of sustainability have been incorporated in the federal policy documents such as the twenty-year *Outline Perspective Plan* and the five-year *Malaysia Plans* since the 1970s (Government of Malaysia, 1971, 1976). During this era, the mission was to balance human activities with the environment, in the effort to eradicate poverty and correct social and economic disparity. Environmental aspects however, have started to be given due considerations since two decades ago. For instance, the *Eighth Malaysia Plan* (2001-2005) (Government of Malaysia, 2001a), reinforced the need for environmentally sustainable development, in addition to economic, social and cultural progress, for long-term advancement of the country. The question of an integrated and holistic management of the environment and natural resources was increasingly emphasized, while strategies for implementing sustainable development through a coordinated and integrated approach were proposed. In view of the Vision 2020 aim for Malaysia, the country's wish to become a fully developed nation in the year 2020 has meant that Malaysia not only encourages economic and social growth, but also environmental issues are addressed.

3.5.3 Draft Kuala Lumpur City Plan 2020

The *Draft Kuala Lumpur City Plan 2020* (Draft KLCP 2020) (Kuala Lumpur City Hall, 2004a, 2004b, 2004c) is Kuala Lumpur City Hall's (KLCH) twelve-year primary planning and development strategy to guide decision makers, city planners, designers and buildings the direction of the city's growth and lead the City into A World Class City Status in 2020. In line with the *National Physical Plan* (NPP)[3], the five thrusts of the *Ninth Malaysia Plan* (Government of Malaysia, 2006), and the six thrusts of the *National Urbanisation Policy* (NUP)[4] (Federal Department of Town & Country Planning Malaysia, 2006), the planning and development strategies of the *Draft KLCP 2020* were formulated to place priority on three dimensions of sustainability namely, environmental quality, social equity and economic prosperity (Kuala Lumpur City Hall, 2004c). Thus, it has five core guiding principles as listed in Table 3.1. Among the issues highlighted are local economy, safety, culture and heritage, connectivity, accessibility, natural resource consumptions, and pollutions.

Table 3.1: Five core principles that frames the Draft KLCP 2020

Five core principles		Description
1.	Planning for wealth creation	Induces growth of supporting financial, professional and business activities.
2.	Planning for safety and comfort	Ensures the city is safe and comfortable; enhances the built environment while protecting the environment and conserving the culture and heritage of the city.
3.	Planning for connectivity and accessibility	Makes the city a well-connected city, enhances accessibility and improves reachability through integrated land use development.
4.	Planning for greener standards	Calls for optimum growth where land use development integrates and co-exists with environment; promotes water resource management; promotes alternative use of energy and renewable energy; reduces greenhouse gas emissions by planning for public transportation; and reduces waste generation.
5.	Planning 'with and for' the people	Ensures that whatever it plans, builds or develop are what the people wants and needs.

3.5.4 Construction Industry Master Plan (CIMP)

The industry in Malaysia is championed by the Construction Industry Development Board (CIDB), a government agency established to promote and stimulate the development, improvement and expansion of the construction industry, and generally to represent to the government and the public. In 2007, CIDB published a 10-year *Construction Industry Master Plan* (CIMP), to be implemented from 2006 to 2015, with the objective of refocusing the strategic position and charting the future direction of the industry to contribute towards achieving Vision 2020 (CIDB Malaysia, 2007b). The master plan sets out its mission "to be a dynamic, productive, and resilient enabling sector, supporting sustainable wealth generation and value creation, driven by a technologically-pervasive, creative, and cohesive construction community" (CIDB Malaysia, 2007b, p.74). Imperative to the success of this mission, eight critical success factors were identified (see Table 3.2). These critical success

[3] The NPP is a long term national level plan to create an efficient, equitable and sustainable national spatial framework to guide the overall development of the country.
[4] The NUP calls for liveable communities and sustainable urban development.

factors are also essential to the promotion of seven strategic thrusts which are listed in Table 3.3.

Table 3.2: Eight critical success factors essential to achieve the mission of the CIMP.
Source: CIDB Malaysia (2007b, p.77-78)

NOTE:
This table is included on page 66 of the print copy of the thesis held in the University of Adelaide Library.

From the aforementioned government initiatives and plans, it can be concluded that sustainable development is indeed the path chosen by the government of Malaysia in strategizing the development of cities or the country as a whole. In other words, it has been realised that socio-economic system must strike a balance with the ecological system to avoid the advent of ecological breakdown and distress syndromes. The principles or thrusts of the *Draft KL City Plan 2020* and the *Construction Industry Master Plan* listed earlier, illustrate the priorities that should guide, or be addressed in, the formulation of the assessment framework in the study.

3.6 Barriers to Sustainability Integration and Justification of the Study

The question remains is "why there are continuous presence of, and increasing problems related to, the environment despite a plethora of sustainable development frameworks, policies or various enabling legislation and regulatory frameworks deployed to reduce and overcome them?" This denotes that there are still barriers related to environmental management measures in this country. Therefore, this section seeks to understand the barriers that have hindered the implementation of the government's initiatives in bringing the country in general, and the construction industry in particular, onto sustainability bandwagon.

3.6.1 Sustainable Development Indicators

Since the introduction of *Agenda 21* in 1992, sustainable development indicators (SDIs) have become increasingly important as a tool to assess progress towards sustainability (Peterson, 1997). In Malaysia, the need for developing SDIs to assist decision-makings was highlighted in the *Eighth Malaysia Plan* mentioned earlier (Government of Malaysia, 2001a). The initiatives on SDIs in Malaysia are broadly categorised into government, non-government and research activities. A majority of these are for evaluation purposes, although some are for reporting as well.

The state-led initiative to formulate strategies for the attainment of sustainable development was pioneered by the Selangor state government as negative impacts of development became more apparent and reached a point where development activities in the state must be carried out in a more holistic way. In line with this consciousness, the Selangor State Planning Committee in 1998 commissioned the project *Formulation of Sustainable Development Strategy* and *Agenda 21 of Selangor* (Hezri & Hasan, 2004; Selangor State Government, 2003; Yuen*, et al.*, 2006). This project provided an opportunity to develop the concept, framework and appropriate SDIs to assess and track sustainable development in Selangor (Selangor State Government, 2001, 2002, 2003).

The development of SDIs for Selangor was guided by the definition of sustainable development for the state. Based on the *Agenda 21 Selangor* (Selangor State Government, 2003, p.3), one of the main outputs of the aforementioned project, sustainable development is defined as "development that requires a reformation of the economy that takes into serious account the impact of development on the environment, natural resources and society”. This definition was introduced based the philosophy, requirement and approach of development currently taking place in Selangor.

At the local level, Malaysia has implemented *Local Agenda 21* (LA21), particularly by the Ministry of Housing and Local Government, in 44 local authorities to create public awareness on the importance of sustainable development at the local level (Government of Malaysia, 2001b). LA21 is a programme to forge cooperation between local authorities (such as District Councils, Municipal Councils, City Councils and City Halls), communities and the private sectors to plan and manage their built and natural environments towards sustainable development.

However, the SDI initiatives in Malaysia suffer some constraints. Most notable issues among these are the efforts to implement indicators which measure sustainable development. As Pereira and Hasan (2004, p.11) put it: “there is lack of an integrated sustainable development policy at the national level, to provide linkages between administrative levels and elevate the status of SDIs and make them important for decision-making.” Consequently, contribution to SDI initiatives is perceived as an additional burden over and above daily work demands among government agencies. Hezri (2004) explains that the implementation of SDIs suffers meta-policy, technical, communication and knowledge constraints. Specific political constraints that hinder the successful implementation of LA21 are poor coordination and integration among government agencies as well as limited administrative capacity within the Selangor state government has somehow restricted its move towards achieving sustainability. Pereira and Hasan (2004, p.12) concluded that “top down approaches have offered support to flow of information between federal agencies as well as between agencies at national, state and local levels of administration. These need to be strengthened through bottom-up participatory approaches.”

3.6.2 Environmental Policies and Environmental Impact Assessment

In Malaysia, management of matters related to the environment is guided by the Federal and State Constitutions and the legislation made under the purview of these constitutions. To date, there are at least 45 environment-related legislation that has been enacted (Md. Jahi, 2001). However, only the *Environmental Quality Act, 1974* (EQA 1974) was enacted purposely for the protection and conservation of the environment. Specifically, it covers provisions relating to restriction on pollution of the atmosphere, noise pollution, pollution of soil, pollution of inland waters, and prohibition of discharge of wastes into Malaysian waters. However, it was observed that within the first thirteen years of the EQA 1974, a period of rapid urbanisation which resulted in environmental problems, many of the measures taken were curative and remedial in nature and focused on pollution control (Sani & Mohd Sham, 2007). The focus then shifted to pollution prevention leading to the amendment of the EQA in 1985.

Following the Rio Summit in 1992, Malaysia's management style with respect to environment has become more pro-active. Recognizing that economic development issues are intricately linked with the environment, a *National Conservation Strategy* was formulated in 1993 to ensure that future development and environment are properly coordinated in line with the sustainable development concept as defined in the Brundtland Report (Sani & Mohd Sham, 2007). The most important change resulted from the amendment of the EQA in 1985, as noted above, was the insertion of a section requiring the submission of environmental impact assessment (EIA) reports for "prescribed activities". The EIA has been made mandatory since 1988 as a proactive tool to incorporate environmental considerations into project planning decisions (Department of Environment Malaysia, 2004). These measures mean that predictions are made on how the environment may be affected if specified development alternatives were to occur, and how best to manage the anticipated environmental changes (World Bank, 1996). The EIA procedures in 1988 marked a serious attempt at preventive measures in order to ensure sustainable development in the country.

Whilst acknowledging the objectives of the EIA are commendable, the EIA itself is project and site-specific. For some areas, there are likely to be many development projects for which an EIA will not be mandatory as they fall outside the gazetted definitions of "prescribed activities". Yet much of the area that remained to be developed can be environmentally very sensitive. Furthermore, EIA implementation in Malaysia has encountered a series of problems. A survey conducted by Vun, Latif *et al.* (2004) revealed that only 27% of the EIAs reports were found to be satisfactory in their ecological input, whereas the others were at borderline or poor. The short period of time and limited resources allocated to EIA consultants could be part of the cause. Further, Department of Environment (DoE) claims that the environmental consultants are unqualified, irresponsible and incompetent (Nik Anis, 2007).

Although EIA has been mandated by the Malaysian government, the political and business support in ensuring the success of the system is low (Boyle, 1998). Briffett *et al.* (2003) argued that in spite of its extensive use in many Asian countries, it has been relatively ineffective in protecting natural resources. Among the political-related problems encountered in the implementation of EIA are: 1) weak enforcement and an absence of strong commitment by local politicians; decisions for go-ahead with certain projects were made before ecological consideration could be summoned (Memon, 2000); 2) improper registration of EIA consultants, hence poor quality EIA reports (Vun*, et al.*, 2004); 3) inability to provide comprehensive, unbiased, reliable and consistent information for EIA consultants in carrying their assessment on the environment (Vun*, et al.*, 2004); and 4) slow process of approval (Harding, 2003). Unsurprisingly, many observers both from within and outside the country feel that while Malaysia has one of the best sets of environmental legislations in the world, the effective implementation of such legislation is still unimpressive (Sani & Mohd Sham, 2007).

These problems lie largely within the Malaysian framework of federalism where the legislative powers are shared between the federal and state governments or environmental agencies are virtually powerless compared to economic development agencies (Boyle, 1998). For instance, the State Economic Planning and Development Unit is largely responsible for socio-economic development, whereas the state DoE (which is a branch office of federal DoE) is responsible for environmental protection. The decision to approve any physical development projects, including those that can be environmentally sensitive, is entirely within the jurisdiction of the state, and therefore, will not require informational inputs from the DoE unless the project invokes EIA to be undertaken. In this context of federalism, any development programme that does not take into account the limited powers of the state and federal governments on matters related to the environment will impede its effectiveness for moving towards sustainable development at the state level.

Another noteworthy weakness in the implementation of environmental legislation in the country, particularly EIA, is ensuring participation of the affected community. According to Saarikoski (2000), Environmental Assessment is now regarded as a system for producing knowledge, as it offers a forum for different stakeholders to deliberate and exchange views on the goals of a proposal and their knowledge of an affected environment and anticipated impacts. Sadly, ensuring adequate and useful participation in the EIA process is still a challenge in certain emerging/developing countries, including Malaysia (Zubir, 2007). In this regard, some local authorities have not given due consideration to the requirements of the *Town and Country Planning Act* about informing the affected community (Megat Rus Kamarani, 2008). This means, many development projects have been approved without the knowledge of the community. Devi (2006) noted that there are occurrences of public meetings for communities by proponents but the whole process is more consultative rather than participatory. If this was the case, then it is sensible to suggest that adequate community participation in development processes is not widely practiced or become a main concern.

3.6.3 Key Programmes in Energy-related Development

Following the occurrence of two international energy crisis and quantum leaps in prices in the year 1973 and 1979, the government of Malaysia has formulated numerous energy-related policies to ensure the long-term reliability and security of the energy supply by diversifying the national energy mix. Further, despite the fact that Malaysia bears no obligation in reducing greenhouse gas emissions (Kasipillai, 2009), the nation has continued to do its best in combating climate change by voluntarily slash by up to 40% its carbon emission by 2020 compared with 2005 levels (Wo, 2009). Chapter 19 of the *Ninth Malaysia Plan* (Government of Malaysia, 2006) indicates Malaysia's commitment to reducing high dependence on petroleum products by increasing the use of renewable energy (RE) by promoting new RE resources. Malaysia will also intensify energy efficiency (EE) initiatives in the industries, transport, commercial and domestic sectors as well as in government buildings. Accordingly, there are many energy related developments that have been implemented in Malaysia but the five key programmes are as follows:

- Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP); initiated in 1999 and ended in 2009 to improve EE in Malaysia's industrial sector;
- Small Renewable Energy Power Programme (SREPP), launched in 2001 with the aim of encouraging private sectors to undertake small power generation projects using renewable resources;
- Malaysia Building Integrated Photovoltaic Technology Application (MBIPV) Project, launched in 2005 and ended in December 2010, with the objective to reduce long-term cost of Building Integrated Photovoltaic (BIPV) technology within Malaysian market;
- A continual programme called Building Energy Efficiency Programme (BEEP) in which optimal use of energy in cooling and lighting by using various strategies is promoted; and
- A green building rating system, Green Building Index (GBI). GBI is briefly explained later in the chapter and will be analysed in detail in the next chapter.

For detail descriptions and discussions on each of the abovementioned programmes, refer to Chua and Oh (2010).

However, the initiatives made appears to be unsuccessful, when the target of 5% contribution for 2010 from RE to the energy mix is far from being achieved, with only 1.8% contribution (Oh, *et al.*, 2010). Malaysia currently has some barriers in the dissemination of RE technology and still not ready to displace non-renewable energy with renewable fuels. Among the most popular barrier is the fuel subsidy in which Malaysia provides enormous subsidy that result in a cheap electric price from the national grid (Ahmad, *et al.*, 2011); hence, provide little direct financial incentive for substantial performance improvements. This explains the lack of motivation among the public to save energy by adopting EE strategies, let alone investing in expensive RE technology.

3.6.4 Energy Guidelines and Standards

One aspect in which there has been successfully growing awareness in Malaysia, however, is energy efficiency. The government had put emphasis on the energy efficiency aspects of buildings by introducing in 1989, the *Guideline for Energy Efficiency in Buildings* (Malaysian Ministry of Energy Telecommunication and Posts, 1989). The intention was to eliminate energy-intensive design practices, and to encourage acceptance of appropriate guidelines by the building design community. The guidelines, however, suffered due to lack of enforcement and did not have the desired impact on the building community. The *General Design Guidelines for Offices* issued by the Kuala Lumpur City Hall (Planning and Building Control Department, 1991) made reference to the Energy Guidelines, but the guidelines were also not effectively enforced (Ibrahim & Abbas, 2001).

In 2001, the government reintroduced the guidelines in the form of a Malaysian standard code of practice, *MS 1525: the Code of Practice for Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings* in 2002 (Department of Standards Malaysia, 2007). *MS 1525* provided only the criteria and minimum standards for energy efficiency in the design of new buildings and retrofitting of existing buildings, so they would be constructed, operated and maintained in a manner that reduces the use of energy. In early 2002, two major local authorities, namely the Kuala Lumpur City Hall (KLCH) and the Putrajaya Corporation (PJC), began to enforce the Code on all new office projects. This marked a new phase of energy efficiency implementation in Malaysia. In 2007, the standards were improved to include the application of renewable energy in new and existing buildings (Department of Standards Malaysia, 2007). Nevertheless, despite many efforts to legislate the issue, the MS 1525 is still not an integral part of the *Uniform Building By-law 1984* (Laws of Malaysia, 2008), thus impeding the progress towards producing more energy efficient office buildings in the country.

3.6.5 Necessity of Building Performance Assessment Systems

It is clear from the review of the aforementioned initiatives that there are gaps between sustainable development policies and their implementation in Malaysia. These gaps or barriers are summarised in Table 3.4.

Table 3.4: Summary of weaknesses or implementation barriers identified in the review of government initiatives

Government Initiatives	Weaknesses or implementation barriers
Sustainable Development Indicators	Lack of integrated sustainable development policy at national level; poor coordination and integration among government agencies; communication and knowledge constraints; limited administrative capacity.
Environmental Policies & EIA	Lack of enforcement and political will; unqualified, irresponsible and incompetent EIA consultants; slow approval process; federalism; inadequate participation of affected community.
Energy Policies & Key Programmes	Low energy pricing de-motivates performance improvements.
Energy Guidelines and Standards	Lack of enforcement and political will.

Generally, two notions could be inferred from this table. Firstly, it seems that knowledge enhancement is a priority to breaking the barriers to the integration of sustainability in stakeholders' decision-making. Secondly, the integration of sustainability in the construction industry has been hindered by politically-related constraints. Hence, it could be argued that self-regulatory or bottom-up voluntary approaches should be promoted within the industry on top of regulation controls. These two notions are discussed separately in the following sub-sections, both aim to justify not only the need for this study but also the purpose that the assessment framework should serve.

3.6.5.1 Enabling Evaluation and Enhancing Knowledge

Reducing environmental impacts not only involves better use of the technology but also requires education, information dissemination and participation (Girardet, 2003). Holdren *et al.* (1995) highlighted the need for more research, communication across disciplines, and education of the public and policy makers to approach a consensus on issues pertaining to sustainability. These ideas are particularly relevant to the Malaysian context due to the fact that the level of knowledge on environment issues and sustainability among Malaysians, including building stakeholders, has generally remained low (CIDB Malaysia, 2007d; Haron*, et al.*, 2005; Ibrahim & Abbas, 2001; Shari*, et al.*, 2006, 2008; Zainul Abidin, 2010).

Arguably, the path towards greater sustainability is increasingly considered to be a bottom-up approach instead of top-down. The consumption of resources, for instance, is a direct function of the demand and supply principle. Demand for resources is governed by society's awareness of opportunities and consequences, aspirations and affluence. Supply of resources, on the other hand, takes place in accordance with the demand. In other words, the consumption patterns or progress towards sustainability depend largely on society's attitude and expectation of life style. Unless there is willingness among the public to align their attitude with the requirements of sustainability, no legislation and no conservation programme, however well designed, will be successful or have the desired impact. People's motivation to change (i.e. interest and demand, and follows with implementation) indeed comes from knowledge (Du Plessis, 2005; Fiedler & Deegan, 2007).

Since the lack of knowledge and awareness in sustainability is paramount among the building key players, specific means and programs need to be developed for raising their awareness in order to promote sustainability in the Malaysian building sector. Yeoh (2005, p.1) suggested that "an assessment system to rate the environmental impact and performance of buildings is one strategic measure that will encourage the industry to pay greater attention to environmental issues, and to subscribe to green building practices." This is one of many views that supports the need for a knowledge basis, and moots the development of new assessment systems to identify sustainable options.

As highlighted in the previous chapter, Malaysia was one of the countries who participated in the international CIB W82 Project carried out in 1995 to give a comparison between visions from various countries in the world on what comprises the notion of 'sustainable construction' (Bourdeau*, et al.*, 1998). Through this project, Malaysia has contributed towards the definition of sustainable construction after describing its national constraints, specific issues and future issues in order to provide the context of its definition. Among the issues identified by the Malaysian experts are quality of life, environmental impact, material and energy consumption, forest depletion, greenhouse gas emission and industrial waste. It can be seen here that Malaysia uses terms that are associated with quantification (and hence measurement and assessment). The issues identified are in fact quantifiable attributes. In other words, to fulfil the requirements of the definition of sustainable construction, the measurement of certain attributes is necessary. The identification of measurement or assessment of the central issues strengthens the concept that measurement leading to awareness is a useful line of action in the pursuit of sustainability.

Further, a discussion document *Agenda 21 for Sustainable Construction in Developing Countries* (Du Plessis, 2002) suggests that benchmarking, assessment and knowledge sharing should be the immediate work that needs to be focused on in emerging/developing countries as one of the technology enablers for sustainable development and construction. In fact, one of the major barriers holding back the development of building and construction of sustainable buildings in South-East Asia is a lack of well documented references, tools and techniques which are relevant to local conditions (Shafii & Othman, 2005).

What have been said earlier points to the evident fact that there is an urgent need to establish appropriate building sustainability assessment framework relevant to emerging/developing countries, particularly the Malaysian context. In doing so, the framework should form the basis for evaluating stakeholders' decisions but also enhancing their knowledge and participation in supporting sustainability throughout the life cycle of their projects; hence, stimulating needed changes in the Malaysian construction industry. In line with this realisation, the Malaysian Institute of Architects or Pertubuhan Akitek Malaysia (PAM), in collaboration with the Association of Consulting Engineers Malaysia (ACEM), has launched a rating system known as Green Building Index (GBI) in 2009 to lead the Malaysian property industry towards becoming more environment-friendly. However, since GBI is single-dimensional in its structure, its effectiveness in addressing non-environmental requirements mentioned above requires further investigation. Moreover, GBI's effectiveness in supporting the three dimensions of sustainable development and reflecting priorities in emerging/developing countries, as highlighted in the previous chapter, remain questionable.

3.6.5.2 Promoting Self-Regulation or Voluntary Approaches

Due to the fact that mandatory controls have been hampered by politically-related constraints, voluntary approaches and initiatives are now being used as a policy tool to improve environmental performance and help achieve sustainability (Bakens, 2003; Chau*, et al.*, 2000; Strand & Fossdal, 2003). Voluntary initiatives may take the form of informative environmental guidelines for providing information and practical guidance on the environmental issues likely to be encountered throughout the building construction process (Woolley*, et al.*, 1997). Alternatively, they may appear in the form of environmental assessment systems which is to stimulate the market demand for buildings with improved environmental performance by providing consumers with an extra reference for making rental or purchase decisions (Crawley & Aho, 1999).

There is a growing notion that market-oriented policies or voluntary-based environmental policies are more effective to achieve the sustainability goals than regulatory control (Achanta*, et al.*, 1999; Larsson, 2000; Leth-Petersen & Togeby, 2001). Voluntarism became a popular idea among some international and government agencies, which came to see environmental regulations as stifling of industry competitiveness, costly to society and unhelpful to improving environmental performance (Perry & Singh, 2001). Advocates of voluntary approaches suggest that they offer greater flexibility for building owners to reach targets so as to gain a better public image, and are useful for the policy makers to promote dialogues with the private sector and to raise public awareness of environmental issues (UNEP, 1998). By the same token, Perry and Singh (2001) agree that the flexibility to determine their own standards and priorities in addressing environmental issues is said to make businesses more positive about improvement than where regulation enforces specific actions. According to Larsson (2000), regulations can be very effective if well enforced, but they usually define a minimally acceptable level of performance. Therefore, they are normally insufficient to lead the industry towards high standards, let alone to create the substantial levels of improvements necessary to fulfil international climate change commitments (Larsson, 1999).

On the other hand, a study conducted by Perry and Singh (2001, p.23), revealed that Malaysia is still not ready to depend on voluntary environmental approach without the intervention of government regulations. This problem is partly because there has been little pressure on companies to be proactive in Malaysia. Further, it was argued that voluntary action will decline as companies fail to obtain the extent of economic or public relations benefits that may have been expected (Perry & Singh, 2001). In fact, in Malaysia, the tightening of standards and extension of regulatory controls has been a more important response to new concerns and gaps in original environmental controls than investment in alternative environmental management strategies, either in the form of economic instruments or voluntary initiatives (Perry & Singh, 2001). Due to lack of business community interest in the environmental performance, Perry and Singh (2001) recommend the government to enforce the upgrading of performance standards and subsequently reward those companies that invest ahead of regulatory requirements. In other words, in order to ensure enforcement of building performance standards, special efforts are necessary in Malaysia such as combination of regulatory measures with incentives like subsidies or awards.

This view is also shared by Lee and Yik (2002) who argued that the presence of both regulatory control and voluntary schemes could lead to a better overall result, as the two can enhance each other. By referring to the building energy codes and a voluntary building performance assessment system HK-BEAM, both of which are being implemented in Hong Kong, they found that the voluntary scheme could promote the achievement of a much higher standard of energy efficiency. In this regard, Lee and Yik (2002) also acknowledged that performance-based assessment methods can and should be used in regulatory control; however, reminded that this could only lead to moderate results, as the compliance criteria would need to be set at such levels that they would be relatively easy to achieve. In order to promote the achievement of the next higher performance target for the whole building sector, they went on to state that regulatory control could be tightened once majority of buildings have achieved a standard above the minimum (Lee & Yik, 2002).

From the foregoing discussion, it is sensible to suggest that Malaysia needs both regulatory control i.e. building codes and regulations, and voluntary scheme e.g. building performance assessment systems – although these systems can also be used in regulatory control – to promote self-regulation within the construction industry for the purpose of leading the industry to higher environmental standards. The evidence would also appear to suggest that further investigation needs to be conducted to gauge local stakeholders' opinion with regard to the best approach for Malaysian construction industry to implement building performance assessment systems i.e. mandatory by the government, voluntary basis, or incremental from voluntary to mandatory.

3.7 Conclusion

This chapter has outlined the characteristics of Malaysia in general, and highlighted the most crucial social and environmental impacts contributed by the construction industry as a result of prioritizing economic issues alone. The plans and commitment of the Malaysian government on sustainability agenda have been reviewed and it was revealed that it is the priority of the country to strike a balance between the socio-economic and ecological systems to avoid further environmental damage. However, this balance has not successfully been reached mainly due to knowledge- and politically-related constraints in the implementation of government-driven initiatives and legislative measures that aimed to integrate sustainability in project developments. This finding also highlights the need to explore specific barriers to widespread sustainable practices from the perspective of local building stakeholders.

In parallel with the barriers identified in the literature, the necessity of building performance assessment systems (BPASs) in Malaysia was discussed showing that this area is particularly relevant for research. It was therefore argued that the purpose of such systems in the Malaysian context should not only serve as a means to evaluate building stakeholders' decisions but also to enhance knowledge and encourage participation. This can be achieved by introducing and implementing voluntary schemes or bottom up approaches to raise the construction industry's environmental standards as opposed to dependency on existing regulatory measures. To be precise, voluntary schemes, such as BPASs, are deemed essential in Malaysia as a means to promote self-regulation within the Malaysian construction industry.

Realising the fact that a BPAS, known as Green Building Index (GBI) was introduced in Malaysia two years after the commencement of this study, it is then considered necessary to examine the effectiveness of GBI (and other similar existing BPASs worldwide) in terms of the following: 1) serving the purpose and acknowledging the local context highlighted in this chapter; and 2) addressing the priorities of emerging/developing countries as outlined in the previous chapter. These aspects are analysed in the next chapter.

Chapter 4: Effectiveness of Existing Building Performance Assessment Systems (BPASs)

4.1 Introduction

The main objective of this chapter is to analyse the effectiveness of existing building performance assessment systems (BPASs) in assessing building sustainability or supporting sustainable development. Specifically, this chapter aims to address following research question "How is the built environment (at building scale) currently being assessed for sustainability, and are the current assessment systems able to support sustainable design as well as to educate stakeholders?" This in turned will inform whether BPASs inspired and developed from developed countries can be effective to the emerging/developing countries in general, and to Malaysia in particular.

The main part of this chapter comparatively reviews and critiques nine BPASs currently being used in developed and emerging/developing countries (in chronological order) in terms of their characteristics and limitations in assessing building sustainability. This review then informs how an assessment system for Malaysia should be developed. Subsequently, the importance of having another BPAS in the Malaysian market, as contributed by this study, is highlighted, followed by an outline of specific requirements for developing the Malaysian assessment frameworks, partly based on the synthesis of research outcomes from all the three literature review chapters. The synthesis also forms the basis for proposing the tentative Malaysian Office Building Sustainability Assessment (MOBSA) Framework at the end of this chapter.

4.2 Clarification on the Terminology

Before embarking on the description of the research, a few key terms and the manner in which they have been used within the thesis should be introduced.

4.2.1 Assessment vs. Evaluation

In the literature concerning assessment of built environment, two terms are frequently used: 'assessment' and 'evaluation'. According to Brandon *et al.* (1997, p. xvi), evaluation is a "technical scientific procedure for expressing a judgment based on values, about the impacts of a policy or of an action on the physical (natural and/or built) environment or for assessing the effect of these impacts on the community (the social dimension)". Assessment, as stated by Cole (1997, p.185) is a 'retrospective analysis' that measures how well or poorly a building (or built environment) is performing, or is likely to perform, against a declared set of criteria. While assessment and evaluation have been used interchangeably in the literature, the term 'assessment' will be used in this thesis in the context of quantifying the quality of building environmental performance, which includes environmental impacts as well as the state of sustainability. But unlike Cole's definition, this use of term in research is not always considered retrospective in the context of building construction as designers can make use of assessment processes to arrive at decisions during the design process.

4.2.2 System/Method/Tool/Scheme/Model etc.

Different authors have also used many different terms for assessment system, such as 'method', 'process', 'scheme', 'programme', 'tool', 'framework', 'technique', 'model' etc, often without differentiating one from the other. This research identifies a means of assessment as an assessment system, irrespective of whether the literature refers to it as a tool, or method or scheme etc. The term framework is used in the context of a methodological statement incorporating an account of ideological and/or conceptual approaches for an assessment method.

4.2.3 Building Environmental vs. Sustainable Building/ Building Sustainability Assessment System

In literature, depending on authors, three terminologies are often used to describe building assessment systems, namely: 'building environmental assessment system', 'sustainable building assessment system', and 'building sustainability assessment system'. The key difference between these terminologies is that the first is often being used for green buildings, while the other two are more relevant in the context of sustainable building. This difference has been clarified by various authors. For example, Cole (1999b, p.279) is of the opinion that the term 'green' has been used to describe "building design strategies that are less environmentally and ecologically damaging than typical practice". 'Sustainability' on the other hand, "embraces notions other than environmental performance. It has social and economic dimensions, embraces all facets of human activity. Lutzkendorf and Lorenz (2006) elaborated this point further by suggesting that a green building is meant to be a building that does not fulfil all the requirements attributed to sustainable building, but which exhibits energy efficiency, resource depletion, impacts on the environment, and protection of health and environment. Additional requirements for a sustainable building are "minimization of life cycle cost; protection and/or increase of capital values; protection of health, comfort and safety of workers, occupants, users, visitors and neighbours, and (if applicable) to the preservation of cultural values and heritage" (Lutzkendorf & Lorenz, 2006, p.355). Therefore, it becomes clear that the second and third terminologies describe a means to assess the performance of buildings across a broader range of sustainable considerations than the first terminology does. However, in order to maintain consistency and avoid confusion, the general terminology 'building performance assessment system' (BPAS) is used instead to mean any method of assessing the environmental impact or sustainability of buildings.

Since the purpose of this research is to develop an assessment framework that integrates all dimensions of sustainability as discussed in Chapter Two, it is then useful to clearly make a distinction between this framework and other existing building assessment frameworks in relation to their scope of assessment. This left to a choice between using the terminology 'sustainable building assessment' or 'building sustainability assessment' framework. Kaatz *et al.* (2006) points out that BPASs facilitate the delivery of buildings that better suited to their physical settings and that impact positively on their socio-economic and environmental contexts. Hence, they recommended that it might be useful to change the terminology from 'sustainable building assessment' to 'building sustainability assessment'. They argued that the former may imply that a given building is 'sustainable' to start with, while the latter emphasizes a whole host of issues related to the socio-technical system of a building project. Therefore, 'building sustainability assessment' framework is used to describe the framework developed in this study.

4.3 Classification of BPASs

Building performance assessment systems (BPASs) vary to a great extent and there are two well-known classification systems. The first was developed by the ATHENA Institute (Trusty, 2000) and the other by IEA Annex 31 (2005). The ATHENA classification has three levels:

- Level 1: product comparison tools, which mainly comprise LCA databases and product informational sources. They are mainly used at the procurement stage;
- Level 2: whole building design or decision support tools. These tools are typically used by designers at early design stage and provide important input to Level 3 tools; and
- Level 3: whole building assessment frameworks or systems. They may be applicable to new designs or existing buildings, depending on the tools.

Haapio and Viitaniemi (2008) then combined the ATHENA classification system with the one produced by IEA Annex 31 and produced a wider field of classified BPAS, consisting of five categories as follows:

1. Energy Modelling software
2. Environmental LCA Tools for Buildings and Building Stocks
   - Level 1: As above, such as BEES 3.0 (US) and TEAM (France);
   - Level 2: As above, such as ATHENA (Canada), BEAT 2002 (Denmark), Eco-Quantum (The Netherlands), Envest 2 (UK), SimaPro (Australasia); and
   - Level 3: As above, such as EcoEffect (Sweden) and ESCALE (France).
3. Environmental Assessment Frameworks and Rating Systems
   - Level 3: Such as BREEAM (UK), LEED (US), SBTool (Canada/International), Green Star (Australia), and Green Mark (Singapore).
4. Environmental Guidelines or Checklists for Design and Management of Buildings
5. Environmental Product Declarations, Catalogues, Reference Information, Certifications and Labels.

According to IEA Annex 31 (2005), there are two groups of systems: Interactive software and Passive systems. Haapio and Viitaniemi (2008) further clarified that systems in the first and second categories above fall under the former group, while systems in the rest of the categories fall under the latter. Interactive software systems provide calculation and evaluation methods which enable the user or decision maker to take a pro-active approach to explore a range of options in an interactive way (Baldwin*, et al.*, 2000). Passive systems on the other hand, support decision making without providing the opportunity to interact with the user (Baldwin*, et al.*, 2000; IEA Annex 31, 2005).

This study has more relevance to passive systems particularly those from the third category of Haapio and Viitaniemi's (2008) combined classification described earlier. The reason for this is that the framework developed in this study takes into account the social and economic issues over and above the environmental ones, in contrast to systems from the first and second categories, which focus solely on energy and environmental issues respectively. As argued by Zhang et al. (2006), and Hondo and Moriizumi (2006), LCA tools (i.e. the second category) has difficulty assessing the entire impact of buildings, particularly when moving from green buildings to sustainable buildings incorporating social issues, such as building siting and neighbourhood connectivity, as well as economic issues. A design guideline or checklist based systems (fourth category) is often unable to evaluate whether the aim was achieved by the suggestions made by the framework (Chew & Das, 2008); hence, not given an emphasis in this research. Similarly, systems used for assessment of individual products and materials (fifth category) were excluded from the study owing to the vast gap between their objectives and scope of this research.

Given this focus, it is then important to choose appropriate BPASs for the comparative analysis. As Trusty (2000) pointed out, the comparison should be within the classification level in the ATHENA classification; Level 1 tools should be compared only with other Level 1 tools and not with Level 2 or 3 tools, etc.

4.4 Background of BPASs

4.4.1 The Emergence and Variety

Due to the rising interest and demand from policy makers and increasing pressure on the construction industry to achieve a sustainable built environment (Forsberg & von Malmborg, 2004), there have, over the past decade, been a plethora of BPASs emerging as one of the strategies in, and perceived as tools for, promoting and contributing to sustainable construction (Cole, 1998, 2001; Cooper, 1999; Crawley & Aho, 1999; Ding, 2008; Holmes & Hudson, 2000; Kaatz*, et al.*, 2002; Todd*, et al.*, 2001). The development of assessment systems for buildings has its origin in the 1990s as this was the year when the first BPAS, the UK Building Research Establishment Environmental Assessment Method (BREEAM) was introduced. Following the launch of BREEAM in the UK, many other BPASs were developed around the world. BREEAM has served as a source of inspiration for many of the succeeding methods (Cole, 2006b); hence, many of the systems have similar roots[1]. Principal examples of BPASs used in different countries are shown in Table 4.1, modified from Chew and Das (2008) with additional two features: 1) a list of assessment systems which are a replica, minor variation or a combination of any two or more of the principal examples; and 2) assessment phase(s) that the BPAS allows for certification purposes. Cole (2005), Jönsson (2000b), and Todd *et al.* (2001) observe that all of these systems are gaining some market recognition (with the exceptions of Green Building Index and Greenship, which are still relatively new).

[1] For example, the Building Research Establishment Environmental Assessment Method (BREEAM) used in the United Kingdom and elsewhere was developed in 1990. In 1998, the U.S. Green Building Council created the Leadership in Energy and Environmental Design (LEED) system, based largely on BREEAM. In 2005, the Green Building Institute adapted the Canadian version of BREEAM for a U.S. market and named it Green Globes (Smith*, et al.*, 2006). On top of that, Australia (Green Star), Hong Kong (HK-BEAM) and New Zealand also used the BREEAM methodology in developing their own building assessment systems (Ding, 2008; Grace, 2000). Apart from the US, LEED is also used in Canada, Spain, China and India (Haapio & Viitaniemi, 2008).

Table 4.1: Summary of principal building performance assessment systems. Modified from Chew and Das (2008)

Year	Principal Examples	Phase of Assessment			Developer	Country
		Dsn	As-built	Ops		
1990	Building Research Establishment Environmental Assessment Method (BREEAM)	√	√	√	Building Research Establishment (BRE) Ltd	UK
1993	Building Environmental Performance Assessment Criteria (BEPAC)	√		√	Environmental research group, University of British Columbia	Canada
1996	Hong Kong Building Environmental Assessment Method (HK-BEAM)	(√)	√	√	HK-BEAM Society	Hong Kong
1998 2006	Green Building Tool (GBTool) Sustainable Building Tool (SBTool)	(√)	(√)	√	International Initiative for a Sustainable Built Environment (iiSBE)	Canada/ International
1998	Leadership in Energy and Environmental Design (LEED)	(√)	√	√	U.S. Green Building Council (USGBC)	USA
2003	Green Star	√	√		Green Building Council of Australia (GBCA)	Australia
2004	Green Globes	(√)	√	√	The Green Building Initiative (GBI)	USA
2004	Comprehensive Assessment System for Building Environmental Efficiency (CASBEE)	√		√	Japan Sustainable Building Consortium (JSBC)	Japan
1998 2005	Australian Building Greenhouse Rating (ABGR) National Australian Built Environment Rating System (NABERS)			√	Department of the Environment and Heritage (DEH), commercialized by Department of Energy, Utilities and Sustainability (DEUS)	Australia
Year	**Additional list**	**Phase of Assessment**			**Developer**	**Country**
		Dsn	As-built	Ops		
1999	ESCALE*	√			CTSB & the University of Savoie	France
1999	EcoProfile*			√	Norwegian Building Research Institute (NBI)	Norway
2001	Comprehensive Environmental Performance Assessment Scheme (CEPAS)	√	√	√	Buildings Department, Hong Kong SAR Government	Hong Kong
2004	EcoEffect*	√		√	KTH Centre for Built Environment BFR, Swedish Council for Building Research	Sweden
2005	BCA Green Mark Scheme	(√)	√	√	Building and Construction Authority (BCA)	Singapore
2009	Green Building Index (GBI)	(√)	√	√	Greenbuildingindex Sdn Bhd	Malaysia
2010	Greenship	√			Green Building Council of Indonesia (GBCI)	Indonesia

Note:
* LCA-based tools for buildings and building stocks. See CRISP (CRISP, 2005) and IEA Annex 31 (IEA Annex 31, 2006) for more comprehensive list. (√) = Only for self-assessment purposes, and not for certification purposes

Another BPAS worth mentioning is Sustainable Building Assessment Tool (SBAT), developed by the Council for Scientific and Industrial Research (CSIR) (2007), specifically for use in the African context. The tool can be used in design stages of a new building, or for the refurbishment of an existing building. It provides a broader evaluative framework for sustainability, including social and economic aspects that are unique to developing country scenarios. However, Kaatz *et. al* (2002) revealed that for SBAT to be more effective, it requires a more in-depth assessment of environmental issues by adopting the best environmental aspects of other BPASs. In addition, it relies on the further development of sustainability performance targets specific to the challenges experienced on the continent by involving interested and affected parties (Du Plessis, 2005; Kaatz*, et al.*, 2002). Consequently, benchmarks and sustainability targets are different for each assessed building development, explaining the tool's inability to indicate how individual buildings are contributing to the overall sustainability of the construction sector (Kaatz*, et al.*, 2002).

In general, BPASs have been developed by governments and private organisations, both those established by the industry on a not-for-profit basis and those seeking to establish commercial measures of sustainability (Hill & Bowen, 1997; Retzlaff, 2008). This leads to the fact that some systems are implemented voluntarily for building owners, developers, and designers to provide a catalyst for market transformation or to obtain a differential identification in the market (Cole, 2003); whilst others are used by the authorities as a stimulus for the adoption of good practice or as a compulsory part of the fulfilment of certain requirements (Cole, 1999a, 2005).

BPASs are developed for different purposes, for example, research, consulting, marketing, decision-making, and maintenance; hence, lead to different users. Different BPASs are also used to assess new and existing buildings. In this regard, they provide a means to rate, rank, or assess potential impacts, performance and improvement potentials compared to typical practice and/or to ultimate goals (Malmqvist*, et al.*, 2010). Apart from individual buildings, some assessment systems assess groups of buildings, developments, or neighbourhood; hence, used as the basis of most green building policies and programs (Cole, 1999a; Ding, 2005; San-Jose*, et al.*, 2007).

Many BPASs are specific to one type of building only, such as commercial development, residential, or renovation projects. Accordingly, this influences the choice of the BPAS. However, developers of many BPASs have often created separate systems for different building types and are therefore able to provide assessments for a range of buildings. Different BPASs also cover different phases of a building's life cycle and take different issues into account. As such, BPASs focus on different aspects, but a common aspect of these systems is that they facilitate a comprehensive environmental assessment of buildings. They focus on energy use in buildings, indoor environmental quality, building materials, water use, waste management, and/or many other environmental aspects in fragmented or integrated manners.

BPASs typically work by awarding points for criteria organized under categories such as water, energy, waste, or site. Many BPASs require a minimum amount of points in each category. Different point values assigned to each element effectively weight them to account for their differing importance and impact on sustainability issues (Papamichael, 2000). Different levels of achievement are based on the number of points that a building or development accrues. Ultimately, a building receives a total score to “reflect” its sustainability. Often, the scores are used to assign a ranking, such as platinum, gold, or silver; or 6 stars, 5 stars, or 4 stars.

4.4.2 Intended Roles in the Building Sector

BPASs are intended to fulfill a number of important roles in the building sector. This understanding is important as they serve as lessons for the implementation of such systems in Malaysia.

4.4.2.1 Reduce Environmental Impacts and Foster Sustainable Construction Agenda

The development of a BPAS lays on the fundamental direction for the building sectorto move towards environmental protection and achieving the goal of sustainability. The most significant contribution to date clearly has been to acknowledge and institutionalize the importance of assessing building across a broad range of considerations beyond established single performance criteria such as energy (Cole, 1999a). Although they largely different from each other and designed around different indicators, many scholars assert that they have the potential to reduce the negative environmental impact of buildings and the building sector (Aotake*, et al.*, 2005; Brochner*, et al.*, 1999; Cole, 1999a, 2000) in the short term (Crawley & Aho, 1999; Uher, 1999). The reason for this, as viewed by these scholars, is that the application of BPASs provides significant theoretical and practical experience in pursuing environmentally responsible design, construction, and operation practices.

Apart from environmental benefits, using a BPAS in the design/build process can also produce significant long-term social and economic benefits for building owners and tenants (Cole, 1996) as this system has the potential to create healthier and more productive places, and reduce building operation cost. Some BPASs may include life cycle analysis which takes into account all costs of acquiring, owning, and disposing for a building system. It is especially useful when project alternatives that fulfil the same performance requirements, but differ with respect to initial costs and operating costs, have to be compared in order to select the one that maximizes net savings (Ali & Al Nsairat, 2009).

Arguably, the application of BPASs represents one of the means of implementing the *Agenda 21*, as they can facilitate the integration of sustainability considerations in construction decision-making (Kaatz*, et al.*, 2006). In response to this new challenge, Kaatz *et al.* (2006) observed that new developments in the field of building assessment should start to aim higher by increasing the effectiveness of these systems in evaluating the sustainability of construction projects and to foster the agenda of sustainable construction.

4.4.2.2 Enhance Awareness, Communication, Collaboration, and Quality of Decision-Makings, among Building Stakeholders

BPASs have an important role of not only assessing a baseline of current status, but also to identify progress and promote desirable behaviour among building stakeholders. For instance, BPASs successfully alerting building owners and professionals to the importance of environmental issues in construction (Crawley & Aho, 1999) and the benefits of environmentally conscious choices (Ding, 2008; Kaatz, Root, & Bowen, 2005; Theaker & Cole, 2001). BPASs can also act as an educational and empowerment medium that produces, transfers knowledge, and enhances communication between, and promotes collaboration among, building stakeholders (Bordass & Leaman, 2005; Cole, 1999a; Gann, *et al.*, 2003). In line with this view, Kaatz *et al.* (2006) identified three key objectives that should be achieved through the application of a BPAS: integration; transparency and accessibility; and collaborative learning.

These benefits clearly demonstrate that BPASs should not be then viewed as instruments solely to evaluate the quality of building performance or for producing green or sustainable buildings. Rather they should also be seen as a means potentially to enhance the quality of decision-making in the building and construction processes by incorporating the principles of sustainable development. As Cole (2003) and Kaatz (2005) point out, a BPAS can be used as a design tool by setting sustainable design priorities and goals, developing appropriate sustainable design strategies; and determining performance measures to guide the sustainable design and decision-making processes – crucial information for any design team. For this reason, BPASs provide greater strategic advice to the design team (Cole, 2004, 2006b) to alter building design or operation to reduce harm to the environment and to improve amenity.

Apart from design phase, a BPAS can also be used as a management tool to organize and structure environmental concerns during the construction and operation phases. In this regard, BPASs do not just identify success at meeting a level of performance but also offering feedback to design and guidance for remedial work. Further, Retzlaff (2009) and Ding (2005) recommend for BPASs to be used, or environmental matters to be incorporated, at an early stage of project development in order to achieve the goal of sustainable construction.

4.4.2.3 Support market transformation

Research community and relevant government agencies have viewed BPASs as one of the most effective methods of market transformation (Aotake*, et al.*, 2005; Cole, 2000; Larsson & Cole, 2001). Theaker and Cole (2001) explain that the wide-spread adoption of BPASs in developed countries could ultimately transform the market in these contexts, in expecting and demanding for buildings with higher environmental performance.

Although the trend toward adopting mandatory green building programs appears to be increasing, most of the current BPASs have primarily been used on a voluntary basis, and their current success can be either taken as a measure of how proactive the building sector is in creating positive change or its responsiveness to market demand (Cole, 2005). A BPAS helps stimulating market demand as it is seen as a means to motivate building owners and developers to improve the performance of their buildings (Brochner*, et al.*, 1999; Cole, 1999a). More importantly, it provides a means for clients to demonstrate and communicate their strive for higher environmental standards to prospective tenants, investors and purchasers (Cole, 1999b; Ding, 2008; Kaatz, Root, & Bowen, 2005; Larsson & Cole, 2001; Malmqvist, 2008; Todd*, et al.*, 2001). Kaatz *et al.* (2005) clarified this state of affairs by stating that if the market is provided with improved information and mechanisms, a discerning client group can and will provide leadership in environmental responsibility, and that others will follow suit to remain competitive. Attaching a label of environmental performance for improved environmental qualities is also believed to increase the real market value of a building; and hence, motivate the widespread moving of building performance benchmarks to higher levels (Cole, 2005; Moro*, et al.*, 2005).

On the government side, the planning or policy system to promote sustainable buildings can be guided by a BPAS to assess the sustainability of buildings and to reduce the chance of arbitrary decisions about what is and is not a sustainable building (Retzlaff, 2009). However, one needs to be alerted of the inappropriateness in using an environmental-focused BPAS for guiding a sustainable development-related planning or policy making.

From the foregoing discussion, it appears that BPASs can be a potent agent of change in the specific context of the Malaysian construction sector as they reconcile market-driven and mandatory (i.e. by reference to standards) approaches to promote sustainable construction practices. In fact, the primary future role of BPAS, as seen by Cole (2005), is a catalyst for the transformation of construction industry culture to accommodate sustainability as a common, consistent and integral part of its decision-making.

4.5 Review of Existing BPASs

4.5.1 Objective of Review

One aspect worth noting is that BPASs were not developed from the scratch, with the exception of the initial version of the BREEAM released in 1990. Rather new ones are commonly built on previous initiatives. In this research, existing BPASs should serve as the basis for further research in order to incorporate features and elements which have proven to be effective and to avoid those which have not. As Cole (2006b) noted, the emerging systems learn from the strengths and weaknesses, and drawn on the collective knowledge and experience of established systems to result in recognition and, as a consequence, support practical implementation, of their systems.

Consequently, there have been numerous comparative studies in the literature which look at the effectiveness of BPASs worldwide (see for instance Cole, 2005; Crawley & Aho, 1999; Horvat & Fazio, 2005; IEA Annex 31, 2006; Kats*, et al.*, 2003; Retzlaff, 2008; Sinou & Kyvelou, 2006; Todd*, et al.*, 2001; Todd & Lindsey, 2000). A relevant study by Sallam (2007) investigated the effectiveness of different BPASs in different countries by examining their functionality. The purpose of Sallam's study was to develop a new framework to assist decision makers in selecting the right BPASs to assess the performance of sustainable communities, particularly in developing countries. On the other hand, the purpose of the review of existing BPASs in this research is generally to study two aspects:

1. The current state-of-the-art in measuring building sustainability performance: this gives an insight into current practice as well as ideas on sustainability criteria to be included in the MOBSA framework; and
2. The limitations and potentials of existing BPASs in assessing building sustainability performance in emerging/developing countries: this provides valuable lessons that inform how the MOBSA framework should ideally be developed.

Therefore, five existing BPASs in developed countries are described, evaluated and comparatively analysed. The specific aim of this review is to evaluate the effectiveness of existing BPASs to support sustainable development, and to reflect the priorities of emerging/developing countries, as specified in Chapter Two. Put differently, the part mainly argues the danger of simply adopting a BPAS from developed to emerging/developing countries. Additionally, four BPASs in emerging/developing countries are also reviewed. It has a similar aim as mentioned above, but more importantly, it also aims to investigate their appropriateness in addressing the Malaysian context, as specified in Chapter Three.

Each BPAS will be first described under the following three headings:

1. **Introduction:** this will provide the background of the system i.e. its inception, and the building types and life cycle phases that the system aims to evaluate;
2. **Assessment categories and weightings:** this will include a list and description of the categories assessed by the system and their prioritization; and
3. **Scoring and rating approach**: this will describe how the overall score of a building is derived and the different levels of rating awarded by the system.

It is acknowledged that the above descriptions are provided as far as can be ascertained from the literature because a few of the selected BPASs, especially those from emerging/developing countries, are new; hence, the related literature is still considered limited. The selected BPASs are then compared and discussed using questions under the following categories:

1. **Spatial scale:** Is the BPAS concerned with individual buildings, sites, communities and regions, or global impacts?
2. **Scope of assessment and prioritization of issues:** E.g. Does the BPAS focus on environmental issues only or on other concerns as well, such as economic development and social equity?
3. **Potential vs. actual performance assessment:** Does the BPAS provide an assessment result that indicates the future potential performance of the project only or an objective and factual indication of the actual performance as well?
4. **Local adaptation and context**: E.g. Does the BPAS have a method for adapting to local or regional conditions and goals?
5. **Weightings**: E.g. How does the BPAS prioritize or weight issues?

The analysis of the systems is largely based on the literature and depends on the assessment undertaken by other experienced users. It was not possible within the limitation of time and resources to apply all these systems first hand. All the information is from secondary sources, and the conclusions are reinforced by using more than one source of references. Further, the systems are analysed as a group rather than as individuals. It should be noted that the aim of this comparison is not primarily to compare how the systems are actually performing in practice; the systems are compared according to their intended use. The comparison is made with an emphasis on the main differences in the systems.

4.5.2 Selecting Systems for Review

Nine BPASs were identified for the review in order to cover a range of types, geographical representations, inclusion of a life cycle perspective and level of sophistication. It is acknowledged that the number of the systems included in the study had to be controlled; otherwise the study would have been too wide and complex. The majority were identified in literature as successful BPASs. As clarified in Section 4.3, this study focuses on criteria-based passive systems that assess the built environment on a building scale, with the unit of assessment being the whole building. It was expected that more could be learned from the comprehensive BPASs. All of the BPASs selected for this study are the latest versions applicable to new construction of office or commercial building type, which is the scope of this research.

BPASs chosen to represent those from developed countries are BREEAM (UK), LEED (US), SBTool (Canada/International), Green Star (Australia) and Green Mark (Singapore). With the exception of Green Mark, all of the systems have significantly evolved over their life span and the buildings that have been certified under these systems have been in used and occupied for a period that makes analysis of their effectiveness in achieving sustainable built environment possible. They are known and well represent existing BPASs. Even though Green Mark is considered a relatively new BPAS (introduced in 2005), the system is included in the analysis as through the author’s observation, it has recently been used by Malaysian developers and consultants to obtain a differential identification in the market. SBTool differs to the rest of the selected systems in that it is not a building specific method in itself but does provide a comprehensive framework around which such a system might be developed. Although SBTool was initiated in Canada, it is now an internationally followed system.

BPASs selected to represent those from emerging/developing countries are LEED-India (India), Green Building Evaluation Standard (China), Green Building Index (Malaysia), and Greenship (Indonesia). Green Building Index is obviously relevant as Malaysia is the context within which the study intends to be applied. In general, however, these BPASs were chosen because they are among the most recently developed and implemented in emerging/developing countries within the Asia Pacific region.

4.5.3 BPASs in Developed Countries

4.5.3.1 The BREEAM System (UK)

Introduction

Building Research Establishment Environmental Assessment Method (BREEAM) is a voluntary programme developed by the BRE Ltd (Building Research Establishment Limited) in the UK in 1990. BREEAM was the first BPAS in the world to be developed (Birtles, 1997, p.223; Larsson, 1998) and seems to be the most widely used, with over 100,000 buildings certified and nearly 700,000 registered (BRE, 2008a; Reeder, 2010). It sets the standard for best practice in sustainable design and has become an effective system to describe a building's environmental performance.

Over the course of the past 20 years, the BRE has produced many different versions of BREEAM for different types of buildings, among them Courts, Ecohomes, Industrial, Offices, Healthcare, Prisons, Retail, and Education. It has expanded to include a bespoke version[2], different country versions and most recently, a post-occupancy version (BREEAM In-Use) and BREEAM for Communities. It can be used to assess the environmental performance of buildings in both the design phase as well as post-construction phase. The result of assessment in the former stage will lead to an Interim BREEAM Certificate, whereas the latter, which is carried out after practical completion but prior to handover and occupation of the building, will lead to the final 'as built' performance and BREEAM Rating.

The BREEAM reviewed here is "BREEAM Office 2008" (BRE, 2008a). It was specified that this system can only be used to assess an office building with the office areas make up more than 50% of the gross internal floor area of the building.

Assessment Categories and weightings

The systems awards credits or points for meeting or surpassing a set of performance criteria. The set of criteria are listed under nine assessment categories (referred to as 'section' in BREEAM). These nine categories and their respective environmental weightings (for new builds, extensions and major refurbishment projects) are as follows (BRE, 2008a):

1. Management (12%)
2. Health and wellbeing (15%)
3. Energy (19%)
4. Transport (8%)

[2] Bespoke version is a system that can be tailored to any building type not covered by another system.

5. Water (6%)
6. Materials (12.5%)
7. Waste (7.5%)
8. Land use and ecology (10%)
9. Pollution (10%)

Each category has different number of credits available. Some categories are allocated a large number of credits, for instance 21 for Energy, and others a far lower number, for instance six for Water. Since BREEAM has existed for 20 years, it is unsurprising to witness its evolution of coverage i.e. the original BREEAM tool consisted of a 19-page report with 27 credits, the current version involves a 350-page report with 105 credits.

Scoring and Rating Approach

For BREEAM Office 2008, the building is rated on a benchmark of Unclassified (<30), Pass (≥30), Good (≥45), Very Good (≥55), Excellent (≥70) or Outstanding (≥85). The process of determining a rating, as specified in the BREEAM Office 2008, is as follows[3] (BRE, 2008a, p.8):

1. Determine the number of credits achieved in each category;
2. Calculate the percentage of the credits achieved for each category;
3. Multiply the percentage of credits achieved by the corresponding category weighting to give the category score;
4. Add all the category scores together to give the overall BREEAM score. Then compare this score with the BREEAM benchmark rating to determine the rating achieved, provided all minimum standards have been met;
5. Up to a maximum of 10% can be added to the final BREEAM score for each Innovation credit achieved.

4.5.3.2 The LEED System (US)

Introduction

The LEED (Leadership in Energy and Environmental Design) Green Building Rating System is owned and administered by the US Green Building Council (USGBC) – a national, non-profit organization, formed in 1993 (USGBC, 2010). LEED is an industry-specific, voluntary, consensus-based, and market-driven BPAS aimed primarily to transform the market (Cole,

[3] In the earlier version, each category has sub-categories allocated with pre-weighted points that are either cumulative or otherwise, depending on performance against certain specified standards such as SAP 2005. Credits are awarded to each criteria (referred to as 'issue' in BREEAM) according to their performance and they are added together to produce a single overall score. These weighted credits were derived from a multi-stakeholder consultation process involving expert panels of academics and researchers, materials and product suppliers, government, local authorities, activists and lobbyists, developers and investors, design consultants. The results of this exercise were fascinating for the degree of consistency of result between different groups (Howard, 2005).

2006b; Zimmerman & Kibert, 2007). Since its inception in 1998, LEED has generated enormous interest in green buildings. LEED has also travelled outside the US to countries such as Singapore, India, China and Malaysia (analysed later in the chapter), in which LEED was used partially or wholly as the basis for the development of their own BPAS.

The LEED family of rating systems and pilot programs included: LEED for New Construction and Major Renovations, LEED for Existing Buildings: Operation & Maintenance; LEED for Commercial Interiors; LEED for Core & Shell; LEED for Schools; LEED for Retail; LEED for Healthcare; LEED for Homes; and LEED for Neighbourhood Development. The system reviewed in this study is the LEED 2009 for New Construction and Major Renovations (LEED-NC) Version 3.0[4] (USGBC, 2009a). This system is used to certifying the design and construction of commercial or institutional buildings and high-rise residential buildings of all sizes, both public and private. LEED requires building to commit to sharing whole-building energy and use data with the USGBC and/or the Green Building Certification Institute for five years after occupancy, even if ownership or tenancy changes (USGBC, 2009b).

Assessment Categories and weightings

For LEED-NC v3 (USGBC, 2009a) a total score of 100[5] is distributed among five categories namely:

1. Sustainable sites (26 possible points)
2. Water efficiency (10 possible points)
3. Energy and atmosphere (35 possible points)
4. Materials and resources (14 possible points)
5. Indoor environmental quality (15 possible points)

Among 100 points, 8 are prerequisites (must be met in order to qualify for certification), and 92 are core credits (each criteria within the above listed categories is given one or, sometimes, more credits for meeting or exceeding the requirements). An additional 10 bonus points are allocated for Innovation in Design and Regional Priority. The Innovation in Design category awards up to 6 points for items not covered by LEED, and for exceeding credit requirements. The Regional Priority category offers up to 4 bonus points as incentives to address regional priorities.

In LEED 2009, each category has a number of criteria allocated with pre-weighted points; hence, the relative importance of each category is explicitly assigned by its total number of

[4] LEED Version 3.0 was released after a series of extensive modifications. For example, after the introduction of LEED Version 1.0 in 1998, it was modified leading to the release of LEED Version 2.0 in March 2000. Subsequent modifications then lead to LEED Version 2.1 in 2002 and LEED Version 2.2 following in 2005 (USGBC, 2009).

[5] The total score of LEED version 2.2 and earlier was 69.

possible points. According to the USGBC (2005), the allocation of points between credits in this latest version is based on the potential environmental impacts and human benefits of each credit with respect to a set of impact categories[6].

Scoring and Rating Approach

LEED follows a simple additive system, where the total score is calculated by adding each credit earned upon filling one or more criteria or their alternative(s). The building is rated as Certified, Silver, Gold or Platinum based on a minimum score of 40, 50, 60 and 80 respectively.

4.5.3.3 The SBTool System (Canada/International)

Introduction

The Sustainable Building Tool (SBTool), formerly known as the Green Building Tool (GBTool), is a software system for assessing the sustainability performance of buildings. It is an implementation of the Green Building Challenge (GBC) assessment system that has been under development since 1996 by international teams from fourteen countries (GBC has been known as Sustainable Building Challenge (SBC) since 2008). The GBC process was launched by Natural Resources Canada, but responsibility was handed over to the International Initiative for a Sustainable Built Environment (iiSBE) in 2002 (iiSBE, 2006; Larsson, 1998; Larsson, 2001). It is still a research product and has been used in Canada more as a framework for discussing environmental performance and establishing performance targets than as a whole building rating system (Reeder, 2010). Because the SBTool is designed as a generic framework that reflects regional practices and goals, it requires expertise from the national or regional third-party organization customising the system (Lee & Burnett, 2006).

SBTool addresses four phases of building life-cycle: pre-design, design, construction and operations. The assessment in each phase is carried out using different data and produces different types of results (Larsson, 2006). For example, the design phase assessment indicates the future potential sustainable performance of the project, based on the information available at the end of the design phase, whereas the operation phase assessment provides an objective and factual indication of the actual performance of the project, based on information available after occupancy.

[6] LEED version 2.2 and earlier versions assigned all criteria equal weight (1 point) and where there were multiple performance levels, each level was worth one point. Hence, the value or the relative importance of each category was implicitly assigned i.e. purely dependant on the number of points available. This was the reason why LEED system was criticized for the fact that certification could be attained by pursuing points that were easy to achieve but did not benefit the environment in proportion to the value of a point. In an effort to address this problem, the USGBC increased the total number of points from 69 to 110 and reweighted credits to reflect environmental priorities in LEED 2009 (Reeder, 2010).

SBTool evaluates both new and renovation projects of residential, office, retail, hotel, motel, hospital, industrial, assembly, institutional, school can be graded along with a combination of any two, three or four different types of building occupancy (iiSBE, 2006). BPASs normally have separate schemes for both new construction and major refurbishment of existing buildings. In SBTool however, the framework contains a whole set of criteria and data for a particular building, but it is designed to activate and deactivate the different criteria to be assessed, depending on the phase the project is at and the type of occupancy chosen. The system reviewed in this study is the SBTool 2010 (iiSBE, 2009).

Assessment Categories and Weightings

In an Excel environment, SBTool is structured hierarchically in three levels[7,] with the higher levels logically derived from the weighed aggregation of the lower ones as 7 issues, 26 categories and 126 criteria. The framework covers sustainable building issues within the three major areas of environment, social and economic sectors (Larsson, 2006; Sinou & Kyvelou, 2006). Seven assessment issues of SBTool 2010 are (iiSBE, 2009):

1. Site suitability and development[8]
2. Energy and resource consumption
3. Environmental loadings
4. Indoor environmental quality
5. Service quality
6. Social and economic aspects
7. Cultural and perceptual aspects

The weighting in SBTool 2010 is at one level i.e. performance criteria level which is the lowest level in the evaluation structure, and it can be partly adjusted according to regional needs (Larsson, 2010). This adjustment ought to be done at the level of GBC national teams in order to provide uniformity and comparability throughout the region[9] (Cole & Larsson, 2002; Horvat & Fazio, 2005; Lee & Burnett, 2006). Alternatively, default values can be used. The default weights of the criteria, are assigned according to “the extension of the potential effect (global=3, urban=2 and building=1), the intensity of the potential effect (direct=3, indirect=2 and weak=1) and the duration of the potential effect (>50 years=3, >10 years=2, <10 years=1)” (Ruiz & Fernández, 2009, p.1137).

[7] The earlier versions of SBTool i.e. GBTool ’98 – GBTool 2002 were structured hierarchically in four levels with Performance Sub-Criteria as the lowest level parameter type. This hierarchy has been reduced to three levels since the release of GBTool 2005.

[8] In SBTool 07, this category was called ‘Site selection, project planning and development’.

[9] In the earlier versions, national teams are advised to adjust weightings at the category and issue levels to suit local needs (or to follow the GBC defaults), whereas weightings at the criteria level are fixed and are evenly weighed.

Apart from weightings, national teams can also adjust the performance benchmarks[10] (Larsson, 2006). The benchmarks and weights reflecting regional or city scale are adjusted by national teams using diverse methods – see for instance (Chang*, et al.*, 2007; Chang*, et al.*, 2005; Lee & Burnett, 2006). Thus, national teams might find it most useful as a reference and basis for developing domestic BPAS and regional authorities can ensure that the system will be relevant to their unique local conditions (Todd, Crawley *et al.* 2001).

Weightings are set to zero (0) for non-applicable criteria such as HVAC in a naturally ventilated building. If any of such cases exist, weights are automatically re-adjusted according to the changes in criteria which remain active to ensure that the total weighting of all active criteria is always 100% (Larsson, 2010). Therefore, given the hierarchical nature of the system, the total weighting of all categories and all seven issues is also 100% respectively.

Scoring and Rating Approach

The scoring is performed at the performance criteria level and the performance score of each criterion is translated to a sustainability measure value in the range from -1 to +5[11]. The scale is interpreted as -1 negative performance, 0 minimum acceptable performance, 3 good practice and 5 best practice (Larsson, 2006). Performance scores are presented in a consistent manner all relative to an explicit declared benchmark – the zero (0) on the performance scale (Larsson, 2006).

Afterwards, each score is multiplied by the weighting, which represents the importance or impact of each criterion on the sustainability dimension. The addition of all the weighted scores of constituent criteria in one category represents the level of sustainability of this category. Subsequently, adding the entire weighted scores of categories represents the level of sustainability of each issue. The same process is repeated in the issue level to obtain an overall evaluation of the project.

[10] There are two types of benchmarks, namely those that can be expressed as numeric values and those that are best described in text form.

[11] In the earlier versions of SBTool i.e. GBTool '98 – GBTool 2002, scoring was made at the criteria and sub-criteria of which are set within performance scales ranging from -2 to +5. These scales have been modified to range from -1 to +5 since the release of GBTool 2005.

4.5.3.4 The Green Star System (Australia)

Introduction

Green Star assessment system was developed by the Green Building Council of Australia (GBCA) in 2003 with the assistance of the BRE and with BREEAM as its basis. However, adaptations have been made in order to reflect the various differences between Australia and the UK, such as the climate, local environment and the construction industry standards practice (Saunders, 2008). Since the initial launch of Green Star, the GBCA has also adapted the assessment methodology to make the delivery mechanism more akin to the LEED approach. Hence subsequent changes made the assessment methodology more similar to LEED than to BREEAM (Reeder, 2010). Green Star has partly or wholly served as the basis for the development of similar system in Singapore, Malaysia and Indonesia, which are examined later in the chapter.

Green Star was first developed for the assessment of office buildings in various stages i.e. design and as-built; and now different versions are available for Retail, Education, Office Design, Office as Built, and Office Interiors. Pilot programs were underway for industrial, multiunit residential, mixed use, healthcare, and office-existing building. The system selected for this study is Green Star Office Design and Office As Built v.3 (GBCA, 2008b).

Assessment Categories and Weightings

Green Star rates a building in relation to eight environmental impact categories and each category has various credits (or criteria) with one or more points allocated. In an Excel environment, Green Star provides a two-tiered weighting structure, as follows:

- Each category has an environmental weighting; and
- The number of points allocated to each criterion (e.g. 3 points for Daylight and 1 point for mould prevention in the IEQ Category) is effectively a weighting between criteria within a category.

Categories, number of points available and weightings are shown in Table 4.2. For a particular project, non-applicable credits are excluded from 'points available'. For example, the use of recycled content of structural concrete is excluded for a refurbishment project.

According to GBCA (2008), the category weightings were derived from a variety of scientific and stakeholder inputs, as well as considering geographical location, to reflect issues of importance in each state or territory. For example, the weighting for Water Category is the highest in the Green Star used in South Australia which is the driest state in the country.

Table 4.2: Eight Categories in the Green Star with their respective number of points available and weightings

Credit Category	No. points	Weighting: NSW %
Management	12	10
Indoor Environmental Quality	27	20
Energy	27	25
Transport	11	10
Water	13	12
Materials	20	10
Land Use and Ecology	8	8
Pollution	14	5
TOTAL		100%

Scoring and Rating Approach

The single (overall) score of a project is determined by taking the following steps:

1. Calculating each category score
2. Applying an environmental weighting to each category
3. Adding all weighed category scores together
4. Adding any innovation points that may have been achieved

Once a score is established in each category, the categories are weighted by dividing the number of points achieved in a category by the number available, and multiplying by 100 percent. The maximum possible score for a Green Star rating is 100 for the weighed categories with an additional 5 points for Innovation. The inclusion of Innovation section in the Green Star is one of the differences to the UK version BREEAM. Since the total of innovation points achieved are added to the weighted score calculated, it is technically possible to score more than 100% although in reality it is virtually impossible.

A grade of 1 to 6 stars is determined for the overall minimum score of 10, 20, 30, 45, 60 and 75 respectively, which is based on original BREEAM rating approach. GBCA certifies only the last three i.e. Four Star Green Certified, signifying “Best Practices”; Five Star Green Certified, signifying “Australian Excellence”; and Six Star Green Certified, signifying “World Leadership.” Although Green Star excludes non-applicable points, it is unsuitable to be used on a global basis as input for zones is denoted by Australian provinces rather than the climatic data.

4.5.3.5 The Green Mark System (Singapore)

Introduction

The Green Mark system was developed by the Building and Construction Authority (BCA) Singapore in 2005 by using LEED and Green Star as the basis (BCA Singapore, 2006). Within three years after being introduced, there are more than 250 Green Mark certified projects in Singapore. Green Mark system has also been travelled to other Southeast Asian countries like Malaysia, Vietnam, Thailand, and also to India, China and Middle East (BCA Singapore, 2009).

In April 2008, it became mandatory in Singapore for all new buildings or works on existing buildings exceeding 2,000sq.m in floor area to achieve a minimum Green Mark Certified rating. Subsequently, the government has recently planned to impose all larger new air-conditioned public sector buildings to achieve the highest Green Mark rating award i.e. the Green Mark Platinum (BCA Singapore, 2009). These requirements ultimately aim to ensure "at least 80% of the buildings in Singapore attain the BCA Green Mark Certified rating by 2030" (BCA Singapore, 2009, p.6).

This government-driven BPAS has separate schemes for both new and existing projects of residential and non-residential, named as follows: Green Mark for Landed Houses, New Residential Buildings, New Non-Residential Buildings, Non-Residential Existing Buildings. Green Mark also has different versions to promote sustainability in existing and new parks, office interiors and supporting infrastructure. For the purpose of this study, Green Mark for New Non-Residential Buildings Version 4.0 (NRB/4.0) (BCA Singapore, 2010) was selected.

Assessment Categories and Weightings

The BCA Green Mark NRB/4.0 assessment structure consists of two levels of hierarchy. The highest level is the five categories within which are a number of criteria where points are assigned. A total of 190 points are distributed in the following five categories:

1. Energy efficiency (116 points)
2. Water efficiency (17 points)
3. Environmental protection (42 points)
4. Indoor environmental quality (8 points)
5. Other green features (7 points)

Similar to LEED, some of these points are prerequisites. Each category consists of a number of sub-categories, each with a different number of maximum points available, ranging for as low as one point, for instance the sub-category of thermal comfort under indoor environmental quality category, to as high as thirty points for air-conditioning system under energy efficiency category.

Scoring and Rating Approach

An overall Green Mark score is derived using a simple additive system, following the LEED's approach. Based on an overall assessment, a building will be awarded one of the following four Green Mark ratings: Certified (50 to 74 points), Gold (75 to 84 points), Gold^{Plus} (85 to 89 points), and Platinum (90 or more points). In order to achieve a Green Star award, BCA imposes three important requirements, namely: 1) all relevant pre-requisites are to be complied with; 2) achieve minimum of 30 points must be achieved from Energy category; and 3) achieve at least 20 points from other categories.

4.5.4 Similar Systems Existing in the Emerging/Developing Countries

4.5.4.1 The LEED-India System (India)

Introduction

LEED-India, which is now called the “LEED India Green Building Rating System for New Construction and Major Renovations” or LEED-India NC, was launched in 2006 by the Indian Green Building Council (IGBC), as a voluntary, consensus-based, market-driven assessment system. IGBC was formed in 2001 to steer and facilitate the green building movement in India by creating national awareness (IGBC, 2008b). LEED-NC rates commercial buildings such as offices, retail, institutional buildings, and hotels, and it addresses design and construction activities for both new buildings and major renovations of existing buildings. Additionally, LEED-India has a program for leased out or rented spaces called LEED-India Core & Shell, and IGBC Green Homes, exclusively for the residential sector.

Obvious from the names, India has adopted the existing US LEED system to rate their local buildings, but according to the IGBC they had the system indigenised to the Indian context (IGBC, 2008c). According to the IGBC (2008b), there are now 126 certified projects in India comprising of all types of buildings. The particular system chosen to be reviewed here is LEED-India NC v.1.0 (IGBC, 2008c).

Assessment Categories and Weightings

Similar to the US LEED-NC v2.2, LEED-India NC offers a total of 69 points distributed in six different categories:

1. Sustainable sites (13 points)
2. Water efficiency (6 points)
3. Energy and atmosphere (17 points)
4. Materials and resources (13 points)
5. Indoor environmental quality (15 points)
6. Innovation and design process (5 points)

Interestingly, IGBC (2008a) referred part of these categories as the five elements of nature namely, *Prithvi* (Earth) for sustainable site, *Jal* (Water) for water efficiency, *Agni* (Fire) for energy, *Vayu* (Air) for indoor environmental quality, and *Akash* (Sky) for daylight and night sky pollution.

Each category has optional credits and all LEED-India NC credits are worth of one point with the exception of onsite renewable energy credit which worth a maximum of three points. Hence, the weighting of each category is purely dependant on the number of points available.

Scoring and Rating Approach

The sum of all accumulated points gives the level of LEED-India NC Certification. However, in order for certification to be issued, seven prerequisites must be satisfied. These prerequisites have no allocated points, hence they are not calculated as part of the final score. The building is rated as Certified, Silver, Gold or Platinum based on a minimum score of 26, 33, 39 and 52 respectively out of the total score of 69.

4.5.4.2 The Green Building Evaluation Standard or the Three Star System (China)

Introduction

The China's Green Building Evaluation Standard (GBES or also called the 'Three Star System'), was offered by the China's Ministry of Housing and Urban-Rural Development (MOHURD)[12] at the end of 2007, based on their 2006 *Evaluation Standard for Green Building (GB/T 50378-2006)* (Ministry of Construction of the People's Republic of China, 2006; Watson, 2010). Despite being government-driven, the GBES was created to be a voluntary rating system that will encourage green development in China (Watson, 2010) which now becomes one of the world's largest and fastest-growing construction industries; consequently, the top energy consuming nations (Ministry of Construction of the People's Republic of China, 2006; Qin & Lin, 2005).

Despite the fact that the development of GBES was based to the LEED system as its main reference, LEED remains the dominating BPAS in the Chinese green-building labelling market (China Business Information Centre, 2010; Lal & Qian, 2007; Watson, 2010). This is evident from the small number of GBES certified projects i.e. around 30 as of 2010, as compared to 200 which applied for LEED certification during the same period of time (China Business Information Centre, 2010). Consequently, the Chinese Society for Urban Studies

[12] MOHURD was formerly known as the Ministry of Construction (MOC). Its official website is in Chinese only.

Green Building and Conservation Professional Committee (i.e. the China Green Building Council, CGBC)[13] was established in 2008 with local branches in over a dozen cities (Watson, 2010). Since then, CGBC has become a driving force of China's green building development and in collaboration with MOHURD, CGBC is one of the only two official agencies that can certify Three Star buildings (China Business Information Centre, 2010).

Considering the current construction market in China, the system mainly evaluates existing and newly built, expanded or reconstructed residential buildings that are vast in quantities, and public buildings e.g. offices, malls and hotels that consume huge energy and resources. For newly built residential and public buildings, evaluation is conducted one year after turnover to the property owner (Ministry of Construction of the People's Republic of China, 2006). The public buildings version was selected to be reviewed in this study.

Assessment Categories and Weightings

A total of 83 items (criteria) are distributed in the following six categories:

1. Land conservation and outdoor environment (14 items)
2. Energy conservation and usage (19 items)
3. Water conservation and usage (12 items)
4. Material conservation and usage (12 items)
5. Indoor environment quality (15 items)
6. Operation Management (11 items)

Each category has three groups of items: 1) "Control items" (prerequisites or mandatory); 2) "General items" (optional credits); and 3) "Preference items" (optional credits) contains strategies that are both cutting-edge and harder to implement, e.g. brownfield redevelopment, more than 10% on-site renewable power generation, etc. For public buildings, there are a total of 26 control items, 43 general items and 14 preference items. Each of these items are not differentiated it terms of their relative importance i.e. all have similar weight of 1 point.

Scoring and Rating Approach

GBES grants three levels of ratings: 1-star, 2-star, and 3-star, hence the nickname "Three Star System." For one of these ratings to be awarded, projects must not only satisfy all the control items (26 prerequisites), but also conform to the requirements of general and preference items in the list, as shown in Table 4.3. For 2- and 3-star ratings, total required preference items can be selected from any combination of categories. However, no

[13] Official website is not yet available during the conduct of this review.

information is available on how the total numbers of item requirements for each category were derived.

Table 4.3: Item required by the GBES for different levels of rating

Rating classification	General Items (Total: 43 Items)						Preference Items (Total: 14 Items)
	Land (Total: 6 Items)	Energy (Total: 10 Items)	Water (Total: 6 Items)	Material (Total: 8 Items)	IEQ (Total: 6 Items)	Operation Management (Total: 7 Items)	
1-star	3	4	3	5	3	4	-
2-star	4	6	4	6	4	5	6
3-star	5	8	5	7	5	6	10

Any item that is not applicable to the conditions of a building, for example due to regional, climatic and building type factors, can be excluded from the evaluation. Consequently, the total items for evaluation as well as item requirements for rating classification have to be adjusted correspondingly.

4.5.4.3 The Green Building Index System (Malaysia)

Introduction

The Green Building Index (GBI) was developed by collaboration between two Malaysian professional organisations namely, the Malaysian Institute of Architects (PAM) and the Association of Consulting Engineers Malaysia (ACEM), and officially launched by the Malaysian Ministry of Works in May 2009. The custodian of all rights of PAM and ACEM in the GBI is the GreenBuildingIndex Sdn. Bhd. (GSB), a wholly-owned subsidiary of PAM and ACEM. GSB was formed to administrate GBI accreditations and trainings of GBI Facilitators and Certifiers. Taking the experience of government-driven BPASs i.e. Australia’s Green Star[14] and Singapore’s Green Mark (which in turn learned from the US-LEED), GBI is claimed to be the world’s first and only professional-driven green building rating for the tropical climate (Malaysian Institute of Architects, 2009). This bottom-up approach is unsurprising, given the fact that government initiatives taken to move the Malaysian construction industry towards sustainability have been hindered by politically-related constraints, as highlighted in the previous chapter. Today, there are 21 GBI-certified buildings in Malaysia (Rahman, 2011).

GBI has different versions for an assessment of residential and non-residential buildings. Assessments are conducted first at the design phase, and finalized at the construction and procurement phase. Non-residential buildings include factories, offices, hospitals, universities, colleges, hotels and shopping complexes. Since GBI has just recently been

[14] It is acknowledged that although the Australian Green Star might have been encouraged by the Government, it is in fact a ‘private’ initiative through the Green Building Council of Australia which in turn is an arm of the Property Council of Australia.

introduced in the Malaysian market, none of them has gone through any review and modification. However, review is planned to be conducted annually. For the purpose of this study, GBI NRNC v.1.0 (GSB, 2009b) was chosen to be reviewed.

Assessment Categories and Weightings

A total of 100 points are available in the GBI NRNC v.1.0 and distributed in the following six categories:

1. Energy efficiency (35 points)
2. Indoor environmental quality (21 points)
3. Sustainable site planning and management (16 points)
4. Materials and resources (11 points)
5. Water efficiency (10 points)
6. Innovation (7 points)

Compared to the LEED system which also has a total score of 100 points, the Innovation points in LEED are treated as additional, whereas in GBI, these points are included in the total score. Each category has sub-categories and each of these sub-categories has at least one criterion or indicator allocated with pre-weighted points that are either cumulative or otherwise, depending on the level of performance. The maximum point available for each sub-category ranges from one point, for example “Regional materials” sub-category, to as high as fifteen points, for the sub-category of “Advanced energy efficiency performance.” This explains the number of maximum points available for each category, as noted above.

Scoring and Rating Approach

Credits are awarded to each sub-category according to their performance and they are added together to produce a single overall score, similar to LEED’s format. The building is rated on a scale of Certified (60 to 65 points), Silver (66 to 75 points), Gold (76 to 85 points) and Platinum (86 or more points).

4.5.4.4 The Greenship System (Indonesia)

Introduction

Developed and administered by the Green Building Council of Indonesia (GBCI), formed in 2009, the Greenship system is voluntary in its application but predicted to be mandatory in the future (Wiradji, 2009). Recently launched in June 2010, Greenship is the latest among the existing BPASs reviewed in this study. According to the GBCI founder, Greenship adopted Australia's Green Star but with some adjustments to make it more applicable to Indonesia (Wiradji, 2009). It was formulated to assess and certify new commercial buildings in the city as this building type consumes nearly 70% of the total industrial energy consumption (Sasistiya, 2009). However, a Greenship focusing on existing buildings is underway as Jakarta has a total of 700,000 older buildings as compared to only 18,000 new buildings being built annually (Satriastanti, 2010).

Assessment Categories and Weightings

A maximum of 101 points may be earned and they are distributed in the following six assessment categories:

1. Appropriate site development (17 points)
2. Energy efficiency and refrigerant (26 points)
3. Water conservation (21 points)
4. Material resource and cycle (14 points)
5. Indoor health and comfort (10 points)
6. Building environmental management (13 points)

Each category has one prerequisite (except 'Energy efficiency and refrigerant' category with two prerequisites) and optional credits allocated with one or more points depending on the level of performance.

Scoring and Rating Approach

Similar to LEED v.2.2's format, Greenship produces a single overall score by simply adding together all of the points awarded to each category. The building is rated on a scale of *Perunggu* (Certified), *Perak* (Silver), *Emas* (Gold) or Platinum.

4.5.5 Comparative Review and Critique

As stated by Cole (1998), BPASs contribute significantly to the understanding of the relationship between buildings and the environment. However, the interaction between building construction and the environment is largely unknown. The BPASs have limitations that may hamper their future usefulness and effectiveness in the context of assessing the sustainability performance of buildings as discussed below.

4.5.5.1 Spatial Scale

The spatial scale at which a criterion is assessed is critical (Cole, 1999a) because it defines the spatial boundary separating outcomes that will and will not be considered (ISO/TS 21931-1, 2006). The spatial scale at which the project is assessed has much to do with the focus of the assessment. Systems that assess only building-level criteria may produce energy efficient buildings but miss other important issues such as siting and connections to the community. In determining the spatial scale of BPAS criteria, each criterion of each

BPAS was classified into one of the categories listed in Table 4.4, adapted from a scaling system developed by the International Energy Agency (IEA Annex 31, 2005) for an assessment of international BPASs.

Table 4.4: Determining the spatial scale of BPAS criteria

Spatial scale	Examples
Global level: *Impacts on resources specifically identified to be global*	• Greenhouse gas emissions • Emissions of ozone depleting substances
Community and regional level: *Impacts on the neighbourhood, community, and region.*	• Sun shading and glare to neighbouring property • Access to basic services and public transportation • Site selection e.g. development of brownfields • Planning considerations – land use, mixed use, neighbourhood density • Light and noise pollution • Load on local infrastructure – stormwater management • Regional materials • Job creation
Site level: *Site-specific attributes*	• Landscaping, green roof, and open space • Onsite energy sources • Rainwater harvesting • Protection of soil, air, water bodies & habitat on site • Onsite parking capacity & priority, cyclist facilities
Building level: *Certain construction techniques, attributes of buildings, or types of building materials.*	• Water consumption • Energy consumption • Commissioning and maintenance • Waste management • Materials reuse, recycled content, sustainable products • Health and safety of users • Barrier-free use of buildings • Reuse of structure/facade
Other: *Criteria that do not fit the above, usually administrative- and communication/process-related.*	• Project innovation • Accredited professional • Provision of building manual • Users' and community participation in the process

It is however important to note that certain criteria may be relevant at narrower spatial scale but they may also have impacts at broader scales. For example, construction activity pollution prevention may include measures to protect soil, air, water bodies and habitat on site, so it would be classified under the site-level category, because it addresses site-specific issues. However, protection of water bodies, such as rivers, also has significant community and regional effects. Thus, criteria have been categorised into the smallest scale at which they have impacts, although many have broader implications. Table 4.5 shows the spatial scale of the criteria in each of the BPAS. The cells contain the percentage of criteria (both prerequisites and optional credits) at each scale.

Table 4.5: Percentage of points of criteria at different spatial scale in BPAS

Spatial Scale	BPAS in developed countries					BPAS in emerging/developing countries			
	BREEAM 2008	**LEED-NC v.3**	**SBTool 2010**	**Green Star v.3**	**Green Mark v.4**	**GBES / Three Star**	**LEED-India v.1**	**GBI v.1**	**Greenship**
Global	3%	4%	6%	5%	4%		3%	2%	4%
Community/regional	12%	14%	17%	9%		8%	14%	9%	13%
Site	17%	18%	9%	11%	18%	13%	15%	18%	16%
Building	65%	60%	65%	66%	75%	77%	61%	65%	60%
Other	3%	5%	3%	9%	4%	1%	8%	6%	7%

Note:
Blank cells mean the system had no criteria at that scale. Columns may not add to 100% due to rounding.

Many of these BPASs share a common methodology but differ in measurement scales and individual criteria. As Table 4.5 shows, all BPASs, regardless of whether they originated from developed or emerging/developing countries, assess performance at a fairly small scale, like that of the individual building. The three BPASs containing the most criteria at the site scale or smaller are Green Mark, GBES/ Three Star System, and GBI, with 93%, 90%, and 83% of criteria respectively. These three BPASs contain the least criteria at the community/regional level and above, compared to the rest of the BPASs reviewed. BPASs containing the most criteria assessed at scales broader than the site are SBTool (23%), LEED-NC (18%) and Greenship (17%). Singapore's Green Mark seems not to address any impacts on the community/regional scale, whereas China's GBES ignores criteria for the most significant global environmental impacts. This is surprising because China is one of the world's top energy consuming, hence greenhouse gas emitting, nations (Ministry of Construction of the People's Republic of China, 2006; Qin & Lin, 2005).

This finding reinforced the argument by Kaatz *et al.* (2006), Seo *et al.* (2006), and Cole (2006a) that criteria in BPASs are often geared toward the building itself and the site itself, with little regard for off-site or global impacts. Cooper (1999) even argued that focusing exclusively on an individual building is considered as insufficient to address sustainable development issues. Accordingly, Cole (2006a) encouraged future BPASs to link across varying scales to permit the comprehensive framing of sustainability assessment.

4.5.5.2 Scope of Assessment and Prioritization of Issues

Each BPAS group the criteria assessed into categories. Many systems have generally similar categories (e.g. energy, indoor environmental quality, sites, water, building materials); however, the number of criteria categorized under each category varies widely across the systems. Different systems also often classify similar criteria under different category. Table

4.6 lists the common categories addressed by the nine evaluated systems, and their ranking (first to third) in terms of relative importance or prioritization emphasised by each system. These rankings were determined based on the weightings given or the total number of points allocated on that category. The listed common categories however, are only those that are addressed by all the evaluated BPAS.

Table 4.6: The first, second and third priority categories emphasized by nine building performance assessment systems

	BPAS in developed countries					BPAS in emerging/developing countries			
Common categories	**BREEAM 2008**	**LEED-NC v.3**	***SBTool 2010**	**Green Star v.3**	**Green Mark v.4**	**GBES / Three Star**	**LEED-India v.1**	**GBI v.1**	**Greenship**
Energy	1	1	n/a	1	1	1	1	1	1
Indoor environmental quality	2	3	n/a	2		2	2	2	3
Site		2	n/a		2	3	3	3	
Water			n/a	3	3				2
Building Materials	3		n/a				3		

Note:
'1', '2' and '3' mean that the system gives first, second and third priority to that category respectively. Black cells mean the system gives lower priority to that category. These are determined based on the weightings given or the total number of points allocated on that area of concern.
* The weightings in the SBTool system are meant to be adjusted by the national team. Further, the categorization of criteria within SBTool is unique compared to the rest of the evaluated systems, making this exercise difficult, if not impossible.

As Table 4.6 shows, energy issues are a high priority in all of the systems. Likewise, indoor environmental quality and site are the second or third priorities in many of the systems. The issues related to water are high priority in the Greenship, Green Star and Green Mark but less important in other BPASs. Building material issues were less important in many of the BPASs, with six out of nine BPASs prioritize this issue lower than the third ranking.

As noted earlier however, the major categories listed in Table 4.6 are only those that are involved in all of the systems examined. Therefore, examining this alone provides a poor indication of the whole scope addressed by each BPAS. The analysis of scope is important as it provides an indication whether or not existing BPASs are based on, and promote, the three dimensions of sustainable development i.e. environmental protection, economic development and social equity, as discussed in Chapter Two. Therefore, to analyse the scope of issues addressed in BPASs, each criterion of each system was classified as "environment" or "other". All of the criteria classified into the "environmental" category specifically related to environmental issues, while all of the criteria classified into the "other" category had potentially broader, non-environmental implications. Table 4.7 shows the scope of the nine BPASs examined, with a division between environmental and non-environmental criteria (shaded rows) involved in each system.

The analysis of the existing BPASs has shown that a plethora of environmental issues are examined in all cases. Reinforcing the result from Table 4.6 where the priorities given by all BPASs from developed, emerging/developing countries are environmental and human health issues; Table 4.7 reveals that most of the criteria within these issues are well covered in many of these systems. However, it is worth noting that a few environment-related criteria remained excluded in most of the BPASs. For example, while using regional, recycled, reused, sustainably sourced materials are basically addressed, using durable materials or design for robustness is generally ignored by most BPASs. Further, most of the BPASs seem to focus on the environmental impacts on the site level and only partly or not at all, addressing the environmental impacts on the immediate surroundings. Likewise, it seems that all of the BPASs assess only the operation energy, except SBTool which explicitly assesses the embodied energy of construction materials. This can be attributed to the fact that national databases for building product information are still being developed (Lutzkendorf, 2005).

However, Chapter Two left the conclusion that tackling environmental dimension alone is inadequate in addressing the concept of sustainable development and construction. Further, environmental and human health issues are not the only priorities in emerging/developing countries – more important priorities are non-environmental issues. As Table 4.7 shows, where BPASs do address non-environmental issues these normally also relate to an underlying environmental concern. For example, connection to community by selecting proper location and providing linkages is important for social and economic reasons, but also provides environmental advantages. Very few BPASs in developed countries address purely non-environmental issues, such as safety and security; social, cultural, and heritage; and economic aspects. Surprisingly, none of the BPASs in emerging/developing countries has taken any of these non-environmental issues into consideration. Other important non-environmental priorities in emerging/developing countries that are missing in BPASs are creating jobs for local people, and emphasizing on the usage of semi-skilled labour.

Table 4.7: Environmental and non-environmental criteria in BPASs

	BPAS in developed countries					BPAS in emerging/developing countries			
Scope	**BREEAM 2008**	**LEED-NC v.3**	**SBTool 2010**	**Green Star v.3**	**Green Mark v.4**	**GBES / Three Star**	**LEED-India v.1**	**GBI v.1**	**Greenship**
Resource consumption									
• Land – brownfield, urban	x	x	x	x		x	x	x	x
• Operation energy	x	x	x	x	x	x	x	x	x
• Embodied energy			x						
• Potable water	x	x	x	x	x	x	x	x	x
• Materials – recycle, reuse, sustainable	x	x	x	x	x	x	x	x	x
• Materials – durable/robust	x		x						
• Materials - regional	x	x	x			x	x	x	x
• Materials – reuse structure/facade	x	x	x	x		x	x		
Environmental loadings									
• Atmospheric emissions	x	x	x	x	P		x	x	
• Solid waste – management, storage,	x	x	x	x	x	x	x	x	x
• Liquid waste – wastewater, stormwater	x	x	x	x	x		x	x	x
• Impact on site – water bodies, soil, flora & fauna	x	x	x	x	P	x	x	x	x
• Other impacts – light pollution, impact on adjacent properties, heat island effect	P	P	x			P	P		x
Indoor environmental quality									
• Air, thermal, visual quality	x	x	x	x	x	x	x	x	x
• Noise & acoustics	x		x	x	x	x		x	x
• Controllability of systems	x	x	x	x			x	x	
Transport issue									
• Cyclist facilities, green vehicle	x	x		x	P		x	x	P
• Parking capacity	x	x		x			x	x	
• Public transportation access	x	x	x	x		x	x	x	x
Project/construction management, commissioning, maintenance plan	x		x	P				x	
Innovation		x		x	x		x	x	
Urban design – development density, mixed uses, community connectivity i.e. location, linkages	x	x	x				x	x	x
Safety & security	x		x						
Functionality & efficiency			x						
Quality of workmanship & products					x			x	
Flexibility & adaptability			x						
Communication – manual or information	x		x	x				x	x
Social, cultural, heritage & perceptual aspects			x						
Economic aspects			x						

Note: Shaded rows are non-environmental category. Blank cells mean the system had no criteria in that category. 'P' means the system only partly address the area of concern.

As previous chapters highlighted, communication issues to enhance public awareness and education as well as to support social cohesion are an integral part of sustainable development, and one of the important priorities to be addressed in emerging/developing countries. Ding (2008, p.463) suggested that "greater communication, interaction and recognition between members of the design team and various sectors in the industry" are required to promote the popularity of BPASs. However, as Table 4.7 indicates, only a few of the BPASs address communication through information sharing such as the provision of maintenance manual or information to the client or building management. Surprisingly, in the emerging/developing countries, only GBI and Greenship take this communication-related criterion into account. This type of communication however, is only written communication at the building level. Spoken communications at the site and community levels such as collaboration between various actors and participation of affected community in the development process, which are the priorities in emerging/developing countries, are missing from all BPASs examined. As Kaatz *et al.* (2005) critiqued, BPASs mainly focusing on the product of development while ignoring the process. This weakness should be addressed in the study, as Kaatz *et al.* (2005, p.1782) predicted that the “future evolution of building assessment will most likely be geared towards the enhancement of the building process and the empowerment of stakeholders through their direct experience in sustainability oriented decision-making.” These critically important notions, they indicate, will require placing equal, if not greater, emphasis on the quality of social processes as on the development of technical competence.

Maybe one wishes to argue that SBTool is not part of this critique as it is the most comprehensive framework reviewed in this study, covering the environmental, social, and economic aspects of sustainability, as shown in Table 4.7. However, it is argued that SBTool is still a research product and has been used in Canada more as a framework for discussing environmental performance and establishing performance targets than as a whole building rating system (Reeder, 2010). More importantly, certain issues that are of paramount importance for emerging/developing countries, as noted earlier, are still missing. Nonetheless, national and global BPASs, such as SBTool, is valuable to provide a starting point for developing a more contextual system (Todd*, et al.*, 2001), as aimed in this study.

In fact, existing BPASs have long been criticized for following a single-dimensional approach or being restricted to the environmental dimension of sustainability only, with limited ability to assess the broader social and economic dimensions (Cole, 2006b; Cooper, 1999; Curwell & Cooper, 1998; Du Plessis, 2005; Kaatz, Root, & Bowen, 2005; Kohler, 1999; Theaker & Cole, 2001; Todd*, et al.*, 2001). Todd *et al.* (2001) further argue that they have focused on incremental environmental improvements designed to produce ‘green’ or ‘greener’ buildings. According to Cooper (1997), four main principles underlying sustainable development should include equity, futurity (concern for future generations), public participation, and environment, but he finds that BPASs focus only on environment and futurity, and ignore issues of equity and public participation. Therefore, Lutzkendorf (2005) summarizes that these BPASs cannot appropriately assess the contribution of single buildings to sustainable development.

Although these critiques are mainly referred to BPASs in developed countries, it seems that they can also be extended to BPASs in emerging/developing countries reviewed in this study. As Soebarto and Ness (2010) argued, BPASs in Southeast Asian Countries such as GBI, Green Mark and Greenship focus particularly on rating the 'greenness' of the building design itself. They highlighted that "there is no place in these tools to assess the social and economic impact of new developments on the existing communities or areas these buildings are replacing" (Soebarto & Ness, 2010, p.8). Further, social issues are only addressed indirectly, usually by referencing other standards that have social equity components built into them. One example is the reference to wood supply certified by the Forest Stewardship Council (FSC) that forms the basis for a credit in all of the systems reviewed (except SBTool, Green Mark, and GBES). The FSC certification system requires explicit consideration of social, as well as environmental, issues in managing forests. Financial aspects are also found missing in all of the BPASs reviewed, with the exception of SBTool. This may contradict the ultimate principle of a development, as financial return is fundamental to all projects because a project may be environmentally sound but very expensive to build. Therefore, the primary aim of a development, which is to have an economic return, may not be fulfilled making the project less attractive to developers even though it may be environment friendly. Environmental issues and financial considerations should go hand in hand as part of the assessment framework.

These critiques highlight the need to modify the existing building assessment practice to respond effectively to the new challenges and requirements posed by the sustainability agenda. However, there have been recurring debates on the possibilities, necessity, and extent of integrating a wider range of issues into building assessment. On the one hand, there are challenges exist if the scope is sustainability assessment rather than environmental assessment, mainly due to the fact that the former is broader and may consequently include more topics. Many researchers concede that shifting from 'green building' to 'sustainable building' approaches will lead to more complex BPASs and that developing appropriate indicators of sustainability that are appropriate for a single building is extremely difficult (Hill & Bowen, 1997; Kaatz*, et al.*, 2006; Lowe, 2006; Lutzkendorf, 2005; Lutzkendorf & Lorenz, 2006). On the implementation side, this difficultly requires greater effort and cost of making assessment (Cole, 1998). For instance, Crawley and Aho (1999) and Curwell *et al.* (1999) argue that the approach of the GBTool (previous name of SBTool) has led to a very large and complex system causing difficulties and frustration for over-stretched assessors rather than a global assessment method as intended.

On the other hand, various researchers advocate that there is an increased demand for complete and comprehensible assessment results, and applicable tools that can be used to validate a single building's contribution to sustainable development (Bossel, 1999; Cole, 2005; Kohler, 1999; Lutzkendorf & Lorenz, 2006; Todd*, et al.*, 2001). In fact, research indicates that BPASs have begun to move towards having broader scopes (Cole, 2003; Cole, 2005; Cooper, 1999; Kaatz, Root, & Bowen, 2005; Kaatz*, et al.*, 2006; Todd*, et al.*, 2001).

In resolving this conflict, two solutions have been suggested namely, a less complex list of indicators and allowing for flexibility and adaptability. Whilst acknowledging that having a much simpler BPAS with a less complex list that permits easy access and use is commendable, Cole (2006b, p.369) questions whether such system would require "new knowledge, skills, experience or investments are needed by industry to create high performance green, sustainable or 'regenerative' buildings". He goes on to suggest that this approach raises a number of important issues regarding the role of such system in enhancing the knowledge within the building sector (Cole, 2006b). Therefore, a less complex list must be agreed but it must be able to be extended at any point in time when the severity of certain issues become more acute or of greater political and public concern (Cole, 2006a; Lutzkendorf & Lorenz, 2006). Kaatz *et al.* (2006) describe the provision of mechanisms that allows for flexibility and adaptability of the assessment methodology as crucial, and called the process as a scoping procedure. This procedure does not only facilitate the necessary integration of issues and views in building assessment but also facilitate participation and transfer of knowledge among stakeholders (Kaatz*, et al.*, 2006).

4.5.5.3 Potential vs. Actual Performance Assessment

The BPASs reviewed in this chapter have predominantly been applied to new construction. For example, the Greenship system currently only assesses newly built buildings at the end of design phase. Similarly, Green Star is also design-based but includes assessment at the end of construction/commissioning phase to determine whether strategies were in fact, implemented. However, there are still doubts about the full effect of design-based BPASs because they create value in a design on the bases of design elements, but this value may or may not correlate with actual performance. As Sustainable Energy Development Authority (SEDA) (2003, p.5) states, "...while well-designed buildings perform better on average than poorly designed buildings, good design is no guarantee of good performance."

The factors leading to the diversity of actual performance are among others, errors in, or absence of, commissioning; poor delivery of air-conditioning and lighting controls; operation of the building in modes not predicted or allowed for in design; and poor tenant energy management behaviour (SEDA, 2003). Many of these issues can be considered and addressed in design but the knowledge and/or financial drivers to do so are not generally present in the design and development teams. Therefore, it was argued that buildings are always susceptible to the risk of design faults and inadequacies of construction, and more importantly, buildings designed to be ‘green’ may not be operated and occupied by ‘green’ operators and users; hence, unable to avoid ‘grey’ performance (Browne & Frame, 1999). Therefore, it is understandable why it is so important for buildings which are certified with a design-based BPAS to be reassessed or recertified using a performance-based BPAS during their operation stage to validate their predicted performance, which in turn substantiate the buildings’ contribution to sustainability.

In order to ensure a building is built and performed as designed, most of BPASs include an as-built assessment e.g. SBTool, GBI, GBES, LEED, Green Star (except Greenship). In addition, realizing the fact that refurbishment and maintenance of existing buildings are also an important part of a sustainable future, the USGBC (US), BRE (UK), BCA (Singapore), IGBC (India), and GSB (Malaysia) have developed their own system to assess existing buildings. For the same reason, iiSBE (Canada) has incorporated performance-based assessment criteria into their comprehensive SBTool framework. However, the usefulness of the systems in this respect is doubtful as the remedial work needed to make a completed building comply with the environmental criteria may be too extensive, too costly and time consuming (Crawley & Aho, 1999; Lowton, 1997). For example, replacing an existing ventilation system by installing more windows to allow for natural ventilation and daylight may be impractical, difficult, or expensive to facilitate (Ding, 2008). This is because existing buildings, which intend to acquire certification, may not initially be designed according to green or sustainable design principles or obtained a performance certification based on their design quality.

Therefore, the implication of the foregoing discussion on the study, it would seem, is twofold:

- Assessment at the end of the construction/commissioning phase must be allowed to determine whether strategies specified during the design stage were in fact, implemented; and
- Performance-based criteria (e.g. actual energy consumption, and post-occupancy evaluation e.g. users satisfaction) that require assessments based on measurements and/or first-hand observations, must be incorporated in addition to, or mutually

reinforced with, design-based criteria (e.g. potential energy consumption) that requires assessment based on simulations and specifications. Both must work together as a process of continuous improvement.

On top of these, if possible, the study should avoid criteria that describe potentials, procedures or technical solutions that do not necessarily imply a better environmental, social or economic performance and may in fact hinder innovation.

4.5.5.4 Adaptation and Context

In addition to the need to bring broader sustainability and performance-based concerns into the framework, currently there are discussions of the need for a BPAS to be tailored to the regional needs. One of these is related to the issue of cross-cultural transferability between developed and emerging/developing countries. Most BPASs were developed to suit the context of developed countries and for local use and thus lack the adaptability necessary to apply them in other countries. They emerged as a response to the specific needs of buildings and environments in their respective countries of origin.

The differences in priorities between developed and emerging/developing countries have been greatly discussed in Chapter Two. Green building concepts in developed countries is often concerned with maintaining standards of living which differs from the concern of green building concepts in emerging/developing countries i.e. meeting basic human needs (Cole, 2005; Gomes & Gomes da Silva, 2005; Melchert, 2007; Morel*, et al.*, 2001). Likewise, Libovich (2005) believed that nations in the emerging/developing world cannot afford to be looking at environmental performance only as the social and economic problems are at the top of these countries' agendas. As a result, the development of BPASs is becoming necessary in the emerging/developing countries (Libovich, 2005), but sustainability issues in these countries require different models of BPAS (Kunszt, 1998; Sha*, et al.*, 2000).

However, as noted earlier, China and India has adopted the US LEED, whereas Malaysia and Indonesia followed the Australia's Green Star and Singapore's Green Mark. Whilst acknowledging that the adopted systems were customized to suit the local context, the priority issues of these adopted-but-customized systems still reflect those of developed countries, as highlighted in the previous section. Although there are clear benefits associated with such adoption, Theaker and Cole (2001) argue that there is always a danger of homogenization and reduced sensitivity to the need for acknowledging and promoting regionally appropriate design strategies. They further explain that the inappropriate cross-cultural ‘importation’ of specific technical strategies may in the short-term, prove potentially detrimental to environmental progress.

To some extent, the SBTool might provide a solution as it attempts to move away from being a national, or context related system. It does this through avoiding reference to national standards and using internationally accepted methods and units. Also, users with authority are encouraged to adjust the default weights and benchmarks within SBTool to reflect regional variations; however, regional, social and cultural variations are complex and the boundaries are difficult to define. These variations include differences in climatic conditions, income level, building materials and techniques, and appreciation of historic value (Kohler, 1999). There are cultural and social variations between regions and countries, and measuring sustainability may vary from one region to another, even when the same criteria are applied (Todd & Geissler, 1999). On top of this, since the default weighting system can be altered, the results may be manipulated to improve the overall scores in order to satisfy specific purposes (Larsson, 1999; Todd*, et al.*, 2001).

4.5.5.5 Weighting

Weighting has emerged as an important issue when establishing a BPAS (Cole, 1997) and there is a considerable interest within the International Framework Committee (IFC) on the protocols for deriving them and their inclusion in BPASs. Clearly some sustainable building issues are more significant than others – priorities that change over time, from building type to building type, and from region to region. Therefore, different weightings are normally assigned to assessment criteria not only to reflect the differences of their importance in a specific region but also to account for their impact on sustainability issues (Papamichael, 2000). Weighting is inherent to the BPASs, and when not explicitly, all criteria are given equal weights or implicitly weight the criteria by points allocated (Todd*, et al.*, 2001). According to Lee *et al.* (2002), weighting is the heart of all BPASs since it will dominate the overall performance score of the building being assessed.

4.5.5.5.1 <u>Critiques on different scoring approaches</u>

Horvat and Fazio (2005) point out that weightings can be classified into two major categories, namely:

- Pre-weighted credits – such as used in LEED, Green Mark, LEED-India, GBES/ Three Star System, GBI, and Greenship.
- Weighting after scoring – such as used in BREEAM, SBTool, and Green Star.

These two categories of BPASs, according to Chew and Das (2008), and Glaumann *et al.* (2009), are correlated with their methodology of deriving the final single assessment score. The former category for instance, uses a "simple additive scoring methodology" where the total score is derived from just adding up all the points. Whilst the latter uses "hierarchical system with weighting" or "additive weighing scoring methodology," an approach that is more advanced with various systems of scoring and weighting credits in order to establish the priorities among the categories and their impact on the final result of assessment.

There are various pros and cons on these systems as argued in the literature. With regard to the simple additive scoring methodology, it is considered attractive to users and can serve several purposes, including design assistance (Todd*, et al.*, 2001). However, it suffers three major points of criticisms. First, it cannot be modified as easily to reflect regional differences or other concerns (Chew & Das, 2008; Todd*, et al.*, 2001). Second, it has been criticized for supporting 'point chasing' and 'green washing' (Athena Sustainable Material Institute [ASMI], 2002; Cole, 2005; Curwell, 1996; Ding, 2008). This means, users of the system base building component decisions on those that will yield the greatest number of points for the least amount of cost or effort, instead of choosing criteria that will deliver the greatest benefit in the local context or according to the environmental impact (Calkins, 2005; Cole, 2005; Green Building Alliance, 2004; Tian*, et al.*, 2005; Todd & Lindsey, 2000). Glaumann *et al.* (2009) believe that this 'point chasing' practice is partly due to the allocation of similar number of point(s) to multiple assessment criteria even though there are obvious differences in their environmental significance[15]. 'Green washing' however, is attributed to the fact that the system keeps silent the areas of weakness or poor performance (Todd & Lindsey, 2000). This means, even if a building rates poorly on a few key factors such as energy consumption, it can still achieve a high score from meeting other, more marginal criteria[16] (Curwell, 1996). Third, scores are lost for the credits that are beyond the scope of a certain project (Chew & Das, 2008). For example, sustainable site development or provisions related to green vehicles are not feasible in the case of urban infill projects with a well-established public transport system (Chew & Das, 2008).

Clearly, not all assessment criteria are equal in terms of difficulty, cost or relevance to life cycle environmental performance; hence, the allocation of points/credits (the weightings) and their aggregation to determine the final score (grade) has a significant influence on the

[15] USGBC has addressed this problem by increasing the total number of points from 69 to 110 and reweighted credits to reflect environmental priorities in LEED 2009 (v.3).

[16] This flaw has been addressed in LEED 2009 (v.3) by requiring projects receiving certification to provide USGBC actual energy and water usage performance data for at least the first five years of occupancy. This will enable the USGBC to compare actual to predicted building performance, provide feedback about operations to owners, and potentially offer useful feedback to design teams (Reeder, 2010).

relative environmental or sustainability performance of a building. Therefore, the issue of implementation cost and difficulties should be acknowledged in the weighting system (Cole, 1998). This rationale, according to Cole *et al.* (1993), has in fact been incorporated in some of the existing BPASs by giving more credits for a given increment in performance as the overall performance level increased. Further, it has been suggested that points/credits should be awarded based on the cost effectiveness of various strategies in achieving the stipulated performance levels (Lee*, et al.*, 2002).

So apart from noting these issues, the overall discussion also highlights the need for a clear and rigorous methodology not only for weighting various criteria but also for selecting the criteria in the first place. This is crucial to encourage more participation by profit-maximising building owners and developers who would like to be rewarded in proportion to the effort made in achieving a higher level of environmental performance.

4.5.5.5.2 Critiques on methods of establishing weightings

According to Burnett (2007), relative weightings which inform the external environmental impacts are appropriate to be determined by using the life cycle assessment (LCA) methods. Whilst agreeing to this view, Jönsson (2000a) contended that LCA alone cannot determine the weightings for indoor environmental quality issues and other performance issues that fall under the category of services and amenities. In fact, the assignment of weights to the various performance issues is the most contentious part of the framework of any BPAS, as Cole (1998, p.9) notes, “The primary concerns being the absence of an agreed theoretical and non-subjective basis for deriving weighting factors.” Similarly, there is no clear logical or common basis for the way in which the maximum number of points is awarded to each criterion (Ding, 2008).

An example that illustrates this point and further complicates the issue of weighting is the fact that most BPASs award their own points to sustainable building criteria. In other words, different BPASs give different point(s) for the same criterion. For instance, GBI awards one point for using regional materials for more than 20 percent of the total material value, LEED awards the same criterion two points, whereas Green Star and Green Mark do not include this criterion at all. Greenship awards two points but for using 80 percent regional materials instead of 20 percent as stipulated in GBI. Such inconsistencies supports the notion that BPASs use subjective standards in assigning point values to criteria, and do not explicitly state the reasons behind the standards (Soebarto & Williamson, 2001; Zhang*, et al.*, 2006); hence, making the various BPASs extremely difficult to compare (Cole, 1998, p.9).

Despite the fact that there is no definite rule to determine the weightings of sustainable building criteria as noted above, there are three approaches that are commonly used. First is through an industry consensus, used by some organizations such as BRE to inform the weightings within the BREEAM system (AlWaer & Clements-Croome, 2010; Cole, 2003; Dickie & Howard, 2000). In this approach, stakeholders are asked through a survey, to rank various criteria on semantic scale; such as, from not important at all to very important, and seek consensus on broad bases[17]. This ranking or scoring is then used to select the most important elements to be included and to establish weightings (Cole, 2003; Dickie & Howard, 2000). The second approach is also based on consensus but use a simple ranking method through arguing and voting for the weighting of assessment criteria by a panel group as applied in SBTool.

Referring to the above two approaches, Glaumann *et al.* (2002, p.85) note that, “the larger and more diverse a panel group is, the more credible the weights are.” Further, the participation of all decision makers and stakeholders in the establishment of proper levels and weightings could facilitate the process of recognition and incorporation of regional diversities (AlWaer & Clements-Croome, 2010; AlWaer*, et al.*, 2008). The problem with this method is that the importance of certain parameter within BPASs is often a function of the interests of the people involved with its development. For instance, investors tend to be very concerned with economic return, occupants are often concerned with the impacts of buildings on human health, maintenance and operations staffs are concerned with operation and upkeep, and environmental advocates are usually concerned with natural resources and ecosystem impacts (Cole, 1998).

The third approach is to establish weightings following an Analytical Hierarchy Process (AHP) method, which is a mathematical decision-making technique, developed by Thomas Saaty in 1980 (Expert Choice, 2009). According to the Expert Choice website description, AHP is,

> a powerful and flexible decision making process to help people set priorities and make the best decision when both qualitative and quantitative aspects of a decision need to be considered...AHP not only helps decision makers arrive at the best decision, but also provides a clear rationale that it is the best (Expert Choice, 2009).

It,

[17] The BRE engaged sixty participants across seven groups: government/policy makers, construction professionals, local authorities, material producers, developers/investors, environmental groups/lobbyists and academics.

engages decision makers in structuring a decision into smaller parts, proceeding from the goal to objectives to sub-objectives down to the alternative courses of action. Decision makers then make simple pair-wise comparison judgments throughout the hierarchy to arrive at overall priorities for the alternatives (Expert Choice, 2009).

The above three approaches: the semantic scale from not important to very important as in BREEAM, the simple ranking methods as in SBTool, the pair-wise questions as in AHP, have been compared in a study conducted by the Centre for the Built Environment, University of Gavle (Westerberg, 2000). It was found that “the individual results differed depending on the scale used and as a whole there was little accordance in the answers.” With regard to AHP approach, it was revealed that, “almost 50% of the answers turned out to be unacceptably inconsistent according to the AHP inconsistency test.” Further, “the pair-wise questions were reported to create an uncomfortable feeling of answering inconsistently” and the method “has been criticised for its linear scale, which does not correspond to many people’s mental scale, which is supposed to be logarithmic” (Westerberg, 2000, p.751). Finally, the research showed that “just rating on a semantic scale gave the least distinct but probably most reliable result” (Westerberg, 2000, p.751). If this is the case, then it is sensible to adopt the second approach for the purpose of this study.

4.6 Requirements for Developing the Malaysian Assessment Framework

As highlighted earlier, BPASs potentially fulfil a number of important roles that a emerging/developing country such as Malaysia should learn from. However, it was also noted that Malaysia has already had its domestic system called GBI currently implemented in its market; hence, one might wish to argue the need for developing another building assessment framework as aimed in this research. It is acknowledged however that in some cases, such as Hong Kong and North America, there are two or more BPASs coexist within the same market (Cole, 2006b). Inevitably, debates have emerged either favouring the coexistence of systems or vice versa. On the positive side, Cole (2006b, p.367-8) agreed on three points: 1) multiple systems in practice in the same country can act as a driver for innovation; 2) a single system is difficult, if not impossible, to address many conflicting goals and cater different stakeholder interest; and 3) a single system stagnates intellectual debate and creates a condition of market ‘lock-in’, particularly when the present system focuses on green issues rather than addressing broader considerations of sustainability; thereby constraining those who wish to extend the scope. Further, “there is not, to date, a method or technique which can be considered as the best one in any situation" (Bentivegna, 1997, p.33).

On the contrary, multiple systems might also confuse the market by sending mixed messages, and they require design professionals to be familiar with multiple assessment systems (Cole, 2006b). Cole (2006b) further clarified that this can be avoided if the alternative system is introduced timely i.e. when the green building market has matured, primarily because by this time, green building community have started to become more cohesive and their differences of opinions began to become apparent. This argument is in line with Zimmerman and Kibert (2007) who predict that the leading 25% of the target market for LEED have now become more familiar with the environmental issues; and may be ready for a more sophisticated inclusion of environmental principles within the tool. In introducing alternative systems, Cole (2006b, p.368) reminded that they will have to be differentiated in at least one of the following ways: 1) serve better the needs and constraints of different occupancy types, stakeholder groups, life cycle stages, region, etc.; 2) easier to use for clients; 3) easier and more efficient to administer; or 4) offer a qualitatively different scope. Clearly, an alternative BPAS should be encouraged in the given market.

Therefore, based on the synthesis of all findings from the literature review so far, the development of the MOBSA framework should be guided by the following requirements:

1. **Embracing the holistic concept of sustainability and addressing the priorities of emerging/developing countries (Chapter Two), and reflecting the current trend of BPASs in moving towards having broader scopes (Section 4.5.5.2);**

   Accordingly, the formulation of criteria within the MOBSA framework should incorporate the following two recommendations:

   - International Organization for Standardization (ISO)[18] (ISO/TS 21929-1, 2006`) notes that all aspects of sustainable development are inter-related; hence, certain issues should be given attention when analysing the sustainability of a building as a whole as illustrated in Figure 4.1.

[18] The ISO has undertaken intense efforts to standardise and make transparent the description and assessment of the environmental performance of buildings. This is mainly due to an extremely inconsistent use of assessment criteria and indicators within existing BPASs (Lutzkendorf, 2005; Lutzkendorf & Lorenz, 2006). ISO Technical Committee (TC) 59 "Building construction" and its Subcommittee (SC) 17 "Sustainability in building construction" have published two technical specifications ISO/TS 21929-1:2006 (ISO/TS 21929-1, 2006) and ISO/TS 21931:2006 (ISO/TS 21931-1, 2006).

NOTE:
This figure is included on page 123 of the print copy of the thesis held in the University of Adelaide Library.

Figure 4.1: Aspects of sustainable buildings. Source: ISO/TS 21929-1 (2006)

- Lutzkendorf and Lorenz (2005) recommend taking into account and gearing to methodological basics for a combined assessment of environmental, social and economic issues as formulated in ISO CD 21931-1 (ISO/TS 21931-1, 2006) and other ISO documents, for the further development of BPASs. This will substantially increase the systems' comparability and allow for more robust benchmarking of assessment results (Lutzkendorf & Lorenz, 2006). The framework of environmental, economic and social indicators as specified in ISO/TS 21929-1 (2006) is summarized in Table 4. 8

Table 4.8: Framework of sustainability indicators as specified in ISO/TS 21929-1

Environmental Indicators	**Economic Indicators**	**Social Indicators**
	General Meaning	
Address an environmental aspect in terms of either environmental loadings or environmental impacts.	Indicate the monetary flows connected to the building during its life cycle.	Describe how buildings interact with sustainability concerns on the community level.
	Main Indicators	
Two types of environmental aspects: • Environmental loadings (The use of resources and the production of waste, odours, noise and harmful emissions to land, water and air) • Environmental impacts (Classes of issues of environmental concern include depletion of renewable and non-renewable resources)	Three considerations in assessing the life cycle economy of buildings: • Life cycle costs on the basis of investment, use, maintenance and repair, deconstruction and waste treatment. • Potential income which depends on: o the building conformity o the building performance o the ability to implement planned periodic building maintenance while minimising the disruptions of the services provided. • Value development during the	Three levels of social aspects: • Community-level (Community concerns that have relevance on buildings and their location) *E.g. urban sprawl, mixed use land, access to services and public transport, social segregation, safety, protection of cultural heritage.* • Building-level (Health and safety of building users, barrier-free use of buildings, user satisfaction, space planning to support social cohesion)

	service life of the building o development of the economic value of a building, and o revenue generated by the building and its services.	• Process-related issues (Indicate the social sustainability of construction process) *E.g. cooperation with building users and neighbours, support social cohesion in the process*
	Consequential indicators	
I.e. Aspects that influence consequentially the amount of environmental loading or environmental impacts.	I.e. Have an influence on the life cycle costs or life cycle economy of the observed building.	Nil
	Other considerations	
Consider the life cycle of the building	Balance the long-term and short-term economic aspects.	Nil

2. **Acknowledging the local context (Chapter Three);**

   On top of learning from the strengths and weakness of existing BPASs, criteria within the MOBSA framework should reflect the local conditions and constraints.

3. **Linking across varying spatial scales (Section 4.5.5.1);**

   This means the spatial scales at which the whole criteria in the MOBSA framework are assessed must not only regard for building and site impacts, but off-site and global impacts as well.

4. **Addressing all building life cycles, and incorporating both potential and actual performance assessments (Section 4.5.5.3);**

   An ideal building sustainability assessment framework will include all the requirements of the different stakeholders involved in the development (Cole, 1998) and effectively influence the decision-making processes occurring at every level and stage of the building process (Kaatz, Root, & Bowen, 2005). These requirements are illustrated in an ISO standard (ISO/TS 21931-1, 2006) as shown in Table 4.9. Specifically, actual performance assessment and post-occupancy evaluation (POE) should be incorporated in addition to potential performance assessment. Realizing the fact that the lack of knowledge on sustainability is paramount among the Malaysian building stakeholders (as revealed in Chapter Three), it is important for the proposed MOBSA framework to also address POE as a means to encourage a continuous learning process.

Table 4.9: Interests of the intended users of the assessment information and intended life cycle stages. Source: ISO/TS 21931 (2006, p.9)

NOTE:
This table is included on page 125 of the print copy of the thesis held in the University of Adelaide Library.

5. **Anticipating the potential unavailability of the country's specific data (Chapter Two);**

   In other words, the country's specific data might not be available[19] in order to define performance benchmarks of certain selected criteria, which in turn impede the assessment of such criteria. Therefore, it is crucial for the study to test the sensitivity of the criteria that suffer missing data for the purpose of assessment as an integral component of the MOBSA framework.

6. **Involving participation of local building stakeholders through communication and dialogue, commitment and cooperation (Chapter Two);**

   As Kaatz *et al.* (2005, p.448) note:

   > Stakeholders provide valuable input into the process of identifying significant issues to be assessed, setting targets and, most importantly, establishing project values. Empowerment through participation and knowledge exchange is another significant spin-off. Moreover, catering to stakeholder participation can make building assessment more context-sensitive, effective, and practical.

   This means, stakeholder participation is essential for the successful implementation of MOBSA framework as it contributes to the market acceptance and support from the industry (Cole, 2004).

[19] Examples include lack of energy codes or national standards on whole building performance, lack of climatic data, outdated existing standards, and lack of LCA data (Strand & Fossdal, 2003). Other specific data may include impacts of the construction industry, such as energy and water consumption, the generation of waste and pollution, job creation and economic contribution of the industry.

4.7 Conclusions: Tentative Malaysian Office Building Sustainability Assessment (MOBSA) Framework

This chapter has outlined the development of BPASs, discussed their intended role in the building sector, and comparatively reviewed nine existing BPASs from developed and emerging/developing countries. It was revealed that widespread use of existing BPASs in developed countries is an important agent to transform the market by stimulating demand for environmentally sensitive buildings. However, these systems are inappropriate in respect of the objective set for the assessment framework by this study, namely to create a basis "that enables sustainability to be addressed and incorporated in office building development, relevant to emerging/developing countries, particularly the Malaysian context."

The reason for this lies in the fact that they do not take into account the particular non-environmental priorities that exist in emerging/developing countries. For example, they lack the capacity to reward job creation for local people, usage of semi-skilled labour, improved safety and security aspects, and enhanced knowledge and awareness. The review also indicates that they do not fully reflect the shift in emphasis from environmental impact to sustainable development that has occurred. Even though SBTool addresses all three dimensions of sustainable development, certain issues that are the priorities in emerging/developing countries, such as communication at the site and community levels or collaboration between various actors and participation of affected community in the development process, are still missing. Nonetheless, SBTool is valuable to provide a reference point for developing a more contextual system, as aimed in this study.

It was also found that the priority issues of BPASs from emerging/developing nations reviewed in this chapter still reflect those of developed countries. This can be attributed to the fact that these emerging/developing countries used existing BPASs from developed countries as the sole references for the development of their own BPAS. However, regardless of the origin of these BPASs, much can be learnt from them for the study. As a result, 102 criteria have been identified and they are grouped under 17 sub-issues and further sub-divided into three Issues i.e. Environmental, Social and Economic, presented in the form of tentative MOBSA framework, as shown in Table 4.10.

Table 4.10: Tentative Malaysian Office Building Sustainability Assessment (MOBSA) Framework

Issue	Sub-Issue & Scale	Criteria
SOCIAL		
	EDU: Education and Awareness	
	O	**Increase participation of tenants** in conserving energy and water as well as reducing waste
	O	Improve **knowledge on sustainable development issues among design team members**
	O	Improve **skills and knowledge of maintenance and operation staff**
	O	Improve **sustainable construction skills among construction workers**
	B	Provide **spaces for education** (e.g. library/reading area)
	COH: Support for Social Cohesion	
	O	Support for **inter-disciplinary work** between architects, engineers, costing specialists, operation people and other relevant actors right from the beginning of the design process
	C	Provide **mixed uses within the project** (e.g. 3-living concept of work, stay and play) to support active streetscape and to reduce the need for commuting transport
	B	Balance between provision of workspaces and **common spaces for social interaction**
	O	Increase **involvement of users** in development process to ensure users' requirements are met
	O	Increase **participation of affected community** in development process
	ACC: Accessibility	
	B	Maximize **personal safety and security** for users to access and use the building
	C	Select sites that are **easily accessible/walking distance to nearby services** (e.g. shops, banks, post office, clinics, eating outlets etc.)
	B	Easy **access to building technical systems** for repair and maintenance
	B	Adequate **access to communication technology** (e.g. internet, telephone, video-conferencing)
	B	**Easy to clean the building facades** and other elements or design (or consider self cleaning facades)
	INC: Inclusiveness of Opportunities	
	B	Ease of **access for disabled** persons (e.g. entry points, routes, changes in level, washrooms)
	B	Provide **facilities for users to perform religious and spiritual quotient** (e.g. praying room and ablution areas)
	B	Provide **facilities for users with children** (e.g. play room/area, child care/nursery, mother's room)
	HUM: Human Health and Well-being	
	B	Provide **separately ventilated and isolated areas/rooms which generate pollutants** (e.g. copier rooms, waste storage areas, janitorial rooms)
	B	Maximize level and quality of **fresh air** in the ventilation systems
	B	Appropriate **illumination level and lighting quality** in public and work areas
	B	Use interior finish **materials** (e.g. solvents, paints, adhesives, carpeting, particleboard) **with low- or zero-pollutant off-gassing**
	B	Provide **recreational facilities** (e.g. gym, sports facilities)
	B	Provide **separately ventilated rooms/areas for tobacco smoking**
	B	Minimize **noise level** and provide satisfactory level of **acoustic performance**
	B	Adequate **monitoring of occupants' satisfaction** with indoor environmental quality (i.e. thermal, visual and acoustic comfort)
	B	Provide **carbon dioxide monitoring and control system** for main occupancy areas
	B	Use **low/zero pollutants cleaning and maintenance products and processes**
	B	Maximize **visual access to exterior views** or view to an atrium from workstations
	B	Adapt practices that **avoid construction accidents**
	B	**Prohibit tobacco smoking** in the building
	B	Minimize **glare conditions** in main occupancy areas
	CUL: Cultural and Heritage Aspects	
	C	Compatibility of urban design and building architecture with **local cultural values** (functionality and aesthetically)
	B	Maintain the **heritage value of existing buildings** for refurbishment project (i.e. new features, systems and materials are consistent with the character of the original design of the heritage building)
	C	Preserve **characteristics of existing streetscapes** (in features such as height, bulk, set back from street, window size and height, colour or type of materials)
	LOC: Local People and Employment	
	C	Provide **training opportunities for local people** to be future skilled construction workers
	C	Increased use of **locally available materials**
	C	Use experienced **local design teams**
	C	Use experienced **local contractors**
	C	Use **local labour**
	C	Linkage to **local service providers**
ENVIRONMENTAL		
	ECO: Land use and Impacts on Ecology	
	S	Minimize **ecological and other damage** to existing soil, water bodies and flora and fauna of the site or adjacent lands due to the construction process

S	Maximize **potential for green/open spaces** on the site for informal recreation
S	Improve **ecological value of natural landscape** (i.e. diversity of the plantings and use of native species from the area)
C	Redevelopment of used/**brownfield site** rather than green field
C	Select **sites that are within urban areas** with existing infrastructure
C	Select **sites that have low ecological value or in non-sensitive areas**
SRM: Supports Resource Management	
G	Increase use of **materials that have less environmental impact in producing them**
B	Use **durable materials** that require less maintenance (for non-structural elements)
B	Increase use of **bio-based products and materials** obtained from managed/sustainable sources (e.g. certified wood)
B	Increase use of **materials that can be recycled**
B	I Increase use of **products and materials with recycled content** (e.g. fly-ash concrete, recycled concrete, reconstituted timber, steel etc)
AIR: Emissions to Air	
C	Select **sites that are near to public transport stops**
C	Provide **connection from building to existing public transportation network** (e.g. footbridge, covered walkway etc.)
S	Provide only **minimum allowable parking spaces**
C	Availability of **pedestrian access between building and basic services** (e.g. shops, banks, eating outlets)
G	Reduce **greenhouse gas emissions** from all energy used for **building operations**
C	Select **sites that are reasonably near residential zones**
S	Provide **more than minimum allowable motorcycle parking spaces** to discourage the use of cars
LAN: Emissions to Land/ Solid Waste	
B	Implement **construction waste management program** with sorting, reuse and recycling measures
B	Provide **spaces for collection of recyclables** (e.g. paper, cardboard, metal, glass and plastic), recycling storage and staging areas in the building
B	**Reuse of suitable existing structure(s)** on the site, as part of the new project
B	**Design for easy disassembly of components** – so that they can be reused or recycled at the end of the service life of the components
B	Increase use of **salvaged, refurbished or used materials** from off-site sources (e.g. used timbers or bricks, refurbished office furniture, fixtures, windows, doors, carpet etc.)
S	Increase the practice of treating **land-clearing debris as a resource**
B	Minimize **use of interior finishing materials** to minimize the direct and indirect consumption of resources
EWA: Emissions to Water	
C	Selection of **site with optimum distance from water body** to reduce the risk of water contamination
C	Implement **stormwater management strategies** to control the quantity and quality of stormwater runoff, hence preventing flood and soil erosion
S	Utilize **on-site wastewater treatment systems** using **grey water** (e.g. from shower, sinks, condensate from cooling towers) for non-potable uses (e.g. site irrigation, toilet flushing)
S	Utilize **on-site wastewater treatment systems** using **black water** (e.g. from toilets) for non-potable uses (e.g. site irrigation, toilet flushing)
ADJ: Impacts on Adjacent Properties	
C	Minimize **light spillage from exterior lightings** into the atmosphere
C	Reduce possibility of **overshadowing adjacent properties**
C	Reduce **potential glare to adjacent propertie**s (e.g. by limiting the use of reflective glass on building façades)
C	Reduce impact of **excessive wind conditions** near the ground floor of high buildings
ENE: Non-renewable Energy Consumption	
B	Use **energy efficient light fixtures and office appliances**
B	Use **highly efficient ventilation and air-conditioning systems**
B	Use **passive cooling strategies** i.e. design of the building's cooling and ventilation systems relying on sunlight, wind, vegetation and other naturally occurring resources on the building site)
B	**Optimise daylighting** in permanently occupied spaces
B	Reduce fossil fuel **energy consumption for building operations**
S	Provide **on-site power generation systems** (e.g. photovoltaics)
B	Use **dimmable** and/or **auto-sensored lighting system** (i.e. controlled according to daylight availability and/or occupancy)
B	Install **energy sub-metering system** for each floor/section/tenancy to monitor energy consumption
B	Facilitate **personal control** of the lighting and thermal comfort systems by occupants
B	Minimize energy transmission through the building skin by a **tight, thermally resistant envelope**
WAT: Potable Water Consumption	
S	**Harvest rainwater** for later re-use to reduce the potable water consumption
B	Use **water efficient plumbing fixtures and appliances** (e.g. low-flush toilets, air entraining taps and shower heads)
S	Minimize **use of potable water for landscaping irrigation**
B	Minimize **use of potable water for cooling system**
B	Minimize **use of potable water for the testing of fire fighting system**
B	Install **water meters** for all major water uses in the project to monitor water consumption and to locate any leakages in the pipe lines

ECONOMIC	
TBL: Triple Bottom Line Accounting – Planet, People, Profit	
B	Minimization of **payback period**
B	Increased **rental/market value** or higher overall property **investment returns (ROI)**
B	Consider both **capital/construction cost, along with long-term operational costs** for both tenant-occupied and leased office building
O	Conduct **triple bottom line (TBL)** to the project (TBL refers to the notion that organisations are responsible for social and environmental in addition to financial outcomes of the project)
O	Conduct **Risk Analysis**
EEF: Efficiency, Effectiveness and Flexibility	
B	Develop and implement a **long-term maintenance management plan** for efficient building operation
B	Provide and operate an effective **facility management control system** to maximize the operational efficiency of building systems (e.g. HVAC, lighting and vertical transportation systems)
B	**Maximize workspace/directly functional area to total floor are ratio** (i.e. Net Letable/ Leasable Area)
S	Maximize **plot ratio** to generate denser development (i.e. ratio of the total floor area to the total site area as permitted by the local authority)
B	**Space planning for maximum flexibility** for different users/requirements
B	Provide **building services systems with maximum flexibility** for different users/ requirements
B	**Structural design with maximum adaptability** for new uses

Note:
G = Global level: *Impacts on resources specifically identified to be global;*
C = Community and regional level: *Impacts on the neighbourhood, community and region;*
S = Site level: *Site-specific attributes;*
B = Building level: *Certain construction techniques, attributes of buildings, or types of building materials;* and
O = Other: *Criteria that do not fit the above.*

The above tentative framework has been developed solely based on the literature reviewed so far. For instance, sustainability issues and sub-issues were derived from the conclusion of Chapter Two (also refer to the extraction, summarization and categorization of the most relevant statements of *Johannesburg Plan of Implementation* provided in Appendix A-5). Performance criteria were derived from the exploration of key priorities of emerging/developing countries in general (Chapter Two), the Malaysian context in particular (Chapter Three), as well as existing BPASs (this chapter). However, it should be noted that it is in no way comprehensive, since there is always advancement in sustainable technologies and theories.

The distribution of these 102 criteria by spatial scales i.e. global, community and regional, site, building, and other levels (refer to Table 4.4 on how the spatial scale of each criterion was determined) are shown in Figure 4.2. Similar to all BPASs reviewed in this chapter, the figure indicates that the Tentative MOBSA framework also contains most criteria at the site scale or smaller (67%). If referred back to Table 4.5, this percentage however is lower than all BPASs reviewed. Put differently, the MOBSA framework has higher percentage of criteria at the community/regional scale and above (24%) compared to all of the reviewed BPASs.

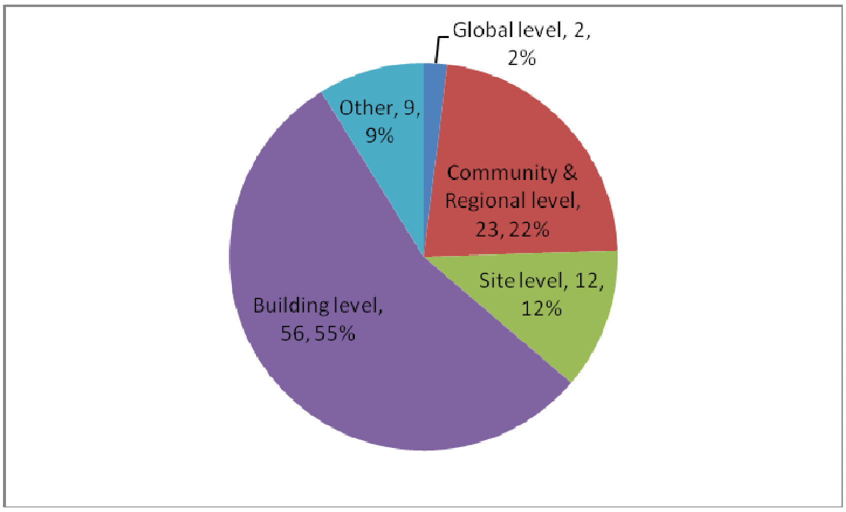

Figure 4.2: Distribution of criteria (within the Tentative MOBSA Framework) by spatial scales

Relying only on the current practice is however a doubtful approach when selecting criteria as some might require reformulation or new criteria may be needed to take into consideration the specificity of the context in which they are applied. This refining process, as noted earlier, should involve local stakeholders' participation to ensure the market acceptance and support from the industry. The next chapter will therefore discuss the methodology of the study that ensures views from Malaysian building stakeholders are incorporated in all stages of refining/developing the tentative MOBSA framework.

Chapter 5: Methodology

5.1 Introduction

Beyond the literature reviewed so far and the tentative MOBSA framework proposed in the previous chapter, there still needs to be considered a theoretical framework on how to proceed with the research, particularly in exploring what would be the form of an assessment framework specifically relevant to the Malaysian context. To address this overarching research question, mixed methods approach has been employed, particularly using the exploratory sequential design.

In understanding the choice of this approach to research, this chapter considers three framework elements as suggested by Creswell (2003, p.3): 1) philosophical assumptions about what constitutes *knowledge claims*; 2) general procedures of research design; and 3) detailed procedures of data collection, analysis, and writing, called *methods*. Therefore, this chapter first provides the rationale of mixing qualitative and quantitative methods, followed by clarifications on the philosophical assumptions of the study. It then clarifies the choice of exploratory sequential design as well as its specific *methods* of collecting and analysing the data. The final part provides a visual model that summarises the mixed methods procedures used in the study.

5.2 About Mixed Methods Research

The study used a mixed methods approach, which is defined by Creswell *et al.* (2003, p.212) as "the collection or analysis of both quantitative and qualitative data in a single study in which the data are collected concurrently or sequentially, are given a priority, and involve the integration of data at one or more stages in the process of research". The rationale for mixing both kinds of data within one study is that neither quantitative nor qualitative methods are sufficient, by themselves, to capture the trends and details of a situation, such as the complex issue of local stakeholders' concerns in pursuing sustainable built environment. When used in combination, quantitative and qualitative methods complement each other and provide a more complete understanding of the research problem (Greene*, et al.*, 1989; Tashakkori & Teddlie, 1998). Creswell and Plano Clark (2011, p.8) pointed out that mixed methods are suitable when,

> one data source may be insufficient, results need to be explained, exploratory findings need to be generalized, a second method is needed to enhance a primary method, a theoretical stance needs to be employed, and an overall research objective can be best addressed with multiple phases, or projects.

However, Teddlie and Tashakkori (2003, p.3) noted, "the [mixed methods] field is just entering its 'adolescence' and identified research design issues as one of the unresolved issues and controversies in the use of mixed methods research. This form of research also poses certain challenges for the researcher. These include the need for extensive data collection, the time-intensive nature of analysing both text and numeric data, and the requirement for the researcher to be familiar with both quantitative and qualitative forms of research (Creswell, 2003).

5.3 Philosophical Assumptions

Mixed methods research is one in which the researcher tends to base knowledge claims on pragmatic grounds (Creswell, 2003). They are based on a view of knowledge as being both socially constructed and based upon the reality of the world we experience and live in (Johnson*, et al.*, 2007). The philosophical underpinning of pragmatism allows and guides mixed methods researchers to use a variety of approaches to answer research questions that cannot be addressed using a singular method.

However, following Creswell (2011), this study attempted to "mix" different paradigms that relate to the usage of exploratory sequential design. Specifically, during the first phase of the study i.e. qualitative phase, the work was undertaken from constructive principles to value multiple perspectives from different stakeholders and deeper understanding of sustainable development issues in Malaysia. When the study moved to the quantitative phase, the underlying assumptions were shifted to those of postpositivism to guide the need for identifying and measuring sustainability criteria and statistical trends.

5.4 Exploratory Sequential Research Design

Creswell and Plano Clark (2011) identified the six major and most often used mixed methods research designs: convergent parallel, explanatory sequential, exploratory sequential, embedded, transformative, and multiphase. In an exploratory sequential design, which is used in this study, the qualitative, text, data is collected and analysed first, while the quantitative, numeric, data is collected and analysed second in sequence.

The purpose of exploratory design is “to use the results from one method to help develop or inform the other method” (Greene*, et al.*, 1989, p.259). In this case, the results from qualitative exploratory study were used to inform the development of quantitative instrument. This means, there is a direct interaction between the qualitative and quantitative strands of the study. This design is particularly useful when the researcher has to develop a new instrument (Creswell, 2003), such as in this case, a survey questionnaire on ‘Office Building Sustainability Assessment Framework for the Malaysian Building Sector’. Within this study, it would be unfeasible to finalize a questionnaire design; since the Malaysia specific criteria of sustainable office buildings were not sufficiently understood. The qualitative study, then, explored, identified and provided clarity about the extent of sustainable building practices among stakeholders to inform relevant criteria requiring further investigation involving larger sample in the population. Therefore, the in-depth knowledge of social context acquired though qualitative research could be used to inform the design or modification of survey questions for self-completion questionnaire (Bryman, 2008).

The priority (Creswell & Plano Clark, 2011) in the study was given to the qualitative approach as it focused on in-depth exploration of issues, involved two-stage data collection (i.e. interview and focus groups) and two-level case analysis (i.e. individual cases and across cases). The quantitative approach on the other hand, focused primarily on assigning the weighting levels for the finally selected criteria. Further, this phase of data collection was limited to one source, i.e. a cross-sectional survey, and the data analysis employed only two statistical techniques: univariate and bivariate analysis.

The qualitative and quantitative phases were connected during the intermediate stage in the research process i.e. the modification of an instrument. The results from both phases were then mixed or integrated, particularly during the interpretation of the outcomes of the entire study. The general steps of this design are illustrated in Figure 5.1, adapted from Creswell (2003), where capitalization indicates an emphasis or priority on the qualitative data and analysis in the study.

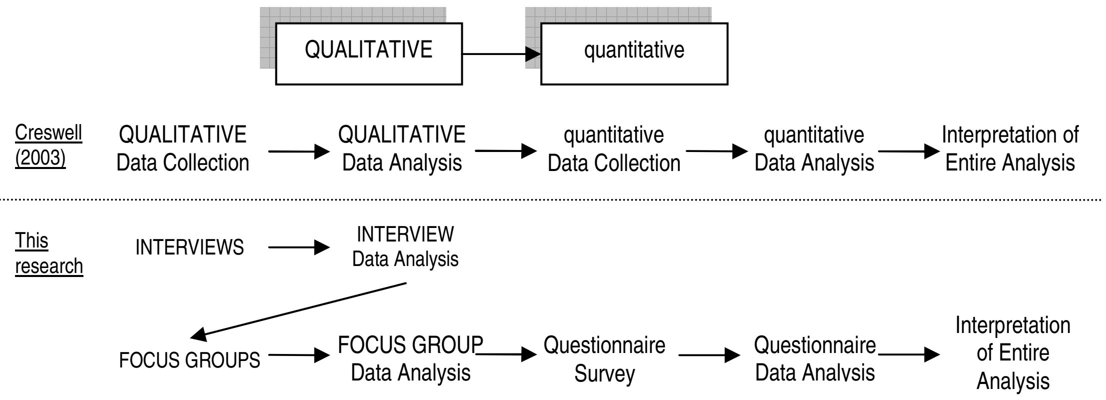

Figure 5.1: Steps of exploratory sequential design. Modified from Creswell (2003).

5.5 Research Methods

The purpose of data collection in a mixed methods study is to develop answers to the research questions (Teddlie & Yu, 2007). Therefore, in order to address the research questions in Chapter One, data collection and analysis methods engaged in this study were conducted sequentially in four phases, in the following order:

- Phase 1a: Stage 1 qualitative data collection and analysis
- Phase 1b: Stage 2 qualitative data collection and analysis
- Phase 2: Connecting qualitative and quantitative phases
- Phase 3: Quantitative data collection and analysis
- Phase 4: Integration of the qualitative and quantitative results

5.5.1 Phase 1: Qualitative Data Collections and Analyses

The goal of the qualitative phase was to discover what local stakeholders believe a MOBSA framework should measure. There are currently no sufficient data on the perception of building stakeholders about sustainable development and sustainable office buildings in Malaysia; hence, this study is new and exploratory. Therefore, a qualitative study is deemed to be the preferable approach to generate the essential data for analysis and this was conducted in two stages, namely: 1) interviews, and 2) focus groups discussion, which are discussed below.

5.5.1.1 Stage 1: In-depth, semi-structured, open-ended interviews

Patton (, p.348) states that “the purpose of qualitative interviewing is to capture how those being interviewed view their world, to learn their terminology and judgments, and to capture the complexities of their individual perceptions and experiences.” Thirty stakeholders involved in the local construction industry were purposefully selected as participants. They included consultants, developers/owners, builders, facility managers, regulators/policy makers currently practicing in Kuala Lumpur, Selangor and Putrajaya. The purposive sampling, particularly judgement sampling, was used to provide the means to investigate a specialized population of stakeholders who have experienced in the relevant field for more than ten years. According to Neuman (2006), purposive sampling provides information-rich, key informants for in-depth study and the opportunity to gain insight and understanding from well-situated participants. In this study, they were asked about their perceptions of the extent of sustainable development being practiced in Malaysia, their views of sustainability, and their current challenges in playing a better role, as well as their aspirations to promote sustainable office buildings development in the country. A sample size of 20 to 30 is deemed adequate to enable internal generalization in a qualitative study (Creswell, 2002; Gay, 1996; Leech, 2005). However, the findings may not be employed to make inferences on other construction industry stakeholders not included here.

Each interview, which last for approximately 45 minutes, was digitally recorded and transcribed verbatim. The data from the interviews were then analysed using content analysis which is a process of “identifying, coding, categorizing, classifying and labelling the primary patterns in the data” (Patton, 2002, p.463). Berelson (1971, p.147) states that the formulation and the definition of appropriate categories take on central importance in content analysis, and the “content analysis stands or falls by its categories.” He also suggests that “categories are most appropriately designed in terms of the particular problem under investigation” (Berelson, 1971, p.148). In this study, the emphasis is on the “substance” rather than the “form” of expression. This analysis process was done conventionally without the use of any software programme. The verification procedures included member checking, rich and thick descriptions of the cases, presenting negative or discrepant information that runs counter to the themes, and academic adviser’s auditing (Creswell, 1998; Creswell & Miller, 2002).

These findings substantiate and fine-tune the tentative MOBSA framework developed through literature review. Therefore, the product of this first stage of qualitative phase is the Stage-1 MOBSA framework. Detail explanations of the participants’ selection criteria, instrumentation, ethical issues, data collection, and data analysis are provided in Chapter Six.

5.5.1.2 Stage 2: Focus groups discussion

Various definitions of focus groups appear in the social science literature, but most share common elements, i.e. they are small groups of people, who posses certain characteristics, and who meet to provide data of a qualitative nature in a focused discussion (Krueger & Casey, 2000). Focus groups explicitly use group interaction or synergy as part of the method where people ask questions, exchange anecdotes and comment on each others' experiences and points of view (Kitzinger, 1994) to produce data and insights that would be less accessible without the interaction found in the group (Kitzinger, 1995; Morgan, 1998). A moderator, who leads the group through a number of topics and activities, guides the discussion (Tashakkori & Teddlie, 2003`).

Focus group approaches are reported to be flexible: “There is nothing sacred, or even necessarily correct about the way that focus groups are conducted” (Morgan, 1998, p.255), and dynamic: “Focus group research is certainly not static, and the approach and methodology are constantly changing” (Krueger & Casey, 2000, p.ix). Morgan (1997) suggests that the simplest test of whether focus groups are appropriate for a research project is to ask how actively and easily the participants would discuss the topic of interest.

The focus group method has only recently been applied into social research (Bryman, 2008). It is particularly suited to exploratory and formative research, generating and formulating hypotheses, and exploring beliefs, experiences, opinions, values, and concerns of research participants within their own perception system (Kairuz*, et al.*, 2007; Kitzinger & Barbour, 1999; Krueger & Casey, 2000). According to Tashakkori and Teddlie (2003, p.309), focus group can be used to “inform the development of questionnaires and interviews” or “later in a sequential mixed methods research study to help researchers better understand and interpret information and findings resulting from the earlier use of other data collection methods” (Tashakkori & Teddlie, 2003, p.309). However Greenbaum (1998, p.69) reminded that “focus group methodology is not designed to provide projectable results to a larger universe because the participants are not necessarily selected at random and because the sample size of the groups is small.”

Most focus group studies use purposive sampling frames where participants may be “drawn together specifically for the research” (Wilkinson, 1999, p.222), or selected to reflect a range of the total study population (Kitzinger, 1995). A purposive sample “targets individuals who are particularly knowledgeable about the issues under investigation" (Chambliss & Schutt, 2009, p.123). Therefore, 38 experts from various backgrounds of the built environment were purposefully selected as participants of a focus groups discussion. These experts consisted of government officials/policy makers/regulators, academicians, design consultants, contractors, property developers and others.

Six focus groups were used, mainly based on six sustainability areas identified in the research. Therefore, the average number of participants in a group was six with one of them being the group moderator. Each group was ensured to comprise people from the same area of expertise but at the same time diverse in terms of their individual profession. Each focus group was asked to seek through consensus the essential criteria to be included in the MOBSA framework by retaining, adding, omitting or modifying the criteria identified in the Stage-1 MOBSA framework. This decision was recorded by indicating the level of importance of each criterion based on four-level of Likert-type scales. The reason(s) for acceptance or rejection, and the basis of modification were also requested. Next, the groups were asked to propose the minimum performance targets or benchmarks for the criteria derived above which are considered important and relevant to the local context.

All results of the discussion were recorded manually and electronically. The data was compiled and analysed to inform on how the Stage-1 MOBSA framework should be refined. Since each group's findings were based on consensus and distinctive, no statistical software programme was used in the analytical process. As a result, 120 performance criteria across seventeen sub-issues were identified and Stage-2 MOBSA framework was subsequently developed as the product of this stage. Detail explanations of the group composition, the running of the focus groups, and data analysis are provided in Chapter Seven.

5.5.2 Phase 2: Connecting Qualitative and Quantitative Phases

Subsequently, it is important for mixing the qualitative and quantitative strands within the mixed methods design (Creswell & Plano Clark, 2011). Therefore, the mixing occurred at two points during the study's research process: data collection, when the second set of data was collected; and interpretation, when both sets of data had been collected and analysed. This phase concerns the former point, whereas the latter is explained as Phase 4 in Section 5.5.4.

Mixing the qualitative and quantitative strands during data collection involved a strategy of “connecting” (Creswell & Plano Clark, 2011, p.66) where the results of one phase build to the collection of the other type of data. In this study, the connection occurred when the findings from the qualitative phase were utilized for modifying an instrument for the second, quantitative phase. This instrument was first developed based on findings from literature, before the qualitative phase was conducted; and subsequently revisited in this phase for final modification.

The main source of, or the basis for, the modification of the instrument was the Stage-2 MOBSA framework which is the product of the qualitative phase. Specifically, the modification was done by retaining, adding, omitting or modifying the criteria listed in the instrument, following the Stage-2 MOBSA framework. However, despite the fact that some criteria were suggested to be omitted by the focus groups (Phase 1b: Stage 2), a few of them were retained in the instrument – based on the presence of any reason(s) for the omission or the validity of the reasons provided – in order to have them rated by a larger sample. Hence, the results of the sample have much validity (Bryman, 2008).

The goal of the quantitative phase was to determine the relative importance (or weightings) of the criteria, identified in the qualitative phase of the study, as perceived by a larger sample of various local building stakeholders. As Morgan (1998) noted, exploratory sequential design is appropriate to be used to generalize qualitative findings to different samples. Additionally, the quantitative results in this study are not only valuable in reducing the huge number of criteria listed in the Stage-2 MOBSA framework to the most important and relevant ones, but they also significant in enlightening the appropriate direction of implementing assessment systems in Malaysia.

5.5.3 Phase 3: Quantitative Data Collection and Analysis (Questionnaire Survey)

The quantitative data was collected via a questionnaire survey, using a self-developed and pilot-tested instrument. According to Babbie (1995, p.257), survey research is “probably the best method available to the social scientist interested in collecting original data for describing a population too large to observe directly”; and “it is especially appropriate for making descriptive studies of large populations”. Salant and Dillman (1994, p.27) suggest that survey research is used to “estimate the characteristics, behaviours, or opinions of particular populations.” The survey research used cross-sectional survey design which collected measures from at least two groups of people at one point of time and compare the extent to which the groups differ on the dependent variables (de Vaus, 2002).

Pilot study was conducted prior to final administration of the questionnaire survey involving 11 participants selected using non-random sampling. According to de Vaus (2002), and Chambliss and Schutt (2009), non-random sampling is appropriate in the preliminary stages of research, such as testing questionnaires. However, the pilot sample was not selected again for the final survey.

The final questionnaire form consisted of four parts i.e. (1) background; (2) sustainability awareness; (3) sustainability preferences; and (4) expectations of MOBSA Systems; with the third part consisted of the core survey items. These items were performance criteria, grouped under seventeen sub-issues which were rated using four-point Likert-type scales. The reason for adopting the four-category of responses is due to the type of the scale adopted. Dillman (2009, p.135) pointed out that the determination of the appropriate length of scale depends on whether the scale is unipolar[1] or bipolar[2]. This question, in fact all of the questions with Likert scales in the study, adopt the unipolar scale, which measure different gradations but no direction. Accordingly, four or sometimes five categories are the optimal scale length. Dillman (2009, p.135) argued that "scales of these lengths have been shown to be more reliable and valid as well as to provide meaningful distinctions for analyses."

Reliability and validity of the survey scale items were established based on both pilot and principle survey administration, using frequency distributions, and internal consistency reliability index. For example, Cronbach's alpha provides an accurate estimate of internal consistency and indicates how well the items in the set were correlated to one another (Hamilton, 2006). A commonly-accepted rule of thumb was that scores of above 0.7 were considered acceptable (de Vaus, 2002). In this study, the Cronbach's alpha coefficient was 0.979, indicating that the 4-point Likert scale used for measuring the importance of sustainability criteria was very internally consistent.

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[1] "Unipolar" scales measure different levels (e.g. very, somewhat, not too, not at all) but no direction, with zero point falls at the end of the scale (Dillman*, et al.*, 2009, p.135).

[2] "Bipolar" scales both the direction (e.g. satisfied or dissatisfied) and the intensity (e.g. very, somewhat) of the construct, with the zero point falling in the middle of the scale In other words, bipolar scales measure both level and direction (Dillman*, et al.*, 2009, p.135). Comparatively, the optimal number of response categories for bipolar scales, which measure both gradation and direction, are either "five or seven which allows for two or three levels of differentiation on either side of the middle or neutral category" (Dillman*, et al.*, 2009, p.135).

The target population for the quantitative phase included various groups of stakeholders within Kuala Lumpur, Selangor and Putrajaya. Four sampling frames available for the study include: 1) 1026 professional architects; 2) 3500 civil and mechanical engineers; 3) 120 planners; and 4) 365 property development companies. On top of these, the study also included 20 policy makers/ regulators; and 150 other relevant construction industry players. Detail explanation on the characteristics of this target population is provided in Chapter Eight. Because the purpose of this quantitative phase is to generalize the results to a population, different participants were used in the quantitative follow-up stage than in the initial, qualitative phase.

There are suggested sample sizes for various statistical procedures, but no single sample size formula or method is available for every research method or statistical procedure. Nevertheless, according to Salant and Dillman (1994) and de Vaus (2002), the required sample size depends on two key factors: how much sampling error can be tolerated and the degree of diversity in the population with respect to the characteristics of the study. Bryman (2008) pointed out that, the larger the sample size the greater the precision (because the amount of sampling error will be less); however, most of the time, decisions about sample size are affected by considerations of time and cost. Dillman *et al.* (2009) and Fowler (2002) argued that it is the sample size, not the proportion of the population sampled, that affects precision. Table 5.1 shows what size of a completed sample[3] is needed in regard to various population sizes and characteristics, as well as various levels of precision.

The amount of variation that exists in a population characteristic differs from one population to another (Fowler, 2002), and the greater the variation, the larger the sample size needed for making population estimates (Dillman*, et al.*, 2009). It was assumed that the members within the populations consisting of architects, engineers, planners, developers and government personnel respectively were relatively homogeneous with regard to the characteristics that this study was evaluating. This is due to the fact that a population of “members of an occupation” (Bryman, 2008) has fewer amounts of variations. By the same token, “when people are in groups – classes, clubs, organisations – they tend to acquire similar characteristics and views at least about the group (if nothing else)” (Fink, 2009, p.57). Therefore, the 80/20 split option seemed appropriate. Put differently, it could be assumed that within each population, those members who do not participate do not differ from those who do.

[3] The “sample” consists of all units of the population that are drawn for inclusion in the survey. The “completed sample” consists of all of the units that complete the questionnaire (Dillman*, et al.*, 2009, p.43).

Table 5.1: Completed sample sizes needed for various population sizes and characteristics at the 95% confidence level, at three levels of precision (Dillman, *et al.*, 2009, p.57)

Population size	**Sample Size for the 95% Confidence Level**					
	±10%		**±5%**		**±3%**	
	50/50 Split	**80/20 Split**	**50/50 Split**	**80/20 Split**	**50/50 Split**	**80/20 Split**
100	49	38	80	71	92	87
200	65	47	132	111	169	155
400	78	53	196	153	291	253
600	83	56	234	175	384	320
800	86	57	260	188	458	369
1,000	88	58	278	198	517	406
2,000	92	60	322	219	696	509
4,000	94	61	351	232	843	584
6,000	95	61	361	236	906	613
8,000	95	61	367	239	942	629
10,000	95	61	370	240	965	640
20,000	96	61	377	243	1,013	661
40,000	96	61	381	244	1,040	672
100,000	96	61	383	245	1,056	679
1,000,000	96	61	384	246	1,066	683
1,000,000,000	96	61	384	246	1,067	683

How to read this table: For a population with 400 members, whom we expect to be about evenly split on the characteristic in which we are interested, we need a sample of 196 to make estimates with a sampling error of no more than ±5%, at the 95% confidence level. A "50/50 split" means the population is relatively varied or heterogeneous. An "80/20 split" means it is less varied or homogeneous; most people have a certain characteristic, a few do not. Numbers in the table refer to completed sample sizes needed for various levels of sampling error.

A sampling error[4] of ±10% appeared to be acceptable for this study, since the aim of the questionnaire survey was to detect general trends of perceptions or to investigate the perspective of the construction industry in general rather than to obtain more representative information. Table 5.2 shows the sample size needed for each of the population group or sampling frame, derived according to Table 5.1.

Baruch (1999) conducted a study to explore what could and should be a reasonable response rate in academic studies. He concluded that the norm for response rate should be distinctive between studies directed towards top management (CEO, directors, managers, etc.) or representatives of organizations, and others such as mid-level managers or conventional population. For the former, he recommended any scholar conducting a study which uses questionnaires to the norm may be 36% ±13%, (23%-49%), whereas for the most other populations, it may be about 60% ±20% (i.e. 40-80%). Since the population targeted for this study was the former group, it was hoped that the survey would result in at least 30% response rate. Accordingly, architects for instance, 193 (i.e. 58/0.30=193) questionnaires would have to be sent out to them to hopefully receive 58 or more completed questionnaires.

[4] Sampling error is the extent to which the precision of the survey estimates is limited because not every person in the population is sampled (Dillman*, et al.*, 2009, p.17).

Table 5.2: Completed sample size needed for various population sizes and characteristics at the 95% confidence level, with a ±10% margin of error

Population group	Population size (number in the sampling frame)	Characteristic of population	Completed sample size needed (number of completed questionnaires needed)	Number of questionnaires need to be distributed to obtain 30% response rate
			(The actual number of questionnaires distributed to and completed sample obtained from each population group is shown in Chapter 8).	
Architects	1026	80/20 split	58	193
Civil and Mech. Engineers	3500	80/20 split	60	200
Planners	120	80/20 split	38	127
Developers	365	80/20 split	53	177
Total	5011	N/A	209	697

Note:
An "80/20 split" means it is less varied or homogeneous; most people have a certain characteristic, a few do not.

This research ensured that there is an acceptable level of probability that the results represent a population (in this study, limited by the sample frames) that is larger than the sample itself. A "systematic sample with a random start" (Babbie, 1990, p.84) was adopted to draw a sample from each sampling frame. This way, every *n*th element in the total list was chosen for inclusion in the sample after the first element is selected randomly within the first interval. On the other hand, no sampling method was employed for government agency employees since all of the members identified were sampled.

Questionnaires were administered by using mixed-mode approaches via group administration, mail and dropping off methods. According to Dillman *et al.* (2009), multiple survey modes are often used not only to reduce survey costs and coverage error, but also to improve timeliness and response rates. Furthermore, answers to many questions are not affected by mode of data collection (Fowler, 2002). A group-administered survey is completed by individual respondents assembled in a group (Chambliss & Schutt, 2009). This method is an inexpensive way to collect data from individuals and a high response rate is usually possible with this method (Chambliss & Schutt, 2009). For mail surveys, Salant and Dillman (1994) states that their greatest strength over telephone or face-to-face interview survey methods, is that they require the least amount of resources (time, money, staff, etc.). Neuman (2006) adds that mail questionnaires can be completed at the respondents' convenience and they offer anonymity and privacy. The weakness of mail surveys, however, include possible lower return rates. There may be more incomplete questionnaires and misunderstanding of questions (Neuman, 2006), because researchers have little control over whether the questionnaires are understood properly and whether they are filled out completely after they are mailed (Salant & Dillman, 1994).

In this research, different coding[5] methods were applied to different types of questions and answers in the survey questionnaire. After coding in the above way, all the data collected from the returned questionnaires were entered into SPSS software and three methods were applied to clean the data, namely “possible code cleaning”, “contingency cleaning” and “missing data cleaning” (Neuman, 2006, p.335).

Both univariate and bivariate statistical procedures were used to analyse the survey data. Cross-tabulation and frequency counts helped analyse the survey demographic information and the participants’ answers to separate items in sustainability awareness and expectation sections. On the other hand, descriptive statistics were used to analyse participants’ answers to separate items under the sustainability preferences section, and minimum mean values were used to select the most important criteria to be included in the framework. Additionally, one-way ANOVA was conducted to compare the means of sustainability issues and sub-issues for different groups of participants.

The finally selected criteria were then assigned with appropriate weighting value and importance level, hence forming the Stage-3 MOBSA framework as the product of this quantitative phase. Detail explanations of the instrumentation, characteristics of target population, questionnaire administration, responses, and data analysis are provided in Chapter Eight.

5.5.4 Phase 4: Integration of the Qualitative and Quantitative Results

Finally, the qualitative and quantitative strands were mixed or integrated during the final step of the research process after both sets of data had been collected and analysed. This integration occurred at three points, namely: 1) discussion of the quantitative results; 2) process of framework development; and 3) interpretation of the outcomes of the entire study i.e. conclusion.

The first integration occurred when the results identified in the quantitative questionnaire survey were cross-checked against the qualitative research findings (i.e. interviews and focus groups discussion), where applicable (Bryman, 2008). For example, if one criterion was found to be the most or the least important, findings from the qualitative study were used to explain this result.

[5] Coding is “a process of converting answers to numbers and classifying answers” (de Vaus, 2002, p.147).

The second integration occurred during the process of proposing performance benchmarks or targets for the criteria identified in the Stage-3 MOBSA framework which is the product of the quantitative study. These benchmarks were derived based on qualitative findings i.e. focus groups discussions, interview data and literature. Proposed benchmarks were subsequently presented to local practitioners and experts in the Malaysian construction industry for validation. Particularly, they were asked to examine the realisability of the benchmarks in current practice. Consequently, the resulted modifications were presented as the Validated Comprehensive MOBSA Framework, applicable to all phases of project assessment and relevant building stakeholders. Detail explanation of the method of validation process is provided in Chapter Nine.

The Validated Comprehensive MOBSA Framework was subsequently integrated with a scoring system, proposed based on the weighting results of the quantitative phase to enable its application in real life. However, the Validated MOBSA Framework for the Design Phase, which contains a fraction but majority of the criteria in the Comprehensive MOBSA framework, was selected to be applied on a case study building; hence, forming the basis for further refining the benchmarks and weightings empirically and identifying criteria with missing input data. Detail case study method is provided in Chapter Ten.

The final integration occurred during the interpretation of the outcomes of the entire study, namely the conclusion and recommendations for the framework and further research, which are provided in the final chapter of the thesis.

5.6 Summary: The Visual Model of the study

The graphical representation of the mixed methods exploratory sequential design adopted in this study is illustrated in Figure 5.2. The model portrays the sequence of the research activities in the study, indicates the priority of the qualitative phase by capitalizing the term QUALITATIVE, specifies all the data collection and analysis procedures, and lists the outcomes from each stage of the study. It also shows the connecting points between the qualitative and quantitative phases and the related products, as well as specifies the place in the research process where the integration or mixing of the results of both qualitative and quantitative phases occurs.

Phase	Procedure	Product
Phase 1a QUALITATIVE Data Collection	• Individual in-depth semi-structured interview with 30 purposefully selected participants	• Text data (30 interview transcripts)
Phase 1a QUALITATIVE Data Analysis	• Content analysis (coding and categorizing/thematic analysis) • Within case and across case category/theme development • Refining tentative framework developed through literature*	• Groupings of multiple case analysis • Codes and categories • Malaysia specific performance criteria • Stage-1 framework
Phase 1b QUALITATIVE Data Collection	• Separate 6 focus groups discussions with an average of 6 participants per group.	• Text data (6 workbooks containing worksheets of criteria and their benchmarks)
Phase 1b QUALITATIVE Data Analysis	• 6 focus groups worksheets compilation and analysis • Refining stage-1 framework*	• Table of criteria relevance & benchmarks • Stage-2 framework
Phase 2 Connecting Qualitative and Quantitative Phases	• Use criteria within stage-2 framework to modify the instrument • Pilot study (n=15) • Randomly selecting 1000 samples from multiple sampling frames	• Pilot-tested instrument
Phase 3 Quantitative Data Collection	• Cross-sectional survey. Distribution and collection using mix-mode approaches • N = 203 office building stakeholders	• Numeric data
Phase 3 Quantitative Data Analysis	• Univariate and bivariate analysis • SPSS quantitative software v.17	• Cross-tabulation and frequency counts • Descriptive statistics • Weight and importance level of performance criteria • Stage-3 framework
Phase 4 Integration of the Qualitative and Quantitative Results	• Cross-checking quantitative results against the qualitative findings • Interpreting how the quantitative results build on the initial qualitative findings	• Discussion
	• Proposing benchmarks for criteria in Stage-3 framework using qualitative and quantitative results • Validation of tentative framework by 9 local experts • Refining tentative comprehensive framework*	• Tentative comprehensive framework • Validated comprehensive framework
	• Proposing a scoring system to implement validated framework using qualitative and quantitative results • Testing validated framework for design phase on a case study project • Refining validated framework for design phase*	• Scoring system • Missing data • Validated and tested framework for the design phase
	• Interpreting and explaining the entire results	• Conclusions • Future research

Note:
* Each stage of refining means criteria were confirmed/agreed/retained/selected, omitted, added, combined, or refined.

Figure 5.2: Visual model for mixed methods exploratory sequential design procedures

Chapter 6: Stage-1 MOBSA Framework – Exploratory Study

6.1 Introduction

Following the development of the tentative MOBSA framework in Chapter Four, this chapter sets out to investigate: 1) to what extent is sustainable development being practiced in Malaysia; 2) how do stakeholders of Malaysian construction industry view sustainability; and 3) how could a new assessment framework be made an acceptable and integral part of the local building practice, specifically for office buildings in Malaysia. It is hypothesised that a new framework could be made acceptable to the local building practice if it reflects an understanding of the local stakeholders' primary concerns in pursuing sustainable office building development and assessment.

It was anticipated that different stakeholder groups would have different views about sustainability as well as different challenges and motivations for pursuing sustainable outcomes; therefore, these views were explored through interviews and then analysed to define gaps that need to be bridged to promote sustainable building development and assessment in Malaysia. The findings from these interviews are particularly valuable in substantiating and fine-tuning the tentative MOBSA framework developed in Chapter Four. In doing so, this chapter is organized into five sections, namely method, results, discussion, Stage-1 MOBSA framework, and conclusion.

6.2 Method

There are currently no sufficient data on the perception of sustainable development among building stakeholders in Malaysia; therefore this study is new and exploratory. As such, an interview method is deemed to be the preferable approach to generate the essential data for analysis. An overview of this method and the sampling procedure has been explained in Chapter Five.

6.2.1 Selection of Participants

The target population of this study were the five stakeholder groups of commercial buildings, from both private and public sectors, currently practicing in Kuala Lumpur, Selangor and Putrajaya. These groups include: 1) consultants; 2) developers/owners; 3) builders; 4) facility managers; and 5) policy makers/regulators. In terms of selection criteria, the building-owners group of stakeholders must be those who work in an organization that owns at least an energy-efficient purpose-built office building. Other groups of stakeholders however, were not particularly chosen based on their knowledge of, and experience in, sustainable or green building. This approach allows a comparison of views between the two groups of sample with different background to be made.

A total of 50 stakeholders were sent an invitation email. However, only 30 stakeholders agreed to be interviewed and these consist of 12 consultants, 5 developers/owners; 3 builders; 4 facility managers; and 6 policy makers/regulators. The interviews were undertaken from early January to early March 2009. Table 6.1 is a summary of the profiles of the interviewees.

Table 6.1: Summary of the interviewees (N = 30)

Position of interviewee	Type of company or organization	N
	Private Sector	**23**
Consultants:		
- Architect & former President of PAM	- Architectural consultant	1
- Architect & Deputy President of PAM	- Architectural consultant	1
- Architect & Vice President of PAM	- Architectural consultant	1
- Architects	- Architectural consultant	6
- Managing Director and former President of ASHRAE Malaysia Chapter & MACRA	- Engineering consultant and trading	1
- Managing Director and former President of ASHRAE Malaysia Chapter & ACEM	- Engineering consultant	1
- Mechanical Engineer and Director	- Building environmental consultant	1
Developers / Building owners:		
- Head of Property Management	- Major real estate developer and investor	1
- Project Coordination Manager	- Major real estate developer and investor	1
- Executive Director & Head of Corporate Investment	- Major real estate developer and investor	1
- Senior General Manager	- Major real estate contractor and developer	1 1
- Project Director	- Bank/ Building owner	
Builders:		
- Managing Director	- Major property contractor	1
- Executive Director	- Major property contractor	1
- General Manager	- Major property contractor	1
Facility managers / Building operators:		
- Property Maintenance Manager	- Major real estate developer and investor	1
- Chief Executive Officer & former President of ASHRAE Malaysia Chapter	- Facility management	1 1
- Operations Manager	- Property management	
	Public Sector	**7**
Facility managers/ Building operators:		
- Principal Assistant Secretary	- Ministry of Energy, Water and Communications	1
- Assistant Director & former President of ASHRAE Malaysia Chapter	- Independent, non-profit making research organisation	1
Government Projects Implementer:		
- Branch Director	- Public Works Department	1
Policy Makers/ Regulators:		

-	Principal Assistant Director (Urban Design)	-	Statutory Body under Ministry of Federal Territories	1
-	Senior Architect	-	Local Authority under Ministry of Federal Territories	1
-	Senior Manager	-	Statutory Body under Ministry of Works	1
-	Senior Technical Advisor	-	Statutory Body under Ministry of Energy, Water and Communications	1
Total				**30**

Acronyms:
PAM = Persatuan Arkitek Malaysia/Malaysian Institute of Architects
ASHRAE = American Society of Heating, Refrigerating & Air-Conditioning Engineers
MACRA = Malaysian Air-Conditioning & Refrigeration Association
ACEM = Association of Consulting Engineers Malaysia

6.2.2 Interview Protocol

The first instruments in this study were in-depth, semi-structured, open-ended interviews, with 30 stakeholders involved in the construction industry which evolve from inquiry composed of a mix of both structured and unstructured questions. The unstructured questions were open-ended to allow the respondents more freedom and creativity to respond to the questions (Patton, 2002). The semi-structured approach provided reasonably standard data across participants but also allowed flexibility to probe answers more deeply and gather more information than is found in a structured interview (Minichiello*, et al.*, 2008). Thus, a more informal conversational style of interview was established focusing on predetermined subject.

Prior theory typically provides a focus for the data collection phase in interview-based research (Perry, 1998). In this study, the literature review has revealed that the Malaysian construction industry has not yet achieved a balance between the socio-economic with the ecological system to avoid further environmental damage. This general finding formed the basis for the questions asked. The questionnaire, highlighting the questions and the related research issues is provided in Appendix C-1.

6.2.3 Ethics and Data Collection

Since the planned survey in this research involves human subjects, ethical approval was obtained in advance from the University of Adelaide’s Human Research Ethics Committee. One original and four copies of the Ethics Application Cover Sheet (Appendix C-2), Information Sheet (Appendix C-3), Standard Consent Form (Appendix C-4) and Independent Complaints Procedure Statement (Appendix C-5) were sent to the Research Ethics and Compliance Unit in early June 2008. After fulfilling the committee’s request for a few minor amendments, the Human Research Ethics Committee approval letter (approval number H-077-2008) was received on 7 July 2008.

Invitation email was sent to the proposed participants along with the Information Sheet, Standard Consent Form and Independent Complaints Procedure Statement. This was followed up with personal telephone calls to arrange a mutually convenient time for an interview if they were willing to participate. It was ensured that participants understood that their participation was voluntary and they would not be identifiable in any published results. Each participant was requested to read and sign a written informed consent form in keeping with the University of Adelaide's ethics requirements before the interview commenced. Ethical concerns were addressed throughout the research process, particularly during the interview and data presentation phases where all data remained confidential. Participants were also provided the assurance that the option to remove themselves from the research process at any time was afforded.

The interviews were undertaken in person. The mode of the interview was largely dictated by the participants' availability in terms of time and place. All the interviews were digitally recorded with the interviewee's consent. The average length of each interview was approximately 45 minutes. Using a tape recorder permitted the interviewer to be more attentive to the interviewee; however, strategic and focused notes were also taken during these sessions. Participants were informed of the university's ethics requirements that digital interview files and field notes would be securely stored for a number of years before being destroyed.

6.2.4 Data Analysis

Once all the interview recordings have been transcribed, they were listened to while reading the transcription to confirm the accuracy of the transcription. The data from the interviews were then analysed using content analysis, performed on individual cases and across cases. It also involved a process of comparing the themes and categories and using a number of cross-case analysis techniques, including text units (sentences) counts for each theme across the cases. This analytical process was done conventionally without the use of any software programme.

6.3 Results of the Interviews

The interview results can be categorised into four themes: 1) Perception of 'Good', 'Green' and 'Sustainable' Office Building; 2) Perception of the Recently Built Office Buildings in Malaysia; 3) The Barriers to Sustainable Building Practices; 4) Suggestions to Reduce Barriers and Move Forward. The following texts will discuss each of these themes in detail.

6.3.1 Perception of ‘Good’, ‘Green’ and ‘Sustainable’ Office Building

Interviewees’ responses in this theme can be grouped into five sub themes, namely: 1) Characteristics of a ‘good’ office building; 2) Strategies to achieve a ‘good’ office building; 3) Characteristics of a ‘green’ building; 4) Difference between ‘green’ and ‘sustainable’ buildings; and 5) General views on sustainability. Each of these themes is discussed in the following.

6.3.1.1 What makes a ‘good’ office building?

Interviewees were asked to comment on what they thought set apart a ‘good’ office building from a ‘poor’ one from the perspective of their specific role in the construction industry. Altogether, 131 answers were described by interviewees, and these are listed into 16 categories in Appendix C-6. The list of these categories in descending order is shown in Table 6.2.

It was found that “Indoor environmental quality (IEQ)” category had the most replies (19% of the answers) from 53% of the interviewees, except developers/owners. The most frequently cited answer was “comfortable or conducive indoor environment”. Others were optimum level of ventilation, daylighting, illumination and indoor air quality. The second most cited category was “Space planning” representing 15% of the replies from 47% of the interviewees, except policy makers/regulators. Among the answers given were efficient floor space; flexible planning; adequate spaces and facilities; and floor-to-ceiling heights.

Table 6.2: Summary of interviewees' responses (grouped in categories) to what makes a 'good' office building

Interviewee	Category of 'Good' Building Criteria															
	1. Indoor environmental quality	2. Space planning	3. Energy efficiency & RE	4. Economic consideration	5. Aesthetics	6. Water efficiency	7. M&E services and versatility	8. Operation and maintenance	9. Materials	10. Safety & security	11. Inclusiveness	12. Sustainable site & management	13. Location & emissions to air	14. Impacts on adjacent properties	15.Construction strategies	16. General design strategies e.g. passive/ holistic/ responsive design
Arch/Female/1	●			●												
Arch/Female/2	●	●●									●					
Arch/Male/3	●	●●			●											
Arch/Male/4	●	●														
Arch/Male/5	●															●
Arch/Female/6		●	●					●								●
Arch/Male/7			●	●												●●
Arch/Male/8	●		●●			●		●	●							●
Arch/Male/9	●●					●										●
Engr/Male/1		●●														
Engr/Male/2	●●		●			●●●										
BEnvCon/Male/1	●															
Bldr-Dev/Male/1	●●	●	●	●	●	●●			●							
Bldr/Male/2					●											●
Bldr/Male/3		●	●		●											
Dev/Female/1		●		●	●											
Dev/Female/2		●		●			●				●		●			●
Dev/Male/3		●●			●		●●●	●	●							
Dev-owner/Female/4		●		●			●									
Dev-owner/Male/5		●●			●		●		●	●			●			
FacMgr/Male/1				●							●					
FacMgr/Male/2	●		●●	●●●		●		●	●	●						
FacMgr/Male/3	●●	●	●	●				●								
FacMgr/Male/4	●●	●					●			●						
GovPI/Male/1				●												●
PMaker/Male/1	●●															
Regr-PMaker/Male/2					●				●					●		
Regr-PMaker/Female/3			●		●●							●				●
PMaker/Male/4	●●●				●											
PMaker/Male/5	●●		●			●●●		●				●			●	
Mentioned by __ interviewees	16	14	10	10	10	6	5	6	6	3	3	2	2	1	1	9
Total answers	25	19	12	12	11	11	7	6	6	3	3	2	2	1	1	10
Order of importance	1	2	3	3	4	4	6	5	6	7	7	8	8	9	9	NA

Note: Arch = Architect
Engr = Engineer
BEnvCon = Building Environmental Consultant
Bldr-Dev = Builder-Developer
Bldr = Builder
Dev = Developer
Dev-owner = Developer-owner
FM = Facility Manager
GovPI = Government Project Implementer
PMaker = Policy Maker
Regr-PMaker = Regulator-Policy Maker
● One characteristic mentioned
●● Two characteristics mentioned
●●● Three characteristics mentioned
Total interviewees = 30
Total characteristics = 131

Next, both “Energy efficiency and renewable energy” and “Economic consideration” categories were equally cited at 9% of the replies by 33% of the interviewees. Under the former category, interviewees, with the exception of developers, asserted that a ‘good’ office building reduces the use of fossil fuel energy consumption; uses energy efficient fixtures and appliances; has envelop that cuts down heat gain and reduces cooling load; and utilizes energy from renewable sources. However, the latter category was considered important by all stakeholder groups. Particularly, they believed that a ‘good’ building is the one built within budget; has low maintenance and running costs or life cycle cost; and provides maximum return to the clients.

Subsequently, both “Aesthetics” and “Water efficiency” categories were equally cited at 8% of the replies or mentioned by 33% and 20% of the interviewees respectively. Despite the fact that “Aesthetics” is a subjective issue, it was stated by all stakeholder groups except facility managers. Whilst policy makers/regulators regarded buildings with high aesthetic value as those that portray a Malaysian character and identity, others (i.e. architect, developers and builders) linked aesthetics to corporate identity and workmanship quality. In “Water efficiency” category, utilization of rainwater harvesting was mostly cited. Others include utilization of grey water system and reduction of potable water consumption. It is worth noting that none of these answers came from developers/owners group.

The “Mechanical and electrical (M&E) services and versatility” category received 5% response by 17% of the interviewees. They frequently used words such as “versatile”, “functional”, “reliable”, and “up-to-date” to describe good M&E services. Next are “Operation and maintenance” and “Materials” categories, each with 4.5% of the replies by 20% of the interviewees. Builders did not respond to “Operation and maintenance” category. Among the answers were the ease of building maintenance; participation from tenants in conserving energy and water as well as reducing waste; and the use of durable technologies. Under “Materials” category, all stakeholders expressed the importance of using local, high quality green/sustainable building materials or those with low embodied energy. Finally, the rest of the categories received less than 2% of the replies.

Clearly, ‘good’ design was deemed to be the process that results in a well-designed building encompassing both the engineering and non-engineering disciplines and meeting the defined objectives and criteria of the owner.

6.3.1.2 What can stakeholders do to achieve a ‘good’ office building?

Interviewees were then asked to suggest on what they can do to achieve a ‘good’ office building. Altogether 19 categories were established through close examination during analysis. Quantitative descriptions of the result are shown in Table 6.3.

Table 6.3: Summary of interviewees’ suggestions of what stakeholders can do to achieve a ‘good’ office building as recorded in the interviews

	No. of times recorded	
What stakeholders can do to achieve a 'good' office building	**N**	**%**
From Consultants (N=12)	**18**	**100**
1. Design accordingly e.g. by following passive design strategies	9	50
2. Incorporate during planning stage	4	22
3. Be a competent and knowledgeable designer	3	17
4. Use building simulation programs	1	5.5
5. Collaborate at early design stages	1	5.5
From Regulators, Policy Makers & Gov. Project Implementer (N=6)	**14**	**100**
6. Introduce guidelines, policies, codes and standards	8	57.1
7. Promote, educate & train industry players	3	21.4
8. Give incentives	2	14.3
9. Reduce subsidies for energy prices	1	7.2
From Developers & Developer-Owners (N=5)	**8**	**100**
10. Appoint a competent and experienced project team	3	37.5
11. Be a knowledgeable developer	2	25
12. Specify in design brief and contract documents	2	25
13. Select urban site	1	12.5
From Facility Managers (N=4)	**7**	**100**
14. Conduct post-occupancy evaluation	3	42.8
15. Ensure operation & maintenance staff are trained & qualified	2	28.6
16. Get involved and incorporate facility management in the early development stage	1	28.6
From Builders & Builder-Developer (N=3)	**4**	**100**
17. Develop awareness and knowledge among builders	2	50
18. Propose to client if not mentioned in the contract	1	25
19. Collaborate with architect & client	1	25

50% of consultants’ suggestions are related to the need for designing according to the stipulated characteristics as indicated in Table 6.2, e.g. by following passive design strategies, whilst 22% of their responses concern incorporating the criteria in the earlier stage of project development i.e. planning stage. 57.1% of suggestions from regulators, policy makers and government project implementer are about introducing guidelines, policies, codes and standards; and ensuring conformance to these requirements prior to planning approvals. Other suggestions are related to governments’ effort to promote, educate and train industry players on good building practices (21.4%).

From the developers' viewpoint, 37.5% suggested that they should appoint competent and experienced design team members as well as reputable and reliable contractors who have the resources to construct and complete the entire building. Others suggested that they should be knowledgeable in sustainable construction and building requirements (25%). This in turn would enable them to spell out detailed requirements in design briefs and contract documents (25%).

42.8% of facility managers' suggestions concern the importance of conducting post-occupancy evaluation e.g. through surveys and scheduled monitoring to assess tenants' feedbacks on the building's environmental quality; whilst 28.6% of their responses aimed to ensure operation and maintenance (O&M) staff to be well-trained and well-qualified to operate and maintain buildings responsibly. Similarly, 50% of the responses from builders are about building their capacity; for example: "To always upgrade knowledge in sustainable construction methods, buildability, cost- and energy-savings methods" (Bldr/Male/1).

It is apparent that each stakeholder group was concerned about education to update knowledge and improve competency level. Therefore, special attention is required to reduce the knowledge gaps among industry players.

6.3.1.3 What makes a 'green' office building?

Interviewees were then asked to comment on what they understood by the term 'green building'. The aim was to understand whether a 'good' design intrinsically means that 'green' design has been achieved as well but more significantly to gauge whether green design automatically incorporates the characteristics of a good design. The responses could be grouped into two types, namely 'specific green building criteria' and 'general meaning', as depicted in Table 6.4. Altogether 71 specific criteria were specified under 8 categories and 21 general answers were obtained under 4 groups. The summary and groupings of the overall 92 answers are provided in Appendix C-6[1]. For comparison purposes, all these categories were given similar names to those of a 'good' building (except "Innovation" which is an additional category for a 'green' building) even though the relevant criteria under them are varied. The following paragraphs provide a comparison analysis of the categories' rankings and individual's responses between a 'good' and a 'green' building by referring to Table 6.5. It is followed by an analysis of the interviewees' answers in describing a 'green' building by referring to Table 6.4.

[1] Appendix C-6 also contains overall interview summaries.

Table 6.4: Summary of interviewees' responses (grouped in categories) to what makes a 'green' office building

Interviewee	Category of 'Green' Building Criteria																General Meaning of 'Green'				Other	
	1. Energy efficiency & RE	2. Water efficiency	3. Materials	4. Operation and maintenance	5. Sustainable Site & management	6. Indoor environmental quality	7. Innovation	8.Location & emissions to air	9. Space planning	10. Economic consideration	11. Aesthetics	12. M&E services and versatility	13. Safety & security	14. Inclusiveness	15. Impacts on adjacent properties	16.Construction strategies	1. Minimum impacts on the env. throughout building lifecycle	2. Efficient use of natural resources	3. Minimum impacts on human health throughout building lifecycle	4. Similar to 'intelligent' building	1. No meaning- prefer 'sustainable'	2. Do not know
Arch/Female/1	●	●	●		●	●																
Arch/Female/2	●		●	●		●																
Arch/Male/3				●																		
Arch/Male/4	●	●	●		●	●	●															
Arch/Male/5	●	●	●●	●	●																	
Arch/Female/6	●	●	●●					●														
Arch/Male/7	●																●		●			
Arch/Male/8	●					●											●					
Arch/Male/9																					●	
Engr/Male/1	●																●					
Engr/Male2	●																	●				
BEnvCon/Male/1																	●					
Bldr-Dev/Male/1																	●					
Bldr/Male/2																	●					
Bldr/Male/3	●	●	●		●	●	●															
Dev/Female/1																	●					
Dev/Female/2																	●					
Dev/Male/3																	●	●	●			
Dev-owner/Female/4	●●●	●●●																				
Dev-owner/Male/5	●	●	●	●●		●																
FacMgr/Male/1					●												●					
FacMgr/Male/2	●			●																		
FacMgr/Male/3	●	●				●											●					
FacMgr/Male/4	●																			●		
GovPI/Male/1	●				●																	
PMaker/Male/1	●		●		●												●					
Regr-PMaker/Male/2	●																			●		
Regr-PMaker/Female/3																		●				
PMaker/Male/4																						●
PMaker/Male/5	●	●●●	●●	●●																		
Mentioned by __ interviewees	19	9	9	6	7	7	2	1	0	0	0	0	0	0	0	0	12	3	2	2	1	1
Total answers	21	13	12	8	7	7	2	1	0	0	0	0	0	0	0	0	12	3	2	2	1	1
Ranking	1	2	3	4	5	5	6	7				-					-	-	-	-	-	-

Note: Arch = Architect
Engr = Engineer
BEnvCon = Building Environmental Consultant
Bldr-Dev = Builder-Developer
Bldr = Builder
Dev = Developer
Dev-owner = Developer-owner
FM = Facility Manager
GovPI = Government Project Implementer
PMaker = Policy Maker
Regr-PMaker = Regulator-Policy Maker
● One criterion mentioned
●● Two criteria mentioned
●●● Three criteria mentioned
Shaded rows = interviewees who did not give specific criteria
Total interviewees = 30

Table 6.5: Comparison of rankings between criteria (grouped in categories) for a 'good' and 'green' office building as cited by interviewees (N = 30)

Category of 'Good' and/or 'Green' Building Criteria	**Ranking (based on number of criteria cited by interviewees)**	
	'Good' office building	**'Green' office building**
Indoor environmental quality	1	5
Space planning	2	-
Energy efficiency and renewable energy	3	1
Economic consideration	3	-
Aesthetics	4	-
Water efficiency	4	2
Mechanical & electrical services & versatility	5	-
Operation and maintenance	6	4
Materials	6	3
Safety and security	7	-
Inclusiveness	7	-
Sustainable site and management	8	5
Location and emissions to air	8	-
Impacts on adjacent properties	9	7
Construction strategies	9	-
Innovation	-	6

Note:
1 = Mostly mentioned, hence most important
Symbol (-) = Not mentioned at all, hence not that important

Table 6.5 clearly shows that the interviewees' order of importance of the categories for 'green' buildings is different from that of 'good' buildings even though most of the categories are similar. For example, "Indoor environment quality" is ranked first for a 'good' building as it was cited by more than half of the interviewees but ranked fifth for a 'green' building as it was cited only by some (23%) of the interviewees. Contrastingly, "Energy efficiency and renewable energy" was cited by the majority of the interviewees and ranked first for a 'green' building but ranked lower for a 'good' building. Other categories that were more frequently cited for a 'green' than a 'good' office building include "Water efficiency", "Operation and maintenance", "Materials", "Sustainable site and management" and "Impacts on adjacent properties".

Table 6.5 also shows that there are some categories which form part of a 'good' building but not in a 'green' building and vice versa. These include "Space planning", "Economic consideration", "Aesthetics", "M&E services and versatility", "Safety and security", "Inclusiveness", "Location and emissions to air" and "Construction strategies". Contrastingly, "Innovation" in design and construction was deemed important for a 'green' building but none of the interviewees indicated this category when describing a 'good' building.

As mentioned earlier, interviewees' approach in describing a 'green' building can be grouped into two categories i.e. specific criteria and general meaning. Table 6.4 indicates that 12 out of 30 (40%) interviewees chose the former approach, whereas 7 (23%) chose the latter. Another 9 interviewees (30%) combined both approaches and the remaining 2 interviewees stated “No meaning – prefer ‘sustainable’” and “Do not know” respectively. Collectively, there were 16 (53%) interviewees who stated the general meanings of ‘green’ building and majority (12 out of 16 interviewees) gave answers that fall under the category of “Minimum impacts on the environment throughout its lifecycle”, whilst only 2 cited “Minimum impacts on human health”.

Regardless of which approach the interviewees chose, it is interesting to note that none of the thirty interviewees cited answers that can be grouped under all of the following common categories assessed by existing building performance assessment systems: “Energy efficiency and renewable energy”, “Water efficiency”, “Materials”, “Operation and maintenance”, “Sustainable site and management” and “Indoor environmental quality” (refer to Table 6.4). Two interviewees perceived a ‘green’ building as comparable with an ‘intelligent’ building; however, no elaboration was given. On the other hand, one interviewee believed that a ‘green’ building reduces impact on the environment particularly focusing on site issues. Even though “Energy efficiency and renewable energy” was mostly cited, there were three cases where interviewees simply cited one additional category in explaining their understanding of a ‘green’ building i.e. either “Water efficiency”, “Operation and maintenance” or “Sustainable site and management”.

Next, individuals’ responses between a ‘good’ and a ‘green’ building were compared by reading Table 6.4 in conjunction with Table 6.2. Excluding nine interviewees who did not give specific criteria in describing a ‘green’ building (shown as shaded rows in Table 6.4), it seemed that some interviewees regarded certain categories as essential for a ‘good’ building but not for a ‘green’ building. These categories include “Indoor environmental quality”, “Water efficiency”, “Materials”, “Energy efficiency and renewable energy” and “Sustainable site and management”, regarded by 7, 3, 3, 2 and 2 interviewees respectively.

Overall, it appears that ‘green’ was perceived as solely related to the environment and many characteristics of ‘green’ design cover at least some, if not all, of the characteristics of ‘good’ design. Stakeholders made the distinction between the characteristics of ‘good’ and ‘green’ design; however, it is important to note that buildings should strive to achieve both (ASHRAE, 2006). In summary, ‘green’ design does not necessarily incorporate many important characteristics of ‘good’ design; but good design, on the other hand, does include many important characteristics of ‘green’ design. Since issues cited for a 'good' building were more extensive than a 'green' building, it may also suggest that the industry perceived a 'good' building as a 'green' building. On the other hand, certain green issues were not regarded as being connected to a 'green' building; hence, it shows that green issues are relatively a recent phenomenon in the country hence has not influenced some of the industry practitioners. It may also indicate that interviewees simply described the main green issues covered in the Malaysia's Green Building Index (GBI)[2] or there is simply a lack of awareness and knowledge among industry players with regard to green issues.

6.3.1.4 Is 'green' building different from a 'sustainable' one?

As discussed in Chapter Two, sustainability has vague meanings and can be understood in many different ways. Hence, it is not only interesting to see how interviewees understand by the term 'green' but also to see whether they perceive any difference between a 'green' and a 'sustainable' building. There were several points of view and these are categorised into four groups: 1) 'Sustainable' and 'green' buildings are the same; 2) A 'sustainable' building covers more aspects than a 'green' building; 3) A 'green' building covers more aspects than a 'sustainable' building; and 4) 'Sustainable' and 'green' buildings are different but I do not know what the differences are. Figure 6.1 contains the breakdown of the above.

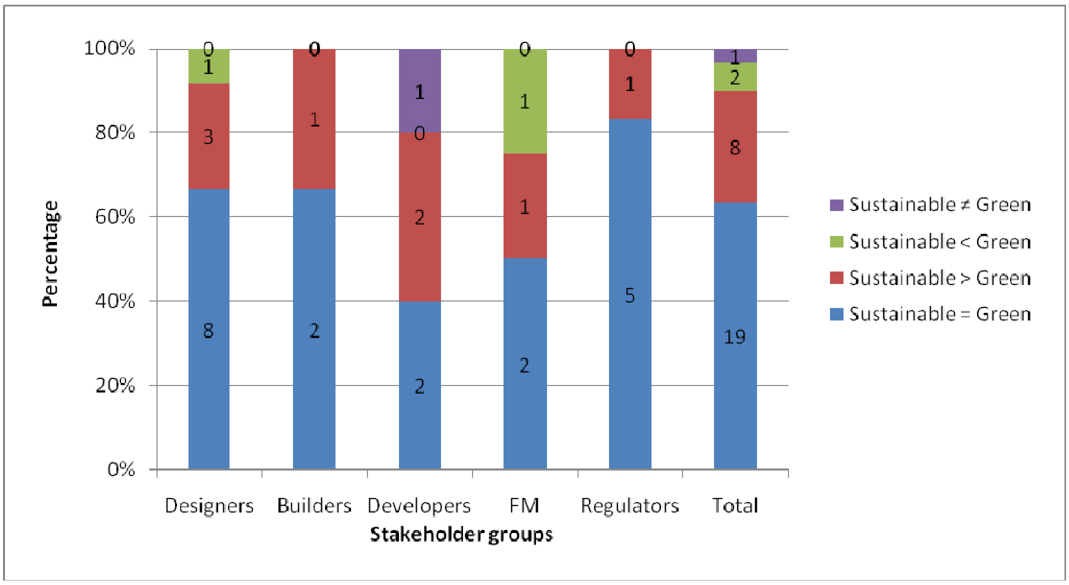

Figure 6.1: Percentage distribution of interviewees' view of the difference between a 'sustainable' and a 'green' building (N = 30)

[2] Information on GBI was widely disseminated in the Malaysian construction industry but the system had not yet officially launched during the conduct of these interviews.

Overwhelmingly, 63% of the interviewees perceived the terms ‘sustainable’ and ‘green’ are similar and the terms are often used interchangeably. This viewpoint came from all groups of stakeholders. Whereas, only 27% believed that a ‘sustainable’ building covers a bigger scope than a ‘green’ building. Half of the interviewees under this category explained that a ‘sustainable’ building does not only care about the environment but also consider the social and economic aspects. Whereas, another half affirmed that a green building many not necessarily incorporate all the elements of sustainability but did not explain further. On the other hand, 7% of the interviewees believed the opposite i.e. a ‘green’ building looks beyond a ‘sustainable’ building but were unable to elaborate further. Finally, one interviewee acknowledged that there must be reasons why these two buildings are called differently but he went no further.

It appears that there are generally no differences between a ‘green’ and a ‘sustainable’ building. Since a ‘good’ building is also regarded as a ‘green’ building, it is sensible to suggest that a ‘good’ building is the one that should be sustainable.

6.3.1.5 How do stakeholders view sustainability in general?

Interviewees were then given a card indicating the three sustainability issues: 1) environmental protection, 2) human health and well-being enhancement, and 3) economic development. They were asked to rate the importance of these issues in comparison to each other in playing their specific role in the construction industry on a scale of 4, where “1” is “Not important”; “2” is “Moderately important”; “3” is “Important”; and “4” is “Very important”.

Descriptive statistics of the result (Table 6.6) shows that the mean values of all issues are between 3 and 4, which means they are considered between “important” and “very important”. Among them, “Human well-being enhancement” was voted as the most important one, which is closely followed by “Environmental protection” and lastly by “Economic development”.

Table 6.6: Descriptive statistics of the importance of sustainability issues (N = 30)

	N	Min	Max	Mean	Std. Deviation	Rank
Human well-being enhancement	30	2	4	3.70	.535	1
Environmental protection	30	2	4	3.60	.621	2
Economic development	30	1	4	3.50	.777	3

Note:
1 = Not important; 2 = Moderately important; 3 = Important; 4 = Very important

When the group means on the ratings of these issues are compared by profession, the results (see Table 6.7) reveals that “consultants” and “builders” rated “Environmental protection” as the most important issue (3.75 and 4.00 respectively), whereas “facility managers” and “regulators/policy makers” voted “Human well-being enhancement” (4.00 and 3.83 respectively). “Developers/owners” however, placed “Economic development” as the top in their ranking (4.00).

Table 6.7: Group means and standard deviations on the ratings of three sustainability issues by profession

		Environmental Protection		Human Well-being Enhancement		Economic Development	
Profession	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Consultants	12	3.75	.452	3.67	.651	3.17	.937
Builders	3	4.00	.000	3.67	.577	3.67	.577
Developers/Bldg. Owners	5	2.80	.837	3.40	.548	4.00	.000
Facility Managers	4	3.75	.500	4.00	.000	3.50	.577
Regulators/Policy Makers	6	3.67	.516	3.83	.408	3.67	.816
	Total 30	Average 3.60	Average .621	Average 3.70	Average .535	Average 3.50	Average .777

Overall, it appears that social aspects of sustainability are the main issue addressed by the Malaysian building stakeholders in office building development (average mean value is 3.70, as compared to 3.60 and 3.50 for environmental and economic aspects respectively). This result is consistent with the “Indoor environmental quality” which was mostly quoted for a ‘good’ building as explained earlier. Therefore, social issue appears to warrant the highest weighting value among the three sustainability issues.

6.3.2 Perception of the Recently Built Office Buildings in Malaysia

Interviewees’ responses in this theme can be grouped into the current social, environmental and economic practices. Each of these sub-themes is discussed later in this section after interviewees’ general perceptions on recently office buildings are explored which is described below.

Interviewees were asked to make some general comments on office buildings being built in Malaysian cities since five years ago (2005-2009). Altogether, there are 44 comments made and these are grouped into 13 categories as shown in Figure 6.2. Generally, the negative comments outnumbered the positive ones and these are explained in the following paragraphs.

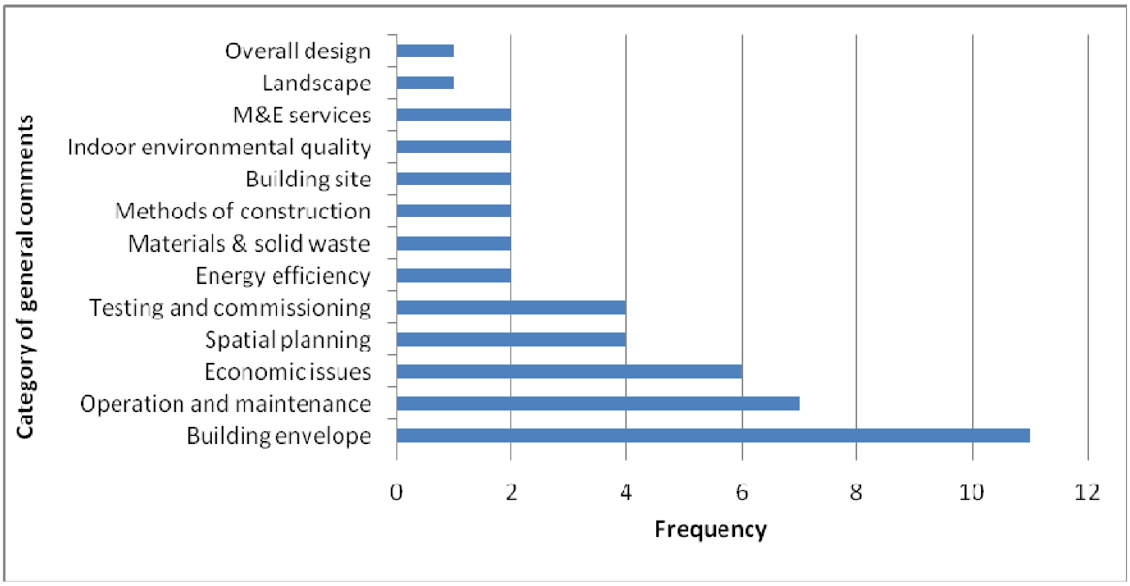

Figure 6.2: Frequency distribution of interviewees' comments (in categories of issues) about recently built office buildings in Malaysian cities. Note: Total comments given by 30 interviewees = 43

The result clearly shows that most commonly cited responses (25%) are about "Building envelope" cited by all stakeholder groups with the exception of facility managers; however, only one out of ten comments is encouraging. For example, one interviewee from a local authority (Regr-PMaker/Female/3) suggested that office buildings built since five years ago are 'greener' in their architectural design that those built prior to that period. However, this view contradicts those given by most of the interviewees from the private sector. Among the comments made by them were "Non-climatic facade designs", "Attractive but no due respect to energy issues", "More concerned on being iconic", "Commercially driven with corporate image", "Obsessed with glass boxes", and "Unnecessary features and decorations".

The second most cited issue concerns "Operation and maintenance", which represents 16% of the responses. In all but one case, interviewees commented that many of existing buildings are poorly operated and maintained. This view came mainly from interviewees with an engineering background i.e. mechanical engineers and facility managers. They bemoaned the fact that preventive maintenance is rarely practiced and building energy consumption is rarely monitored. This is due to the fact that building owners or tenants normally refuse to employ energy manager especially during economic downturn.

Subsequently, comments regarding "Economic issues" are the third most commonly cited (14%). It is interesting to notice that some of the comments seemed to justify those discouraging comments made under the category of "Building exterior". For instance, "Most of our developers are concerned with dollars and cents. Nothing is considered from the environmental and social aspects" (Arch/Male/7). By the same token, one interviewee pointed out how economic-oriented decisions have a clear effect on space planning:

> Normally, office buildings are built for investment purposes… And one thing that brings to their mind is the return... As a result…net lettable area has got to be maximized and... cost obviously has got to be very low…sometimes I see corridors are getting smaller and smaller… (Dev/Female/2).

Hence, these views are consistent with the result reported in Section 6.3.1.5 which reveals that developers/owners rated "Economic development" as the most important issue in their profession.

The fourth most commonly cited are "Spatial planning" and "Testing and commissioning", each represents 9%. Three issues raised under the former category are, 1) do not facilitate sub-divisions; 2) without due consideration on the impact on energy use; for example, "Not many people have moved to the total open plan to the perimeter…where the daylight is" (Arch/Female/6); and 3) impersonal with no socio-cultural quality. The latter category of comments was mainly raised by mechanical engineers and facility managers. Three of them stated that office buildings were generally not properly commissioned and maintained five to ten years ago, but more commonly practiced since then, especially by multi-national corporations. Even though this was also agreed by another facility manager, he commented that what is currently being practiced is only basic and proper commissioning is still considered an option.

Other comments are related to "Energy efficiency", "Materials and solid waste", "Methods of construction", "Building site" "Indoor environmental quality", and "M&E services", each represents 4.5%. Arch/Male/5 recognised the state of energy consumption of office buildings in Malaysia when he said: "A typical office buildings in Malaysia uses 265 kWh/m2/year...We should try to reach 140-150 if we can". However, another interviewee acknowledged the government initiatives in adopting the energy efficiency concept in government buildings but somehow sceptical about the sustainability of the adoption due to the current low electricity prices.

With regard to "Materials and solid waste", an architect explained the situation: "wrong choice of materials...they have huge carbon footprints" (Arch/Male/4). An interviewee from Construction Industry Development Board (CIDB), on the other hand lamented on the improper waste disposal management (especially scheduled wastes) among local builders. One builder admitted that environmentally destructive “Methods of construction” are a normal practice when he said:

> It is a common practice among contractors to flatten the whole site, chop all of the trees and bare the land during site clearance. Even though the building footprint is small but the site area covers for operation is huge (Bldr/Male/3).

Undoubtedly, this response is consistent with that of the interview from the CIDB, who specifically said: “In terms of managing the environment at the earthwork stage, I think it is still not up to the standard. That’s why we still have flash floods, river sedimentation and so on” (PMaker/Male/4).

Clearly, this part of the research clarifies the negative aspects of currently built local office buildings that need to be taken as lessons learnt to avoid further recurring in future developments. Besides, it is also important for the positive comments to be considered and incorporated in the MOBSA framework to facilitate wider sustainable practices in the construction industry.

6.3.2.1 Current Social Practices

This sub-theme comprises of five issues, as follows: 1) Malaysian office building characteristics; 2) Space planning; 3) Knowledge and awareness; 4) Culture of feedback; and 5) Universal design. Each of these issues is described in the following.

6.3.2.1.1 Are there any significant differences in office building characteristics between Malaysia and other countries?

The result to this question is shown in Figure 6.3. Surprisingly, 43% of the interviewees, across all stakeholder groups, unhesitatingly admitted there is nothing to look out for or nothing comes from local. As one interviewee indicated, “...nothing really comes from us. Maybe because what we have adopted are imported. We get the best from everywhere...we modified equipments from overseas to suit our climate and conditions” (Engr/Male/2).

In contrast, 47% of the interviewees noted that there is something to look out for and to learn from. Subsequently, they gave a total of 23 suggestions concerning the responsiveness of local office buildings to the local hot and humid climate. Interviewees from an architectural background correlated climate responsive design to passive mode design strategies; for instance,

> There are essentially five modes: passive mode, mixed mode, full mode, productive mode[3] and composite mode[4]...Passive mode must be the first level of design consideration in the process, followed by other modes to further enhance the energy efficiency... (Arch/Male/5).

Interviewees from an engineering background linked climate responsive design to good indoor environmental quality by comparing different engineering design requirements between tropical and temperate zones; for example:

- In tropical hot and humid climates, buildings need higher indoor air movement than those in temperate climates due to high level of humidity;
- Fresh air intake for buildings in hot and humid climate should not be as high as those in drier climate due to the cost of removing humidity;
- Illuminance level required in local buildings is much lower than those in higher latitude due to higher sun's intensity; and
- More local buildings use water-cooled chillers rather than air-cooled chillers due to their higher level of efficiency and also due to low water price and high local temperature.

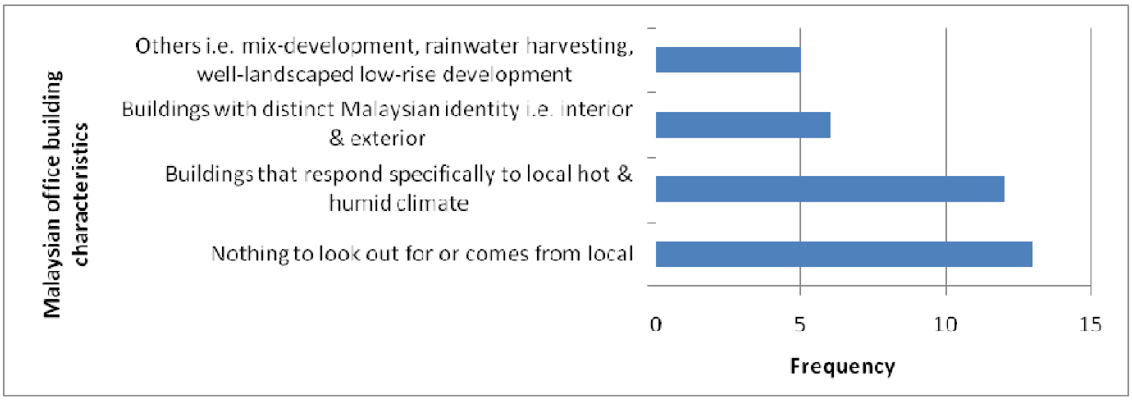

Figure 6.3: Frequency distribution of Malaysian office building characteristics as cited by interviewees. Note: Total suggestions given by 30 interviewees = 36

Another 26% came mainly from developers and regulators who appreciated the ideas of using Islamic patterns and Malay motifs either for decorations or overall building forms to reflect the Malaysian identity. It would seem that the specific characteristics of office buildings that portray a Malaysian architectural identity are still vague or generally perceived as non-existent. Moreover, the measurement of its success is highly subjective which requires considerable judgement, hence difficult to be incorporated in the MOBSA framework. However, the framework can still be developed to be Malaysia specific by

[3] Productive mode is the use of systems that generate on-site energy e.g. photovoltaic systems, wind generators, etc (Yeang, 2008).
[4] Composite mode is a composite of passive mode, mixed mode, full mode and productive mode e.g. seasonal strategies (Yeang, 2008).

taking into account the climate responsive aspects which providentially lead to objective measurements.

6.3.2.1.2 <u>How can office spaces be planned to enhance Malaysian cultures and religious beliefs?</u>

The result to this question clearly shows that the most commonly cited responses (28 out of 96 responses cited by 26 out of 30 interviewees) are providing “Religious facilities at appropriate location and with appropriate size and design” (see Figure 6. 4). There was considerable unanimity across the stakeholder groups with regard to this provision, and one of the unifying responses was the fact that the provision has been addressed by local authorities in their building guidelines. However, the guidelines do not prohibit such facility to be located inappropriately or in non-strategic places such as basements. Hence, a few solutions were suggested; for example, locating toilets, praying and food facilities on the same floor, preferably at the podium level. Apart from praying facilities for Moslems, one interviewee recognised the importance of providing another facility to encourage interactions between Moslems and other religions within the same organisation when he said:

> Christians only go for Sunday prayers at a church. Moslems have five times prayers so they need to have a particular place for that. They should be given a place to relax at the same time... With proper lounge for the Moslems to use after prayer…at the end of the day, other race will join in so they interact. Our culture is to mingle together. We should not segregate people with different culture and religious beliefs (Bldr/Male/2).

The second most cited responses (17 provided by 16 interviewees) are providing “Eating facilities at appropriate location”. Several interviewees also recommended the best locations for eating facilities; for example, the ground floor which is accessible to the public. One interviewee then called for separately ventilated pantries to avoid the strong odour of Malaysian foods to be circulated in the office space.

Subsequently, suggestions regarding the provision of “Facilities for users with children” such as crèches, nursery, and mothers’ room are the third most commonly cited (14 cited by 12 interviewees). A few interviewees added that the facility should be provided if there is sufficient demand not only from staff in the building but also from neighbouring blocks.

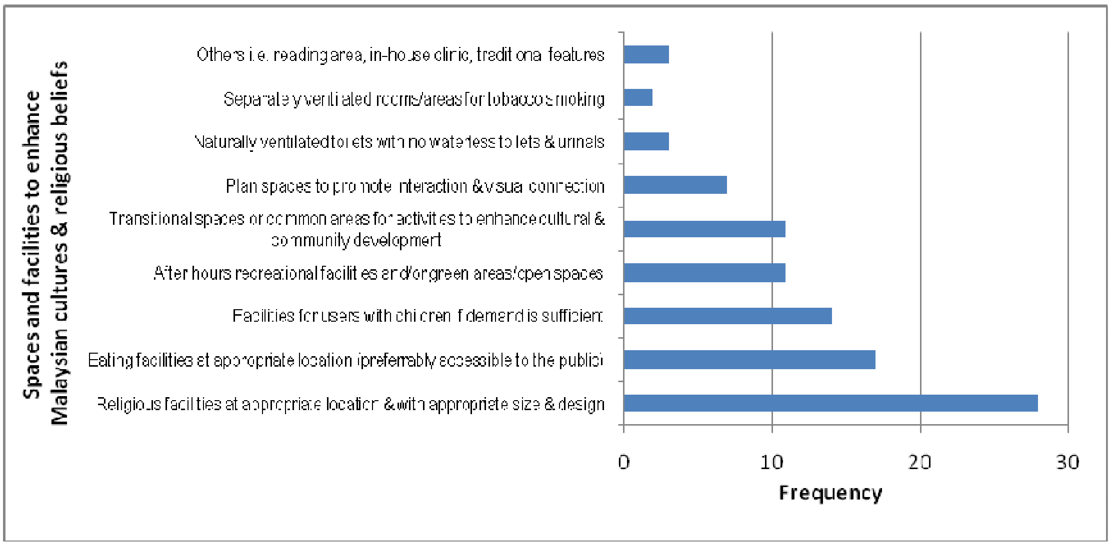

Figure 6. 4: Frequency distribution of spaces and facilities to enhance Malaysian cultures and religious beliefs as cited by interviewees. Note: Total suggestions given by 30 interviewees = 96

Provide “After hour’s recreational facilities and/or green/open spaces” and provide and utilize “Transition spaces (e.g. lobbies, patios, open verandas, terraces) or common areas (e.g. lounge, informal discussion area) for activities to enhance cultural and community development” are the fourth most frequently mentioned (11 stated by 10 interviewees). One interviewee from a local authority insisted on having fifteen percent of the site area to be an open/green space for developments within the area under its jurisdiction. One interviewee was adamant that gymnasium and common spaces are unimportant: “...if you need to exercise you don’t need to have a gym...Interaction in Malaysian culture is more like an empty talk” (Dev/Female/2). Others conceded that recreational facilities and common spaces are generally essential to promote good health and well-being and to enhance cultural development and productivity.

Besides providing certain spaces, some suggestions (7 mentioned by 4 interviewees) are concerned about the idea to “Plan spaces to promote interaction and visual connection”. For example,

> “...every 3 storeys, they are connected by internal staircase...like a triple-volume with a lounge...So every 3 floors, they have their definite break area...they can meet other departments from the other 2 floors. It becomes the social area. Everybody knows that they can go there from 1-2pm or for informal discussions” (Dev-Owner/Female/4).

Clearly, almost all of the suggested facilities are building common areas which provide services to building tenants and not leased to a particular tenant. The increment of these areas was perceived to reduce the overall rentable areas throughout the property; hence, reduce the developer’s or owner’s profit. Based on opinions from six interviewees, one interviewee believed it was difficult to have them balanced because clients normally set their targeted net rentable area which had to be met by architects. The rest supported the idea of balancing between social spaces and workspaces, primarily to reduce stress, enhance workers' productivity in a long run, create a livelier indoor environment and most importantly, to enhance the workers' quality of life. In summary, this research shows that opportunities for cultural and community development among workers is important to be addressed in the MOBSA framework since Malaysia itself is a multi-cultural and multi-religion country.

6.3.2.1.3 *How do stakeholders increase their knowledge and awareness in green/sustainable issues?*

One of the arguments made in Chapter Three concerns about the low level of knowledge on sustainability issues among Malaysian building stakeholders; hence, it is important to recognise the interviewees' place of education and trainings in order to increase their knowledge and awareness in this area. Overwhelmingly, all of the interviewees greatly supported such initiatives and believed them as exceptionally important.

When questioned to explain their efforts or specific initiatives undertaken, 53% of the interviewees claimed that they "Emphasized on attending/organising formal education and trainings outside own organisation". Architects clarified that they frequently attended or sent their senior architects to attend Continuing Professional Development (CPD) programmes. Other stakeholders groups also claimed that they attended conferences, seminars, workshops or forums to keep abreast with the latest green technologies, materials and products. Interestingly however, the building environmental consultant claimed that additional knowledge needs to be sought overseas by attending international educational programmes due to the notion that the development of local educational programmes on sustainability issues is still embryonic.

A lesser number (37%) of the interviewees had "Emphasized on informal in-house talks and self-training/self-taught". Whether in a form of lectures with proper visuals or just talks, these interviewees believed that the culture and enthusiasm of practicing sustainably must be inculcated in their companies. A couple of them even asserted that they performed weekly internal peer discussions solely for knowledge and information sharing. Whilst, a few others believed more in self-training or self-taught through personal research using published materials and the internet. Finally, only 10% did not emphasize on education and trainings, and the reasons being trained staffs can easily search for higher pay elsewhere (Arch/Male/7); and employer's ignorance and negligence on green or sustainability issues (Arch/Female/1).

Next, the interviewees from the private sector were asked to state any tools (i.e. softwares, guidelines) being used to help them designing, constructing, developing or maintaining a green or sustainable building. 57% from all professions, with the exception of the engineers and building environmental consultant, had never used any tools (see Figure 6.5). "ASHRAE guidelines, Malaysian ISO Standards, procedures and checklists" are the mostly used tools, cited by 6 out of 14 interviewees from all professions except the developers. Only 3 architects and 1 building environmental consultant have used "building simulation tools" while many of them still preferred to evaluate their designs based on intuition. Only very few used "building environmental rating tools" and "energy monitoring" such as energy loggers.

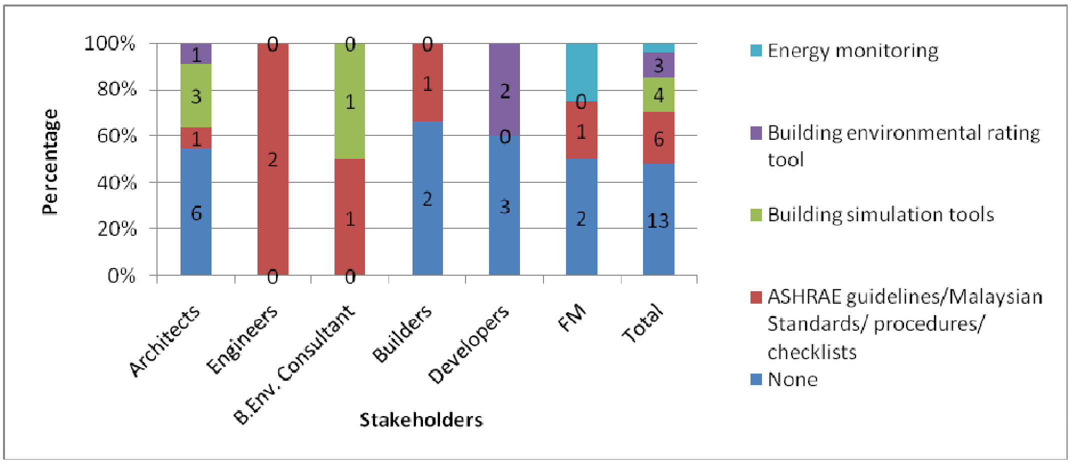

Figure 6.5: Percentage distribution of tools used by the interviewees.
Note: Total answers given by 23 interviewees = 27; Total number of tools given by 23 interviewees = 14

6.3.2.1.4 Can the culture of feedback be practiced more widely?

In use, buildings do not always work as intended. Some features perform better and some worse. Different things happen which nobody anticipated; therefore, the stakeholders were asked whether it was important for them to know how the building that they had designed, built, or developed performs during its occupancy period or how satisfied occupants were with the building's indoor environmental quality. This part of interview aimed to investigate the extent of post occupancy evaluation (POE) been undertaken by design and building teams in the country.

The result shows that there was virtually unanimous agreement that feedbacks that could help clients obtain information on the performance of their completed projects were very important. Three reasons were suggested, namely: 1) to provide a continuous learning process; 2) to eliminate the current poor practices of building maintenance, hence reducing the problem of Sick Building Syndrome (SBS), as one put it: “More than 80% of buildings in Malaysia are not well maintained” (Arch/Female/6); and 3) to maintain good reputation: “...investors would want to maintain their good reputation by offering buildings which would satisfy the users” (Dev/Female/2).

Unfortunately, despite the obvious benefits of receiving feedbacks, a few interviewees conceded that this seldom happened. When it does, much is confidential, and at best made available unattributably or anecdotally. As one interviewee stated: “…unfortunately we can’t get access [to the building]. It is always a little problem in the beginning because people are so used to very wasteful practices” (Bldr/Male/3). Furthermore, feedback is not a standard part of the design service. As one interviewee indicated:

> Normally...most of the consultants…their fees are locked into one job. When it is completed, they move on. But for us, we actually ask for a little bit more fees for the one-year finetuning period. The architects...sometimes they are interested and sometimes they are not interested [to know the results] (BEnvCon/Male/1).

FacMgr/Male/2 explained that certain consultants have a self-denial syndrome of which they feel their pride and prestige is affected when their design defective issues are made known. Therefore, it could be argued that certain professionals were unlikely to admit and openly discuss shortcomings in systems and in-use performance, and to identify where they and the industry need to improve.

Only 30% of the interviewees, with the exception of builders, explicitly mentioned that they actually practiced it. For example,

- Arch/Female/2 claimed that architects generally maintain advising their clients (if requested) after Defect Liability Period (DLP) but they do not take the liability or responsibility if the building costs too much to be operated and maintained;
- BEnvCon/Male/1, FacMgr/Male/2 and FacMgr/Male/3 conducted occupant surveys and IEQ measurements during occupancy stage. Interestingly, BEnvCon/Male/1 added that he normally called for seminars to educate the industry players on the results and the lessons learnt to enable implementers to access relevant knowledge and apply it in project designs;
- Developers with ISO9001 certification i.e. Dev/Male/3 and Dev/Female/1 carried out “Client Satisfaction Survey” as part of their ISO procedures to determine the future market trend and demand for similar development.

Regardless whether they actually practiced POE or not, generally, they bemoaned the fact that POE had been challenging to be widely practiced in Malaysia. The most common reason for this was the lack of desire and incentive for building owners to conduct POE, hence to carry out refurbishment works on their building, and this was agreed by consultants, developers and policy makers. Two examples are typical of the reluctance among private clients:

> No tenants would ask for it [POE]...the way we argue it to our client...they should at least pay us to do this because we need to monitor and finetune their building for one year. We need to confirm that the new building is working (BEnvCon/Male/1);

and,

> Only multinational companies would request [for POE] and they pay for it...Locally...the awareness is not there (Engr/Male/1).

Apart from acknowledging the lack of awareness among local building owners, these interviewees recognised that in practice, most private organisations were unable to cope with feedbacks and could not (or thought they could not) afford it.

Similarly with public clients: the culture of feedback was not easy to be created in government organisations due to the lack of specific budget allocated for effective operation and maintenance (Regr-PMaker/Female/3). Further, there are no existing laws and regulations that require identification and correction of any problems (PMaker/Male/5). Hence, a solution was prompted: "...local authorities should enforce it [POE]...perhaps they could appoint consultants to evaluate...whether the building is operated according to what it had purposely been designed for" (Arch/Male/8).

The aforementioned challenges imply that the local construction industry was slow to learn from its completed products, particularly once they were in the hands of their users. Nevertheless, according to Bldr/Male/3, POE can become more practiced in new buildings or facilities management if local building performance assessment systems put an emphasis on revisiting the operation stage of a building life-cycle.

6.3.2.1.5 Does universal design matter?

Answers to the current state of accommodating universal access (i.e. for disabled people, elderly, strollers and 'abled' people) in office building designs are varied. For example, 20% of the interviewees explicitly acknowledged that the minimum requirements have already been spelt out in the *Uniform Building Bylaw* (UBBL) and the *Malaysian Standard MS 1184: Code of Practice on Access for Disabled People to Public Buildings*. Nevertheless, other 10% further clarified that accessibility is only mandatory for government and semi-government buildings; and only to a certain limit for private buildings. Even though that is the case, others clarified that the mandatory compliance is still depending on local authorities and their level of enforcement. For example: "...you can see there are a lot of buildings been approved without this accessibility" (BEnvCon/Male/1).

Other 20% associated accessibility aspect with clients' social obligation/responsibility and corporate image but Dev/Female/2 conceded that the aspect had only been considered after being demanded by foreign investors and tenants. Another 20% linked accessibility to the current practice of only complying with the minimum requirements of UBBL and MS 1184, as one interviewee stated: "...not to segregate the disabled and the 'abled' facilities. So it is a facility for everybody, which is not mentioned in the MS 1184...Out toilets should be friendly for the disabled rather than put one cubicle just for them" (Regr-PMaker/Female/3). According to GovPI/Male/1, merely complying with the minimum requirements also resulted in disjointed facilities i.e. not covered throughout the development. These responses seem to be in line with views from three other interviewees which indicate that certain consultants are ignorant, not realistic and uncompassionate in designing for accessibility; hence, their designs became an economic 'waste'. For example, "...our toilets for disabled...have been deteriorated. So these toilets become store for our cleaners" (FacMgr/Male/3); or "...the ramp is too steep. Without help, the disabled can't get onto that" (Dev-Owner/Female/4). A couple of interviewees bemoaned the fact that universal access was important but usually neglected especially in office buildings where mostly used by 'abled' people.

This research clearly indicates that the provision of universal access in the local building sector is still not widespread and disintegrated. Since current efforts only focus on complying with the standard's or local authority's minimum requirements, stakeholders need to be rewarded for their initiatives to go beyond the minimum requirements stipulated in the UBBL and MS 1184.

6.3.2.2 Current Environmental Practices

This sub-theme comprises of seven issues, namely: 1) Environmental issues; 2) Environmental strategies; 3) Reused and recycled materials; 4) Wastage reduction; 5)

Ecologically friendly and healthy products/materials[5]; 6) Office recyclables; and 7) ISO 14001 certification. Each of these issues is described in the following.

6.3.2.2.1 What environmental issues have stakeholders considered?

This question aims to explore the extent of the interviewees' environmental practices and to define the gaps that need to be bridged to promote sustainable building development in the country. 52 environmental issues were recorded to be practiced and these are then classified into seven categories. For comparison purposes, the result of "what they had practiced", as reported earlier in Table 6.4, is combined with the result of "what they thought" and this is shown in Figure 6.6.

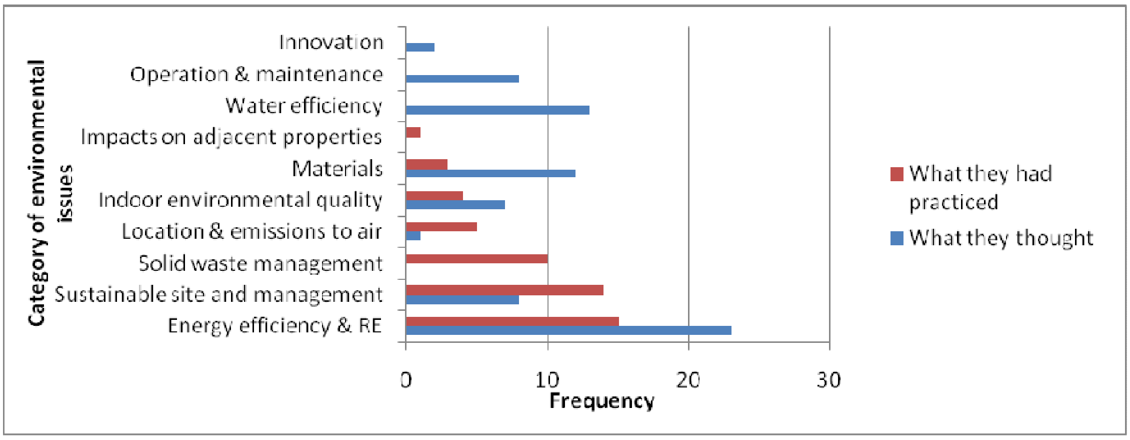

Figure 6.6: Frequency distribution of environmental issues (grouped in categories) thought to be important for a 'green' building vs. those that had been practiced. Note: Total answers given by 30 interviewees = 52

It was found that generally, there are only five environmental categories that had been practiced and at the same time were thought as essential for a 'green' building, namely: 1) "Energy efficiency and renewable energy"; 2) "Materials"; 3) "Sustainable site and management"; 4) "Indoor environmental quality"; and 5) "Location and emissions to air". Another two environmental issues i.e. "Solid waste and management" and "Impacts on adjacent properties" were claimed to be practiced but none of the interviewees thought they were important for a 'green' building. Contrastingly, three gaps exist in their current practice; for example: "Water efficiency", "Operation and maintenance" and "Innovation" were thought to be important for a 'green' building but none of the interviewees cited that they had incorporated these issues into their practice or projects.

The findings also show that "Energy efficiency and renewable energy" was by far the most prevalent of the environmental issues interviewees had incorporated into their

[5] Ecologically friendly and healthy products/materials are those derived from sustainably managed sources, have low environmental impacts and/or have low level of chemical emissions that affect indoor environmental quality.

projects (29% of the responses). This result is in parallel with the ranking of perceived criteria of a 'green' building. Consecutively, "Sustainable site and management" issue was the second most commonly incorporated practice (27%), followed by "Solid waste and management" (19%). It is also important to note that more interviewees thought that "Energy efficiency and renewable energy", "Indoor environmental quality" and "Materials" are important compared to those who actually practiced them.

Therefore, it is important for all the categories of environmental issues, especially those which were not or least practiced, to be incorporated in the MOBSA framework to close the practice gaps as well as to encourage more environmental practices among stakeholders.

6.3.2.2.2 *What strategies could stakeholders implement to address the environmental issues?*

Realizing the environmental issues practiced by the interviewees, the interview went further to examine the strategies that they implemented to address those issues. 21 categories of suggestions are established: 8 from consultants; 4 from regulators, policy makers and government project implementer; 4 from facility managers; 3 from builders and builder-developers; and 2 from developers. Table 6.8 contains the quantitative descriptions of the result.

Majority (38%) of consultants suggestions are related to strategies to optimize land use and reduce impacts on ecology, such as minimize disruption to existing natural features and design for optimum building shape and placement. Another 19% concern about implementing passive design strategies e.g. building shape, massing, orientation and space layout, envelope, daylight and ventilation strategies. A lesser number of suggestions (14.3%) are related to specifying local green products/materials and materials that can be recycled, whilst only 9.5% concern about designing or specifying systems that minimize potable water consumption. With regard to the latter strategy however, an interviewee noted, "We do not need to reach the stage of recycling all the wastewater yet because our water is abundant and cheap but it will come" (Engr/Male/1).

Table 6.8: Summary of interviewees' suggestions in terms of what stakeholders could implement to address the environmental issues. Note: Total suggestions given by 27 interviewees = 47

Category of Local Stakeholders' Suggestions to address the environmental issues		No. of times recorded N	%
From Consultants (N=12)		**21**	**100**
1	Optimize land use and reduce impacts on ecology	8	38
2	Passive design strategies	4	19
3	Specify local green materials	3	14.3
4	Design/specify systems that minimize potable water consumption	2	9.5
5	Design/specify highly efficient mechanical/active system	1	4.8
6	Appeal for higher density for green development in a city centre	1	4.8
7	Consider socio-cultural issues	1	4.8
8	Multi-disciplinary collaboration	1	4.8
From Regulators, Policy Makers & Gov. Project Implementer (N=6)		**10**	**100**
9	Establish and enforce finite standards and guidelines	3	30
10	Demonstrate "Leadership by Example"	3	30
11	Grant incentives for those who adopt and impose punitive surcharges on the non-compliance	3	30
12	Escalate the energy rates to reflect the true cost	1	10
From Facility Managers (N=4)		**8**	**100**
13	Monitor indoor environmental performance and occupants' satisfaction	5	62.5
14	Ensure equipment is maintained to the original specification or condition	1	12.5
15	Maintain logbooks and utilise facility management tools	1	12.5
16	Conduct awareness program for new tenants	1	12.5
From Builders & Builder-Developer (N=3)		**6**	**100**
17	Advise other project team players to 'act' green (for design & build projects)	3	50
18	Implement measures to minimize environmental damage due to the construction process	2	33
19	Minimize the use of timber formwork as much as possible	1	17
From Developers (N=2)		**2**	**100**
20	Refer to EIA report for development in rural areas/ green fields	1	50
21	Appoint a 'green' manager to monitor the implementation of environmental and waste management plan on site	1	50
Total number of suggestions recorded		**47**	**100**

From the perspective of regulators/policy makers, the first three categories of their suggestions concern the followings (each category represents 30%): 1) establish and enforce finite standards (not just guidelines) that set out appropriate design criteria for compliance by developers to ensure planning and building approvals; 2) demonstrate "lead by example" by complying with the more stringent building codes and standards and subsequently demonstrating the economic benefits to the private sector; and 3) grant incentives for those who successfully adopt the respective standards and impose punitive surcharges on non-compliances, even for existing buildings over a specified time frame.

Majority (62.5%) of facility managers' suggestions concern the importance of regular monitoring the operation and occupants' satisfaction. Builders on the other hand, believed that they are only complying with developers/clients' requirements and environmental destruction is something beyond their control. Hence, half of their suggestions are about the necessity for advising other team players on strategies to reduce environmental impacts, particularly for design-and-build projects; for instance: advising developers for not maximizing number of units for development on hillside to minimize land cuttings; and advising design consultants to preserve natural features on site and to enhance repetitiveness in components' dimensions. Only 33% of builders' suggestions are related to their own responsibility for implementing measures to minimize ecological damage on the site or adjacent lands. Lastly, developers suggested that they could refer to Environmental Impact Assessment (EIA) report for development in rural areas/ green fields before determining the development zoning (50%); and appoint a 'green' manager on construction sites (50%).

Generally, it seems that the environmental strategies suggested here are relatively similar to the strategies suggested to achieve a 'good' office building, as described earlier. Therefore, it is sensible to suggest that they perceived a 'good' office building as the one that addresses all the environmental issues. In summary, all stakeholders were, to a certain extent, aware of their own responsibilities and the concerted effort needed in achieving sustainable construction. This awareness however is only reflected on what they know in theory; hence, not necessarily been practiced in reality. Hence, it is deemed important for the strategies to be incorporated in the MOBSA framework to ensure they are widely practiced.

6.3.2.2.3 *<u>To what extent do stakeholders utilize reused elements/components and recycled materials?</u>*

Interviewees from the private sector (totalled 23) were asked the extent to which they were motivated to specify or utilize reused elements/components and recycled materials in office building projects. Those from the public sector (totalled 7) on the other hand, were asked whether they would encourage the industry to use these materials. The result is shown in Figure 6.7.

Overwhelmingly, half of the interviewees have never specified or used these materials in their professional career. For example, Bldr/Male/2 recognised that building components and finishes are destroyed during renovation or demolition process. He further admitted that dumping unseparated and reusable construction wastes in landfills has also been a common practice. Similarly, FacMgr/Male/1 asserted that reusing salvaged materials to new building projects has rarely been practiced.

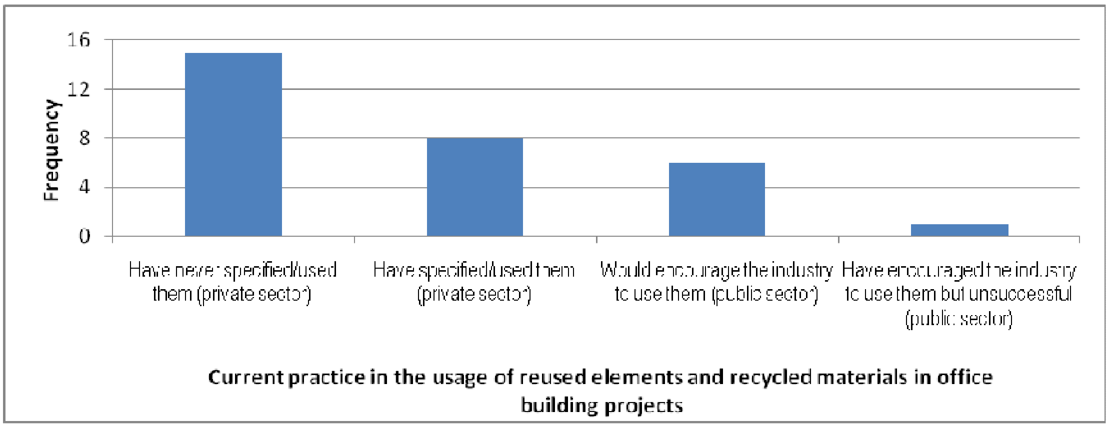

Figure 6.7: Frequency distribution of interviewees' current practices in the usage of reused/recycled products/materials in office building projects (N=30)

Only eight interviewees claimed the opposite. Examples of reused/recycled materials given include:

- Recycled steel as Malaysian-made steel has a certain percentage of recycled content;
- Waste materials from construction site i.e. timber formwork, left-over cement, discarded glass and broken tiles as part of interior décor;
- Reused timber as formwork for new construction;
- Fly-ash concrete in new construction projects.

Clearly, waste recycling is still seen in terms of fly-ash, timber and steel reuse, but this viewpoint needs to be expanded to strategies that add much higher value to reused or recycled materials. Besides, none of the interviewees acknowledged the experience of using recycled concrete aggregate in new concrete. This confirms the views given by two builders which indicate that concrete is currently not being recycled in Malaysia.

With regard to responses from the public sector, only PMaker/Female/3 had actually tried to encourage the industry to use these materials, however in vain due to readily available cheap resources such as labour and raw materials. Questioned about the subsequent steps taken by the local authority, this same interviewee commented that applications to upgrade an existing building by retaining existing structures were given the priority and consultants were allowed to submit their skeletal building (without finishes, fittings and fixtures) for building approval. Whilst, the rest only said that they would encourage the industry but also admitted that using reused or recycled components/materials were not being practiced in government building projects.

Generally, interviewees showed a degree of reluctance, regardless of whether or not they had specified or used this kind of materials before and also regardless of whether they worked in the private or public sector. This reluctance was interpreted by the concerns they voiced, which totalled 59 and are classified into 10 categories (Figure 6.8).

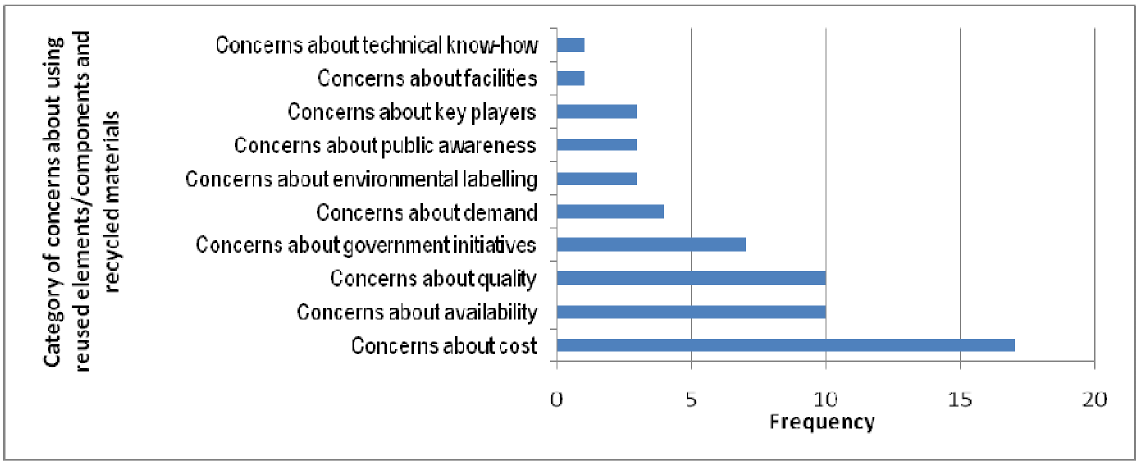

Figure 6.8: Summary of interviewees' concerns that impede the widespread usage of reused elements/components and recycled materials. Note: Total comments given by 30 interviewees = 59

Obviously, the interviewees' concerns are primarily about "cost" (29% of the comments). Many interviewees believed that reconstituted timber, concrete with fly-ash content, recycled concrete and glass are much more expensive than new materials because they involve additional processes in the factory.

The second most cited concerns are about the "availability" and "quality" (each represents 17%) of those components or materials in the local market. Within the former category, responses seemed varied. For instance, four interviewees indicated that they had never come across with these materials; two stated that these materials were very limited in terms of their range and quantities; and one explained that recycled timber was seldom available due to its great demand for local high-end house projects. Whilst within the latter category, interviewees generally claimed that clients always prefer new materials as it is a common belief that reused and recycled materials are not new, hence low in quality. For example, as one interviewee indicated, "Malaysian market doesn't provide them because the suppliers perceive that recycled materials are equated with poor quality material, which is not true" (Arch/Male/3). This belief seemed to be confirmed by three developers when they indicated that they would demand these materials only if they met the specification and standard requirements and if there were documented track records in terms of their performance in local case studies.

Consequently, there were some comments which mainly concerned about “initiatives from the government” (12%); such as: “Opportunity will only come with a regulation because people won’t use them voluntarily” (PMaker/Male/1). This comment is consistent with Regr-PMaker/Female/3 who tried to encourage the industry to used recycled materials voluntarily but in vain. Related to the quality issue is the lack of “demand” from clients (7%). In one case, initiatives were taken to specify them but eventually rejected by the client. Two consultants recommended for such materials to be included in any building assessment systems implemented in the country to create more demand.

It is important to note that consultants could only understand the environmental impact from different building elements and seek optimal solutions for the overall impacts of a building design if environmental aspects of these elements were properly documented and labelled. This became another area of concerns among consultants (5%); for example, two of them bemoaned the fact that differentiating recycled materials in the market was difficult due to the absence of standard measure to prove and declare their recycled contents.

In spite of many issues that impede the widespread usage of reused elements and recycled materials in the office building sector, 37% of the interviewees were optimistic about the opportunity for these materials in the future; whereas 33% claimed that the opportunity would only come if their concerns are addressed in the future. The remaining was less optimistic by indicating little opportunity or no opportunity at all or they were simply not sure.

6.3.2.2.4 How do stakeholders reduce wastage in their practice?

In this section, the interviewees (i.e. consultants and builders only) were asked to explain how the reduction of waste was considered in their design or construction activities. As shown in Figure 6.9, most interviewees (73%) chose to comment on Industrialized Building Systems (IBS)[6] as a replacement to conventional construction method (reinforced concrete frames and brick as infill). This consideration is manifested in a couple of ways:

[6] The IBS is a construction process that utilises techniques, products, components, or building systems which involve prefabricated components and on-site installation. From the structural classification, there are five IBS main groups identified as being used in the country, and these are: 1) Precast concrete framing, panel and box systems; 2) steel formwork systems; 3) steel framing systems; 4) prefabricated timber framing systems; and 5) block work systems (CIDB Malaysia, 2003).

- Lightweight prefabricated formwork that is easily erected and dismantled to replace traditional timber formwork. For this, engineers designed for repeatability (BEnvCon/Male/1); and
- Precast concrete components i.e. precast load-bearing wall panel, precast frame and precast floor (Arch/Male/8).

However, none of interviewees indicated that they considered using sandwich panel[7], block panel[8], and steel frame structures.

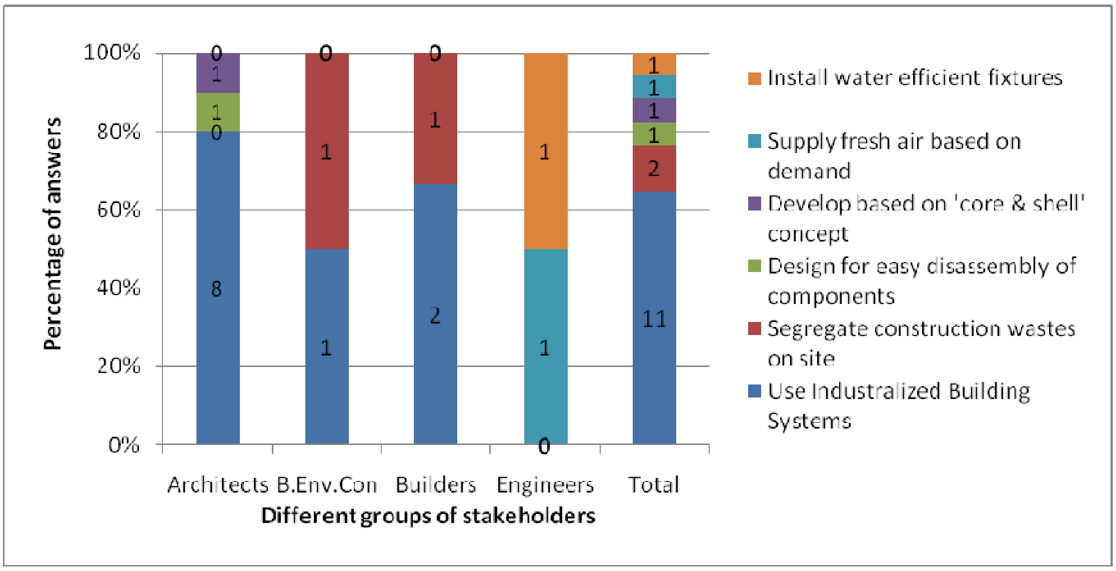

Figure 6.9: Frequency distribution of methods used by interviewees to reduce waste from buildings. Note: Total suggestions given by 15 interviewees = 17

There were also some issues raised relating the use of IBS instead of the conventional system. These include: 1) higher initial capital investment (Bldr/Male/2); 2) higher cost involved for transporting factory-produced components to the site (Arch/Male/3 and Arch/Male/4); 3) volume and economies of scale (Arch/Male/3 and Arch/Male/4); and 4) tremendous need for technical know-how e.g. design using Modular Coordination concept i.e. a system of preferred dimensions (Arch/Male/9). Interestingly, two interviewees indicated that they reduced waste by sorting construction wastes on site; however, unsure of the final destination of their sorted wastes due to their unfamiliarity with any recycling centres in the area.

Only one interviewee reduced waste by designing for easy disassembly of components; that is, "...to facilitate reuse, the connection between components in the built form and in

[7] Sandwich panel system is "a layered structural system composed of a low-density core material bonded to, and acting integrally with, relatively thin, high-strength facing materials" (Badir, *et al.*, 2002, p.21). It is normally used as a wall, roof or floor element.
[8] Load-bearing block system is "a cast hollow block, which can be composed of a variety of material, such as concrete, lightweight concrete, stabilized mud, and dense polystyrene" (Badir, *et al.*, 2002, p.21).

manufactured products needs to be mechanically joined for ease of demountability. The connection should be modular to facilitate reuse in an acceptable condition" (Arch/Male/5). Another interviewee criticized the current legislation as encouraging the creation of wastage instead of promoting recycling. When further questioned, the same interviewee suggested the idea of developing based on 'core and shell' concept where finishes, fixtures and fittings are specified by occupants not landlords to avoid new tenants replacing brand new materials/products installed by the landlord.

6.3.2.2.5 To what extent do stakeholders utilize ecologically friendly and healthy products/materials?

Interviewees from the private sector (i.e. 9 architects, 3 builders and 5 developer-owners only) were also asked the extent to which they were motivated to specify or utilize ecologically friendly and healthy products/materials in office building projects. Those from the public sector (i.e. 1 government project implementer and 5 regulators-policy makers); however, were asked whether they would encourage the industry to use these products/materials.

There was virtually unanimous agreement among interviewees from both sectors that the products/materials need to be exploited in the construction industry. However, one builder somehow put across an interesting point that healthy products are more applicable to renovation projects as the buildings are normally occupied or occupants move in much quicker. New buildings on the other hand, normally have two months before occupancy, hence having ample time to be flushed-out with fresh air to remove any airborne contaminants e.g. volatile organic compounds (VOCs). It would appear then that VOC emitted by products such as adhesive, sealants, paints and finishes only occur during installation hence need to be removed only during pre-occupancy stage. If this is the case, then this view seems to contradict with Kibert (2005) who pointed out that VOCs can continue to be released from VOC-contained products for years after installation, thus harming occupants. Therefore, the easiest solution is to use non-VOC or low-VOC products instead.

Despite the general encouraging responses given, most indicated their concerns that impede the widespread usage of ecologically friendly and healthy products/materials. In total, 84 concerns were identified and these are classified into four categories (Table 6.9). The result clearly shows that interviewees, across all stakeholder groups, mainly concerned about the "recognisability" of these products/materials. To be precise, these products/materials do not carry any certification or eco-label to designate them as being preferable on the basis of consensus standards because of two reasons: 1) no authority to certify them locally (PMaker/Male/1 and Arch/Female/6); and 2) they are mostly imported (Arch/Male/5) or certified by other countries (Engr/Male/1).

Table 6.9: Category of interviewees' concerns that impede the widespread usage of ecologically friendly and healthy products/materials. Note: Total comments cited by 30 interviewees = 84

Category of concerns	No. of times recorded	
	N	%
1. Concerns about recognisability (labelling)	29	34.5
- Not easily recognizable (no ecolabel)	25	30
- Some are recognizable (with ecolabel)	4	4.5
2. Concerns about availability	28	33.3
- Not widely available	14	16.6
- Available	8	9.5
- Available but imported	3	3.6
- Not sure	3	3.6
3. Concerns about awareness and demand	14	16.7
4. Concerns about cost	13	15.5
- More expensive	11	13.1
- Not necessarily more expensive	2	2.4
Total number of comments recorded	**84**	**100**

Only a few interviewees believed the existence of such labelling programs locally but clarified that the product range is very limited and mainly covers wood products certified by Malaysia Timber Certification Council (MTCC). As one interviewee stated, "Malaysian timber is extensively exported…We have to give eco-timber because imported countries force us to..." (Engr/Male/1). Questioned about the difference between MTCC's and FSC's (Forest Stewardship Council's) certified wood products, another interviewee replied, "the local one does not look into the social aspects of felling trees, displacement of indigenous people…whereas FSC does" (BEnvCon/Male/1). Additionally, Arch/Female/1 indicated her doubt on the adequacy and credibility of existing eco-labelling.

The second most cited concerns are about the "availability" (33.3%) of these materials/products in the local market. Although 16.6% indicated the products are not widely and readily available, 9.5% suggested the opposite. Related to this concern is the lack of "Awareness and demand" (16.7%) which in turn contributed by three factors: 1) high cost (mentioned by 13.1% of the interviewees). One developer-owner added that she would be willing to pay more only if such decision would lead to substantial savings in the future (Dev-owner/Female/4); 2) merely relying on consultants for relevant information (Dev-owner/Female/4); and 3) the practice was not required by law (Regr-PMaker/Male/2 and Regr/PMaker/Female/3).

Clearly, the materials' benefits on the environment and human health are generally acknowledged but unsurprisingly, the economic aspects remain one of the hurdles. More importantly, the research highlights a tremendous need for all concerns to be addressed before the usage of ecologically friendly and healthy products/materials can be widespread in country.

6.3.2.2.6 How could separating and collecting office recyclables be widely practiced?

The result indicates that there was a general consensus that the practice of separating and collecting office recyclables e.g. paper, glass bottles, aluminium cans, and cardboard should be supported and encouraged. As shown in Figure 6.10, majority (35%) of the interviewees, across all stakeholder groups, also proudly admitted that they actually practiced it in their own office, whereas 31% did not explicitly declare their current state of implementation, but simply supported the practice. On the other hand, several suggested the pre-requisites to the successful practice e.g. enforcement by the top management (12%), and increase the level of peoples' awareness (12%).

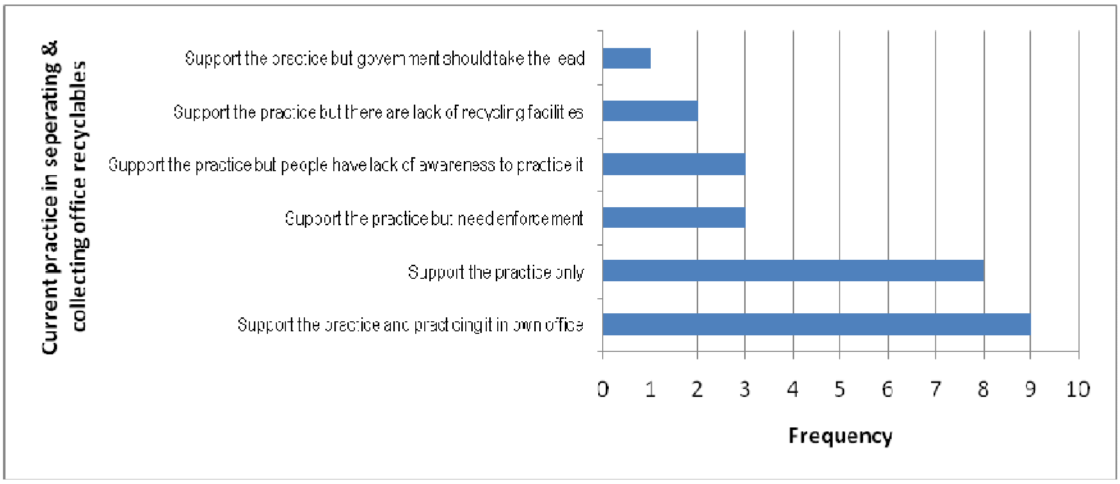

Figure 6.10: Frequency distribution of interviewees' current practices in separating and collecting office recyclables (N=26)

The interviewees were also asked about the importance of allocating spaces for collection of recyclables at the point of use (copy rooms, break areas, etc.), and recycling storage and staging areas at the loading dock. The result reveals that nearly half (48%) of the interviewees agreed that the provision of the facility is the key to encourage recycling among tenants. However, several (28%) did not believe so and suggested that the tenants' awareness should come first; whilst 16% claimed the facility is essential but the practice requires enforcement. Collectively, these interviewees believed that recycling awareness should be first inculcated among tenants to ensure the culture of recycling is developed and maintained even when the top management personnel are changed. Enforcement should then come into place only when the culture is not successfully developed and even so, it must be followed up with reminders and monitoring. Only 4% believed that the general awareness is adequate but the locally mandated requirements for recycling and local recycling infrastructure should be made available prior to providing facilities at the collection points.

In summary, public awareness, enforcement, and availability of local recycling infrastructure are of paramount importance to promote recycling in the country. Therefore, it is sensible to suggest that these conditions have to be met before building owners and consultants could see the worthiness of accommodating potential for enhanced recycling in the building design. However, it is important to note that design should not only accommodate present opportunities for recycling, but also anticipate future opportunities.

6.3.2.2.7 Why is there a lack of interest in seeking ISO 14001 certification?

As construction is an important industry in any economy, it has an obligation and the potential to make a significant contribution to sustainable development through implementing ISO 14001[9]. Hence, it is important to see the extent to which construction companies seek to acquire registration with ISO 14001. It was found that 10 out of 12 consultants interviewed had never worked with ISO 14001 EMS certified construction companies in their professional career. One asserted that none of his clients, either public or private organisations, insists on this requirement. The response from developers seemed to confirm this notion as 3 out of 5 developers interviewed admitted that ISO 14001 has never been their contracts' requirement.

1 out of 2 consultants who claimed that they have had working experience with ISO 14001 certified builders suggested that these builders are more disciplined and proactive in their approach to environmental management. However, this is not always the case as the other consultant pointed out the opposite i.e. these builders seldom practiced according to the ISO requirements. This may indicate that ISO 14000 has not become an integral part of the construction companies' culture. It also raises a question about the

[9] The ISO 14000 standards have been developed to stimulate better environmental management practices by businesses. The standards provide a mechanism that links the concept of sustainable development with the construction procurement process.

credibility of the audit exercises which are required on a periodical basis in order to provide assurance that the environmental management system (EMS) is operating as planned.

Two builders interviewed were certified with ISO 14001 and acknowledged that in the area of waste minimization and pollution prevention, better environmental performance and reduction in operating costs have brought more business opportunities, market share gains and lower cost relative to competitors. Contrastingly, another one builder bemoaned the fact that ISO certification was solely pursued for the purpose of marketing strategy and not so much about continually improving their approaches to achieve the objectives of sustainable construction.

Finally, PMaker/Male/4 from the Construction Industry Development Board explained that one of the main reasons for the lack of interest in seeking ISO 14001 certification among construction companies and real estate developers in Malaysia, is related to cost which would roughly be in the amount of RM20,000 (or AUD6600), twice the cost of obtaining ISO 9000. He further clarified that most of the ISO 14000 certified developers and builders are multi-national companies and those who expand their markets overseas where environmental management is a desirable or compulsory requirement.

6.3.2.3 Current Economic Practices

This sub-theme consists of four issues, namely: 1) Prioritization; 2) Capital and operation costs; 3) Sustainable property market value; and 4) Parking capacity. Each of these issues is described in the following.

6.3.2.3.1 <u>Have economic issues been the stakeholders' first priorities?</u>

Majority of the interviewees (77%) believed that they had always considered economic issues as the first priorities in any decision-makings for office building projects (see Figure 6.11). It is also important to note that the remaining 23% of stakeholders who did not consider economic issues as first priorities did not include developers.

The most common economic issue cited was the economic return especially when the projects involved clients who build to sell. For owner-occupied buildings, "Corporate Social Responsibility" was cited as the driving factor in decision makings apart from economic considerations (BEnvCon/Male/1). For most local developers and building owners however, PMaker/Male/5 believed that they only concerned about having their buildings meeting the minimum mandatory standards enforced by the approving authorities and built at minimum cost without giving so much thought about energy efficiency concept as it was considered an economic waste due to heavily subsided electricity tariffs. Nevertheless, he added that the situation has slowly started to change. For others who believed economic issues were not their first priorities cited “health and well-being of building users”, “deliver on time and in good quality”, and “company’s goals” instead. Only one interviewee cited that economic issue is “equally important as environment and social issues” (Arch/Male/5).

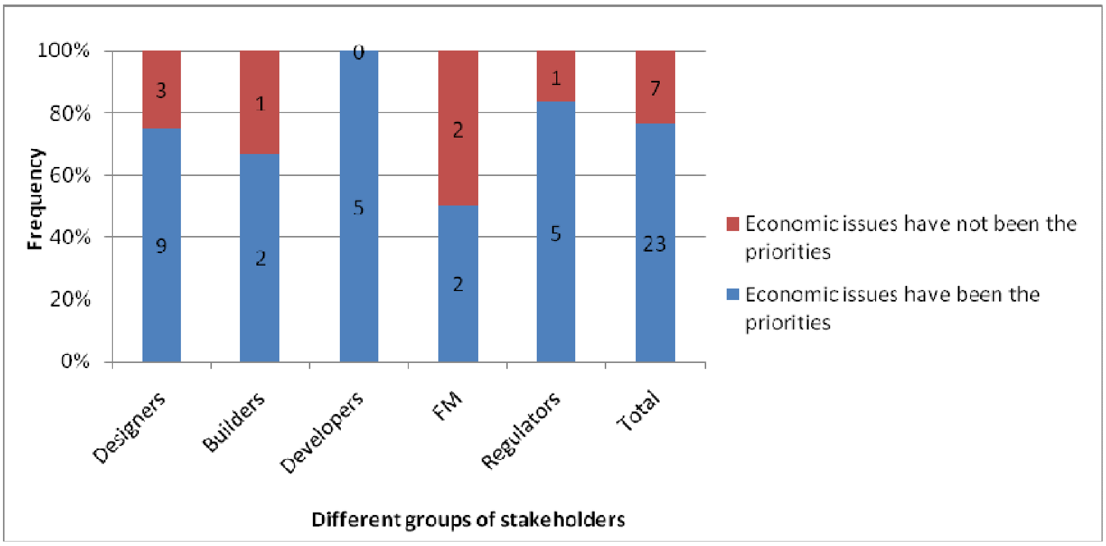

Figure 6.11: Frequency distribution of interviewees who have and have not considered economic issues as the first priorities (N = 30)

6.3.2.3.2 <u>Capital cost, operational cost or both?</u>

60% of the interviewees, consisting of all stakeholder groups, had always considered minimising the capital or construction cost as more important than minimising the long-term operational costs (see Figure 6.12). These stakeholders admitted that generally the local construction industry is less concerned about the operational and maintenance costs as these costs are perceived to be the tenants’ problem, unless the properties involved are for rent/lease. Further, Dev-owner/Female/4 clarified that her organisation had limited capital at the time of construction and willing to pay to reduce operational costs when more capital could be earned from future rental incomes. Another reason for developers and owners to prioritize on minimizing capital cost was the lack of advice from, or negligence among, consultants. For example, “Lots of consultants neglect life cycle costing and do not have the knowledge to execute life cycle cost analysis” (Arch/Male/8). Negligence in life cycle costing was also relevant to local builders.

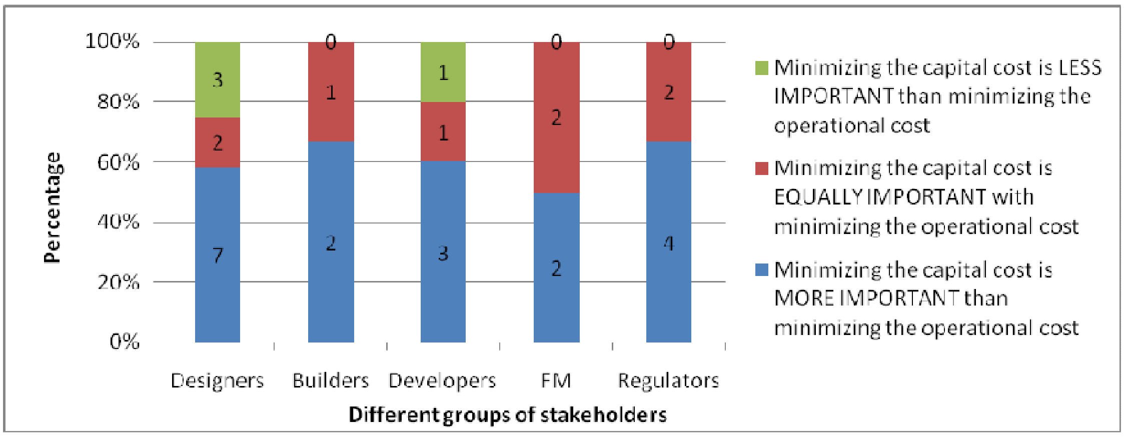

Figure 6.12: Frequency distribution of interviewees with different priorities between capital and operational costs (N = 30)

Only 27% of the interviewees had always considered minimising the capital or construction cost as equally important as minimising the long-term operational costs. For instance, FacMgr/Male/2 indicated that he managed the Capital Expenditure (CapEx) of energy performance contracting on behalf of his client in order to improve the operational and maintenance quality or minimize the long-term operational cost of his client's building. Similarly, Bldr/Male/3 criticized the practice of cutting corners to minimize construction cost as the practice, "can end up with higher cost for repair and maintenance during Defect Liability Period...might also affect the builder's good reputation..."

The remaining 13% support the importance of minimising the operational and maintenance cost and the reason being that it has always been more expensive because it is incurred over a long period of time.

6.3.2.3.3 <u>Does a sustainable building guarantee higher market value?</u>

Six interviewees (i.e. developer, builder-developer and developer-owner only) were asked to comment whether there was a relationship between sustainability and property market value in the Malaysian context. The responses indicated there was none and the reasons for this non-relationship are twofold: 1) lack of local empirical data to prove the economic benefits of green or sustainable buildings to local investors; and 2) lack of awareness amongst property investors. For instance, Dev/Female/02 admitted that her organization had once conducted a customer/investor survey aimed to assess the viability of increasing sale prices of their proposed green commercial development. Sadly, the results showed that the potential commercial building investors rated elements of green building very low in their priorities of future investments. Therefore, it is unsurprising that this lack of demand on green building has resulted in an absence of green criteria on value component when undertaking a valuation of a commercial office building. Instead, the most quoted factors include “location, office floor area, connectivity and so on” (Dev/Female/2).

Hence, the key variables within the property investment market are still rental and yield. Only when these factors are being adjusted, either explicitly or implicitly, to reflect the sustainability of an asset, will it be possible to characterize the market as having changed. Due to the lack of awareness amongst market operators as well as lack of case study data, no clear evidence emerged from the interviewees that sustainability is a factor in rental negotiations or investment purchasing.

6.3.2.3.4 Are we ready to reduce the parking capacity?

Interviewees were also asked about the extent to which they would be prepared to reduce car parking spaces than the minimum allowable by the authorities in order to promote the use of public transport. The responses showed that certain local authorities have in fact offered car parking discounts. This was confirmed by one interviewee from a local authority who said, “...we give 45%, 30% or 25% [less parking requirement] depending on the proximity of the building to the public transportation hub” (Regr-PMaker/Female/3). Accordingly, one developer-owner conveyed her gratitude message for getting an approval to provide 30% less car parking spaces than the official requirement: “Otherwise, I would have to construct another one basement floor. So, that saves a lot of our money and a lot of construction times” (Dev-owner/Female/4).

In another case, despite being granted with 30% discount of parking spaces, a developer-owner provided more parking spaces than the minimum allowable instead. When asked to justify, the interviewee replied,

> Of course...we can provide less car parks, [so] we [can] save more spaces and money...theoretically. But based on our experience, when we have good buildings but the car parks are very bad, the values will depreciate when the spaces are hard to sell or people are less inclined to gravitate towards the building (Dev-owner/Male/5).

This view was supported by two other interviewees from the government sector: “In Malaysian context, the danger of providing less number of car parks is that your building might not be sellable” (GovPI/Male/1); and “they [developers and owners] do not dare to provide less car parks” (Regr-PMaker/Female/3). Arguing about the general response from the private sector, these interviewees conceded that private developers and building owners were generally not ready to take advantage of this incentive.

Apart from marketability issue, another reason for providing more parking spaces was due to the perceptions that most tenants would prefer driving, and public transports are only being used for lower class people. Further, public transportation services are perceived to be unreliable and inefficient. Therefore, without tackling this issue, car ownership will continue to become a necessity rather than an option. In summary, the industry is currently still not ready to provide fewer parking spaces than the minimum requirements. Nevertheless, as a starting point, the practice of not exceeding the minimum requirement should be encouraged and recognised.

6.3.3 The Barriers to Sustainable Building Practices

This theme identifies interviewees' perceptions on the major barriers to widespread sustainable office building practices in Malaysia. The study identified 91 barriers and these are then categorized into 9 categories, as presented in Figure 6.13. They are listed in order of frequency of citation, but this measure must be treated with caution for a number of reasons. Firstly, some barriers are applicable to more stakeholder groups than others, and therefore would be expected to appear more often. Secondly, although some barriers were reported infrequently, when they did occur they had a major impact on the achievement of sustainability. Hence, no relationship should be inferred between frequency and importance of the barriers in hindering sustainability. However, it is interesting to note which reasons appeared most regularly in stakeholders' interviews. Each of the barriers is described, in turn, below.

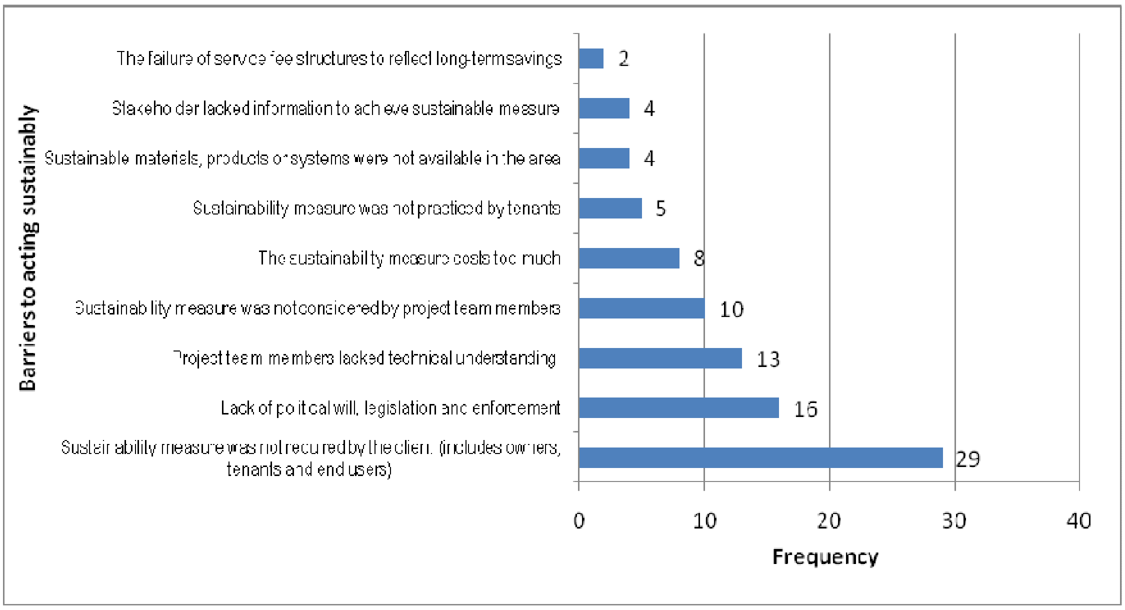

Figure 6.13: Barriers experienced by stakeholders to achieving sustainability
Note: Total barriers cited by 30 interviewees = 91

6.3.3.1 Sustainability measure was not required by the client

By far the most common explanation (32% of the replies) for the lack of achievement of a sustainability objective was total absence or lack of expressed interest in the client's requirements of the development. Architects, contractors, and developers all agreed that clients' desire to incorporate sustainability measure into their building projects is an essential element in overcoming the time and cost barriers inherent in adding these features. Clients could be the purchasers of the schemes or tenants. In the speculative developments, the clients are defined as 'the market', and currently there is little perceived market demand for sustainable offices. Even if architects or developers wanted to incorporate sustainability features, it would not be achieved without some interests shown by clients. For example, in Malaysia,

> Local tenants won't say, "If the buildings are not energy efficient, we won't move in." If they say things like that, like it or not, we have to deliver them. Not only us but the whole industry will do it. That's number one – there is no demand (Dev/Female/2).

Two contributing factors to the lack of demand are, (1) lack of education or awareness about the benefits and opportunities of green/sustainable buildings; and (2) perception of sustainable building practices will increase costs and reduce profits. The need to make additional investments in machinery, equipment and training is very often an excuse not to comply with standards and practices based on principles of sustainability. While it is true that the change to more sustainable building practices will incur some costs, there are also associated savings resulting from efficient resource use, higher productivity and reduced risk. The challenge is to find ways of capitalizing on these benefits of sustainability to increase profitability.

6.3.3.2 Lack of political will, legislation and enforcement

The second most cited category of barriers falls under "Lack of political will, legislation and enforcement", which represented 18% of the replies. Interviewees specifically indicated that the majority of politicians and regulatory stakeholders have a very limited understanding of sustainable development, its implications for the development paths and infrastructure choices they promise to their electorates, and the role construction sector can and should play. Hence, they become ineffective force for advocacy and raising awareness amongst the public. Consequently, little changes have been brought about in policy, legislation and implementation that sustainable building practices require.

6.3.3.3 Project team members lacked technical understanding

14% of the barriers are related to all members of the core project teams – including consultants, project managers, facility managers and building operators – who often do not have adequate technical understanding of, or knowledge to actually implement, sustainable practices. It was revealed that poor maintenance management that minimizes operational efficiency of building systems is one of the building sector's present predicaments. This dire situation in Malaysia was correlated to the poor capacity of facility managers and building operators, as one interviewee explained,

> Many FM [facility management] companies are ignorant in doing preventive maintenance...This caused the building systems to go through major repairs, overhaul or replacements after [the first] three years of operation… Many FM companies do not have proper checklists on how to ensure systematic maintenance of every part and component. …We have the most advanced technology but we don't have the people who know how to operate and maintain it (FacMgr/Male/2).

The same interviewee also believed that poor maintenance management had been contributed by the involvement of FM companies with unexperienced and unqualified personnel. A mechanical engineer further added that the case is also applicable to consultants as many of them "lacked consideration and technical understanding on operation and maintenance issues during the design phase" (Engr/Male/1). Further, the vast majority of construction and facility management firms are small enterprises that rely on outsourcing personnel as required. This has severely affected skills training and the retention of expertise in the industry as construction workers become highly mobile.

6.3.3.4 Sustainability measure was not considered by project team members

The fourth most cited category of barriers falls under "Sustainability measure was not considered by project team members" which represents 11% of the replies. It was usually not the case that operational or practical difficulties thwarted good intentions, but simply that sustainability issues were never on the agenda. Several interviewees suggested that the lack of interest in sustainable building on the part of other members of their project teams is a barrier to the routine use of sustainable strategies in their professions. The difference between the two barrier rankings (i.e. barrier 3 and 4) suggests that some, but not all, of the lack of technical understanding can be explained by a lack of interest. This indicates that some building professionals are open to learning about sustainable building, but have not had adequate training in it.

6.3.3.5 The sustainability measure costs too much

9% of the barriers are about the high investment needed which was claimed as a challenge to the routine use of sustainable strategies in their professions. These barriers were cited by stakeholders from the private sector who often prioritize the need to quickly recoup an investment over qualitative improvements and life cycle cost savings. In many instances, although cost differentials had not been thoroughly investigated, developers were certain that anything other than 'business as usual' would be more expensive. BEnvCon/Male/1 pointed out that the cost of providing environmentally sustainable buildings and developments is about 10-15% higher than for standard schemes and was not convinced there is a widespread demand for such buildings especially during economic downturns. This was supported by two speculative developers of large scale developments who were doubtful about the market's willingness to pay higher rents for such buildings. In other words, developers would be more willing to implement sustainable solutions if they could charge higher rents or gain a marketing edge through sustainability.

6.3.3.6 Other barriers

To a lesser extent, the following barriers were also mentioned:

- Sustainability measure was not practiced by tenants (6%) due to wrong attitude and the lack of awareness in conserving energy and water, and reducing waste.
- Sustainable materials, products or systems were not available in the area (4%) or mostly imported hence, very expensive.
- Stakeholder lacked information to achieve sustainable measure (4%); hence, a 'safe' solution was normally opted for, explaining why many sustainability objectives simply fell by the wayside. Where information is available, it has not been successfully integrated and effectively disseminated and promoted.
- The failure of service fee structures (which based on overall construction cost instead of performance) to reflect long-term savings (2%). These offer little incentive for building professionals to pursue higher performance standards or reward for their moderation and/or innovation in building or system designs.

6.3.4 Suggestions to Reduce Barriers and Move Forward

Finally, interviewees were given the opportunity to share their opinions on actions to reduce the barriers and to promote sustainability in the Malaysian construction industry. Altogether 126 actions were identified; these are then grouped into 4 different categories: 1) Actions by government and regulatory stakeholders; 2) Actions by the research and education sector; 3) Actions by the private sector; and 4) Actions by clients (refer to Table 6.10). Details of these are explained below.

Table 6.10: Summary of suggestions to reduce barriers and move forward recorded in the interviews.
Note: Total suggestions given by 30 interviewees = 126

Category of Local Stakeholders' Suggestions to Reduce Barriers and Move Forward			No. of times recorded	
			N	**%**
Actions by Government and Regulatory Stakeholders			**60**	**47.6**
1	*Encouraging and Supporting Implementation*			
	-	Provide effective incentives and disincentives	22	
	-	Change standards and regulations to support sustainable building practices	6	28.6
	-	Enforce regulations	3	
	-	Reduce subsidies	3	
	-	Conduct promotions	2	
2	*Capacity-building*			
	-	Raise awareness among government officials and politicians	5	
	-	Introduce compulsory continued professional education	2	7.1
	-	Create an advisory (sustainable building 'champion') body	2	
3	*Monitoring and Evaluation*			
	-	Participate in monitoring and assessment schemes	8	6.3
4	Internal Housekeeping			
	-	Lead by example	3	3.2
	-	Change professional fee system	1	
5	*Partnerships and Cooperation*		2	1.6
6	*Access to Funding*		1	0.8
Actions by the Research And Education Sector			**34**	**27**
7	*Capacity-building*			
	-	Raising awareness	26	25.4
	-	Expand learning offerings	3	
	-	Technology transfer	2	
	-	Build internal capacity	1	
8	*Partnerships and cooperation*			
	-	With industry sectors, non-governmental organizations and government	2	1.6
Actions by the Private Sector			**25**	**19.8**
9	*Encouraging and Supporting Implementation*			
	-	Create demand	6	
	-	Use new technologies and efficient building systems	5	10.2
	-	Commercialize new services, materials and tools	2	
10	*Capacity-building*			
	-	Support the development of external capacity	3	3.2
	-	Enable continued organizational learning	1	
11	*Internal Housekeeping*			
	-	Assess risk and benefits	2	
	-	Foster more efficient use of resources and reduce environmental impact of the industry	2	3.2
12	*Monitoring and Evaluation*			
	-	Participate in certification scheme	2	1.6
13	*Access to Funding*		1	0.8
14	*Partnerships and Cooperation*		1	0.8
Actions by Clients			**7**	**5.6**

15	*Capacity-building* - Develop own understanding of sustainability and the benefits of more sustainable choices	4	3.2
16	*Monitoring and Evaluation* - Participate in certification scheme - Monitor benefits and impacts	2 1	2.4
Total number of suggestions recorded		**126**	**100**

6.3.4.1 Actions by government and regulatory stakeholders

This most cited actions fall under the responsibility of "government and regulatory stakeholders" which represents 47.6% of the replies. The stakeholders included in this area are national and local government, regulatory bodies such as standards organizations and those bodies responsible for regulating the professionals and the industry sectors. Majority (28.6%) of the suggestions under this category aims to encourage and support the implementation of sustainable building practices such as: 1) providing financial incentives to developers and builders who may need assistance to cope with increased up-front costs of resource-efficient technologies in their projects; 2) reviewing policies, legislation and regulations on a continuous basis, and deregulating or developing new regulations as our understanding of sustainability grows; and 3) marketing the showcase buildings to create a "brand" or identity for sustainable building by recognizing, rewarding and publicizing outstanding projects.

Other suggestions include: 1) building the capacity within the public sector to raise the level of understanding among government officials and politicians; hence, bringing the changes in policy, legislation and implementation that sustainable building practices will require (7.1%); and 2) participating in monitoring and evaluation schemes, and setting up legal structures for their implementation (6.3%).

6.3.4.2 Actions by the research and education sector

The second most cited category of actions falls under the scope of "research and education sector" which represents 27% of the replies. The majority (25.4%) of the suggestions concerns the capacity-building, particularly by raising the awareness. This could be done by introducing sustainable building construction as an integral part of built environment courses taught at tertiary institutions by which the new curricula is monitored by professional bodies responsible for accreditation such as Malaysian Board of Architects (LAM). There were also recommendations for this sector to expand the scope of its offerings by including continuous professional development (CPD) programmes that provide a credible accreditation system for 'green' or 'sustainable' building professionals. To promote sustainability issues with the general public that eventually constitutes the client base, a number of public awareness campaigns or outreach programmes in schools and the media (e.g. magazine articles or television programmes) were suggested.

6.3.4.3 Actions by the private sector

Thirdly, the interviewees suggested actions by the "private sector" to reduce the sustainability barriers, which represent 19.8% of the replies. Stakeholders in this category include built environment practitioners, contractors, developers and manufacturers of construction materials, components and tools. Under this category, 10.2% of the suggestions concern the responsibilities of the private sector to implement sustainable building practices, for example: 1) assist with the promotion and commercialization of new services, materials and tools, and help their originators to create viable businesses; 2) create demand for efficient and healthier buildings; and 3) use more sustainable technologies and processes in its own business activities.

3.2% of the responses are about capacity-building such as adopting continuous learning within own organization via in-house training programs or partnerships with research and education institutions. Another 3.2% are related to internal housekeeping to encourage uptakes on sustainability measures or fully commit itself to sustainability. Specifically, interviewees believed that it has become necessary for this sector to assess the risk and benefits that can be drawn from a change in business practice towards more sustainable methods and processes e.g. by conducting "risk analysis, life cycle analysis (LCC)" (FacMgr/Male/2) and "triple bottom line (TBL)" (Arch/Female/02).

6.3.4.4 Actions by the clients

Finally, the remaining 5.6% of the suggestions fall under the responsibility of "clients" who have direct influence on the market for sustainability by demanding products and services to support sustainable building practices. Generally, interviewees felt that education for the clients or public at large about the principles and concept of sustainable building is even more essential than technical training. For instance, an interviewee called for more education about "what sustainability means, how it relates to their lives and businesses and the benefits of demanding more sustainable options" (Arch/Female/2). Others (2.4%) advocated clients to monitor the costs, savings and other benefits and impacts resulting from purchasing and using more sustainable services and products. This experience can then be used to motivate other clients to adopt procurement systems that demand sustainable construction and thus expand the market.

6.4 Discussions

This section summarizes and discusses the results presented in Section 6.3 particularly in addressing the three sub-research questions mentioned in Section 6.1.

6.4.1 How do Stakeholders of Malaysian Construction Industry View Sustainability?

The research identified 131 ‘good’ building criteria encompassing both engineering and non-engineering aspects which can be categorised into environmental, social and economic issues of sustainability. The identified ‘green’ building criteria however, fell solely under the category of environmental issues or covered at least some of the characteristics of a ‘good’ building. The results offer some support to the notion that the construction industry perceives a ‘good’ building as more or less compatible with a ‘green’ building. Since majority regarded ‘green’ and ‘sustainable’ buildings as similar and the terms are often used interchangeably, it suggests that, from the stakeholders’ perspective, if a building is a ‘good’ building, it should be ‘green’, and in doing so, it could be considered as ‘sustainable’. This is in contrast with the arguments developed by Cole (1999a), and Lutzkendorf and Lorez (2006) that there is a clear distinction between ‘green’ and ‘sustainable’ building design practice, as discussed in Chapter Four (Section 4.2.3). The distinction between the notions of ‘green’ and ‘sustainable’ is critical in structuring a building performance assessment system (Cole, 1999a) which is addressed in this research. However, the question of whether to use the term ‘green’ or ‘sustainable’ for the MOBSA framework is not an important issue because they are perceived as similar by the Malaysian stakeholders.

What is understood by ‘sustainability’ is that the priorities of action or the weights assigned to environmental, social and economic issues differ between developed and emerging/developing countries (Krausmann*, et al.*, 2008). It was found that in general, consultants and builders rated “Environmental protection” as the most important issue, whereas facility managers and regulators/policy makers voted “Human well-being enhancement”. Developers/owners on the other hand, placed “Economic Development” as the top in their ranking which is in line with Shafii (2007) who explained that clients in Malaysia are reportedly driven by commercial rather than environmental or social concerns. Overall, it appears that in this research, “Human well-being enhancement” was voted as the most important one, followed by “Environmental protection” and lastly by “Economic development”.

However, the research also found that 77% of the interviewees agreed that economic issues had always been their first priorities in decision-makings, especially when the clients involved were speculative developers. This type of developers normally place economic return as the highest priority as they build for generic users and structure their projects to be rented or sold. For them, minimizing capital cost may not necessarily be their main agenda, because depending on the location, a more expensive building can often be more profitable. On the other hand, clients who build to keep or occupy were said to place ‘satisfaction of need’ as the first priority. According to Bordass (2000), this latter type of clients is more interested in environmental building performance than the former but owner-user type of clients is reducing as they increasingly turn to the speculative market due to the uncertainty of their organisations’ future. Hence, it could be argued that the developer group of stakeholders are not prepared to have their earnings reduced in exchange for a less polluted environment. However, Sani and Mohd Sham (2007) argued that unrestrained growth in Malaysia is slowly being replaced by ‘smart growth’ as a compromise to the apparent conflict between environmental conservation and the need for development. This supports the argument given by Baba (2002) that “trade-off between the environment and economic development should be done in the balance between priority of development in less developed countries and more consideration upon environment in relative developed countries.”

6.4.2 To What Extent is Sustainable Development Being Practiced in Malaysia?

This section considers the progress in Malaysia to date in terms of promoting and practicing sustainability in office building development. It does this by summarizing and discussing the results based on the extent of current social, environmental and economic practices. Even though findings are grouped and discussed separately under these three issues, many aspects are interrelated; hence, cross references are made whenever necessary.

6.4.2.1 Current social practices

The result shows that half of the interviewees agreed that there are no specific characteristics of Malaysian office buildings as the buildings mainly adopt foreign architecture and technologies. Another half believed the opposite and gave comments either related to climate responsiveness or local architectural identity. These two different categories of responses might indicate that they are seen as non-correlated. However, according to Lefaivre and Tzonis (2003), climate responsive or passive architecture has an obvious link to the local culture or identity. It enables an architect to base his design more on bottom-up conditions than top-down rules, making the design outcome inherently more regional.

Since Malaysia is a multi-cultural and multi-religion country, the interviewees generally support space planning that facilitates cultural and community development among workers, including the addition of the following spaces (in order of priority):

- religious facilities;
- food service facilities;
- daycare facilities;
- recreational facilities;
- spaces for teamwork and social interaction;
- naturally ventilated toilets;
- separately ventilated rooms for tobacco smoking.

Even though these facilities seem common in local office buildings and in one case required by the local authorities (i.e. religious facilities for the Moslems), currently they are not strategically located, not appropriately sized and designed, or not provided at all. Since these spaces are not leased to a particular tenant or included in the net rentable areas calculation, their provisions may reduce the client's profit, especially speculative developers who build to sell for short-term profits. However, the long-term benefits of balancing between social spaces and workspaces cannot be underestimated. This balance was claimed by some interviewees as crucial to enhance workers' productivity and quality of life; and promote participation, interaction and community development among staff with different culture and religious beliefs. A recent study by Haynes (2008) discovered that behavioural components (i.e. interaction and distraction) of office productivity have a greater impact on perceived productivity than the physical components (i.e. comfort and office layout) regardless of the work pattern adopted within the office environment (i.e. individual process, group process, concentrated study or transactional knowledge). Clearly, the opportunity to facilitate social and work interactions in an office environment is of paramount importance (Peterson & Beard, 2004).

This research also found that despite the clear requirements for a barrier-free built environment in the Malaysian Standards (Department of Standards Malaysia, 1993, 2002) and the Uniform Building Bylaws (Laws of Malaysia, 2008), many consultants choose not to conform with universal design guidelines; hence, the progress in creating such environment in Malaysia moves at a snail's pace. This can be attributed to the fact that the use of the Malaysian Standards in designing and building physical development of a city is voluntary unless the regulatory authority of a particular city regulates it as mandatory (Department of Standards Malaysia, 2002). Where such universal design is mandatory, interviewees saw the efforts as only focusing on complying with the minimum stipulated requirements with no sense of reality and compassion. The consultants' neglect of the universal design might be the result of lack of knowledge on how to design built environment in compliance with the requirement of the universal design (Heylighen, 2008). Clearly, universal design in Malaysia is "still perceived as a pedagogical process, rather than legally enforceable compliance practice" (Abdul Rahim & Abdullah, 2009, p.50).

Realizing the fact that there is still a wide gap in knowledge and awareness on sustainability issues in Malaysia, interviewees unanimously support the importance of relevant education and trainings, indicating their positive attitude towards improving their knowledge and understanding. Haron *et al.* (2005) pointed out that the more environmentally knowledgeable respondents tend to have more positive environmental attitudes, which in turn increased their environmental behaviour and participation. However, when investigated in terms of the interviewees' environmental behaviour and participation by means of using tools to assist their sustainable design, construction, development or maintenance, it was found that more than half of them have never used any. This indicates that many of them still prefer to make decisions and assess their building performance based on intuition. This can be attributed to the fact that the usage of predictive and assessment tools are not easy and time-consuming (Papamichael, 2000). A few interviewees among consultants rationalized their disregard on any simulation tools by stating that energy or environmental specialists are more likely to assist with suggestions for design changes with potential to improve performance. Unfortunately, in Malaysia, these specialists are very limited in number. The only energy/environmental consultant interviewed in this research proudly admitted that his company is the only company in Malaysia that has the capacity and expertise to provide such services for public and private clients (only likely to be true in 2009 when the interview was conducted).

On the positive side, interviewees in general acknowledged the fact that in order to improve the overall building performance in a changing market, the industry and its clients need to identify opportunities and pitfalls by means of rapid feedback (post occupancy evaluation or POE). Accordingly, there is a tendency to initiate programmes of monitoring and benchmarking either by owners or design teams, as part of a culture of feedback, service and continuous improvement. However, POEs are far from being a 'mainstream' activity within the construction and property sector. POE is still not a standard part of the design practice mainly because it is not a requirement or of interest to the client. It was found that the local construction industry is unable to cope with the feedbacks and unable to afford it, so it seems; hence the industry has been slow to learn from completed projects, particularly when they are already occupied. Evidence for this is that consultants are almost never paid to go back and review the outcomes of their design decisions (Zimmerman & Martin, 2001), particularly when the clients are not the tenants of the building who have little financial benefits of refurbishment to save energy bills. In fact, the demand for POE studies elsewhere, including in developed countries, has been limited. For example in the UK, the demand for such studies is only slowly growing due to corresponding recommendations of Egan's Construction Task Force (Egan, 1998) and due to the success of Probe (Post-occupancy review of Buildings and their Engineering) studies: "After decades of neglect, a new research agenda is slowly emerging for POE in Britain" (Cooper, 2001, p.161).

6.4.2.2 Current environmental practices

The study gathered as many as 52 environmental issues as specified to be practiced. However, issues such as "water efficiency", "green operation and maintenance" and "innovation" have not been practiced even though these were mentioned as important aspects of a 'green' building but there is a possibility that they were overlooked rather than not being practiced at all.

The current state of the environmental practices in the local construction industry can also be informed by the criticisms made by the interviewees with regard to the recently built office buildings in Malaysian cities. The comments given are various, touching issues related to the environment, social and/or economy. However, majority of the comments are negative; for instance, building envelopes were mostly criticized as non-responsive to the local climate, and focusing more on aesthetics and corporate image. This result supports the notion that "the market is often driven by features and fashions rather than functionality" and glassier buildings without apprehending the notion of 'big windows can mean big problems!' seem to be the current trend (Bordass, 2000, p.343). Exacerbating this is the fact that building maintenance seems not to have gained the level of attention it warranted. Reactive and preventive types of maintenance have rarely been practiced and energy consumptions have rarely been monitored. Space planning also claimed to be totally oriented towards gaining economic returns with no consideration to suit different and changing tenancy situations. Another issue worth noting is the testing and commissioning of buildings; though believed to be commonly practiced only recently, it still considered improper or inadequate. Lastly, a few interviewees admitted that environmentally destructive methods of construction are still considered a normal practice among contractors in Malaysia. These criticisms highlight an urgent need to improve knowledge and awareness of all players to ensure commitment, implementation and participation in achieving sustainable construction.

The study also found that half of the interviewees had never specified or experienced in using reused components (i.e. not processed, but are simply collected from a demolition site and re-sold) or recycled materials (i.e. reprocessed materials that have already been used). Those who claimed to have the related experience in reusing building components mainly cited timber formworks. This initiative has undoubtedly extended the useful life of the material; however it is still insufficient as timber/plywood formwork can only be recycled for maximum of five times and it implies a high proportion in embodied energy value (Mari, 2007). Alternatively, Mari (2007) recommended the use of steel or aluminium formwork as it is more durable; hence, cost-savings, and require much lesser total embodied energy. The study also discovered that reusing timber components, sanitary ware, roofing tiles, door-sets and other components is deemed not a popular initiative for an office building project. With the exception of recycled steel and fly-ash concrete, many other recycled materials were unmentioned. Therefore, it is probable that other recycled materials are not available or have not been popularly used in the construction industry. In fact, a couple of interviewees agreed with this situation and admitted that concrete is presently not being recycled in Malaysia. This can be attributed to the fact that, recycling of concrete and other building materials is a relatively new concept compared to recycling of steel scrap, paper, plastics or glass (Ozkan, 2000).

The findings of the interview point to the construction and demolition waste treatment or recovery having yet to be commonly practiced, and disposing unseparated and reusable construction wastes in landfills is certainly a common on-going practice. Compared with the early study carried out sixteen years ago by Mohd Nasir *et al.* (1995), the situation remains unchanged, leading to the suggestion that, for these stakeholder groups at least, the progress of implementing sustainable waste management in the local construction industry has been too slow, let alone reaching its tipping point. This notion is further supported by Begum *et al.* (2009) in their recent study who found that majority of contractors in Malaysia do not practice source separation and source reduction, reuse or recycling at construction sites. All in all, the slow uptakes of utilizing reused and recycled materials or components in the Malaysian construction industry is reflected by the four major concerns, namely: (1) cost; (2) lack of availability; (3) perception of “low quality”; and (4) non-existence of environmental profiling. Begum *et al.* (2009) suspect that the poor practice of sorting, salvaging and recycling at construction sites are mainly due to cost and the lack of knowledge regarding the consequences of waste and the potential for waste reduction or minimization among local contractors.

With regard to the current practice of reducing wastage, majority believed that Industrialized Building Systems (IBS) are one of the most appropriate methods to be adopted. Among the mostly cited IBS components are lightweight prefabricated formwork and precast concrete components. However, IBS are unfavoured by most of the interviewees as they require much higher initial capital cost and technical know-how than does the traditional system; hence, consistent with a similar finding by Badir *et al.* (2002) in their survey among IBS companies in Malaysia. By the same token, a recent survey conducted by Begum *et al.* (2007b) among local contractors revealed that low waste technology (e.g. IBS) is perceived as the least significant factor that contributes to waste minimisation and also the least practiced factor in the Malaysian construction industry. By concerning more on higher costs and efforts (rather than the long-term benefits for both construction business and public) in adopting such technology, it then reflects the local business culture which mainly dominated by pursuing short-term profits among the Malaysian contractors.

It appears that in this research, the builder group of stakeholders does practice waste segregation on site. Begum *et al.* (2009) revealed that in Malaysia, large contractors involved in large projects (as those participated in this research) sort their waste materials more than medium and small contractors. However, the practice is still inefficient and uncoordinated. Furthermore, there are doubts among the interviewees that all of the segregated wastes on site have actually been sent for recycling i.e. they might have ended up in the landfills.

Similar situation was found in the uptakes of ecologically friendly and healthy products/materials in the local construction industry which are considered rather slow, and the reasons being: (1) non-existent of local certification or eco-labelling, except for local timber products; (2) not widely and readily available in the local market, except imported products/materials; and (3) lack of demand from clients. There were also doubts on the adequacy of existing eco-labelling system; hence, cohere with the argument by Lavagna (2006) that it is not enough to have an environmental “mark” on the product that says “this product is environmentally friendly” in the building sector. Consultants need to know the environmental profile of the product, as indicator in the moment of the design choice (Lavagna, 2006). In line with this realization, one interviewee speculated that these concerns will be addressed in the country within the next five to seven years. In addressing these concerns, Ronning and Vold (2006, p.11) suggested two strategies for considering life cycle costs and environmental consequences of purchases:

1) Buyer driven: Develop better environmental guidelines, use these and increase the environmental competence of buyers; and
2) Supplier driven: Challenge the supplier and producers to provide the necessary information that is adapted to the buyers’ needs.

This research so far shows that it would not be possible to achieve the results hoped for with the first strategy due to the lack of resources and competence on the purchasing side. Therefore, Malaysia has to focus on the second strategy, where the supplier or producer becomes more active in understanding the requirements, knowing their customers’ needs and taking responsibility for developing and updating criteria and documentation.

The findings also revealed that only 35% of the interviewees actually practiced separating and collecting office recyclables in their office, and the remaining only supported the practice. Even though the majority agreed that the provision of space for collection of recyclables, recycling storage and staging areas in office buildings would encourage recycling among tenants, a number of them disagreed. Instead, they believed that self-motivation among tenants through increased awareness on the need to recycle is the key to the success implementation. A few others however believed that awareness alone would be insufficient in the Malaysian context without any enforcement by the top management. Also, the lack of local recycling infrastructure and inefficient services in collecting recyclables at the regional level are claimed to be of paramount importance to be addressed in order to promote recycling in the country.

Finally, the study found that 83% of consultants interviewed had never worked with ISO 14001 certified construction companies in their professional career, indicating that public and private clients rarely state that certification is a precursor of their contracts. This is consistent with the survey results conducted by Tan (2005) which revealed that ISO 14001 has not become an integral part of the local construction companies’ culture especially those who concentrate solely on the local market in which sustainable construction is still relatively a new concept. Those who produce environmental-friendly certified products and services in the country are heavily geared towards fulfilling the foreign market demands especially in developed countries where the growth of green consumerism are higher. An interviewee from the Construction Industry Development Board asserted that only multi-national construction and real estate development companies who venture overseas are motivated and can afford to seek ISO 14001 registration and maintain the certification. According to Tan (2005), Malaysian companies who moved towards achieving clean and more efficient operations, believed that they are rewarded with an expandable market, improvement in company image and management. Clearly, if a nation is slow in accepting ISO 14000, it is likely that it will lose out in the competition with other nations that are more ready to accept and implement the system. This may have been realised by the government through their recommendation for introducing tax incentives for the adoption of ISO 14001 as one of the key action steps to promote environmentally-friendly construction practices in Malaysia (CIDB Malaysia, 2007b).

6.4.2.3 Current economic practices

The study found that majority of the interviewees had always regarded minimising the initial capital cost as more important than the long-term operational cost. The client group of stakeholders were unaware of, or unwilling to accept, the fact that these higher capital costs can be offset by reduced running and maintenance costs, reduced risks, increased productivity, a happier, healthier and more loyal workforce, and an improved public image that can result in an increased market share and improved shareholder appeal. In cases where unawareness and unwillingness were not an issue, developers admitted that they were improperly or inadequately advised by consultants to consider both initial and future costs and benefits (savings) of an investment to facilitate the effective choice between different building alternatives or to select more competitive technologies. This negligence among consultants indicates the lack of knowledge in life cycle costing. Therefore, it is unsurprising for this phenomenon to result in a spread of poorly operated and maintained office buildings in Malaysia, as discussed earlier.

On the positive side, there are two circumstances where minimizing the long-term operational costs does become the first priority. First is when the project is to be rented/leased and managed by the client (speculative developer or owner-occupier). According to Bordass (2000), although speculative developers are always interested in saving money, capital cost is not always the biggest thing. What counts is the return on investment, which means maximizing lettable area and rental value; and minimizing time to completion and occupancy (Bordass, 2000). Conversely, a few interviewees believed that office spaces that are built to be sold by clients among speculative developers rarely reflect the consideration of operational costs because in any case, the developers do not pay the fuel bills. Therefore, the whole scenario can be illustrated as in Figure 6.14. It should be noted that the terms 'economic return' and 'satisfaction of need' in this figure are referred to the discussion in Section 6.4.1.

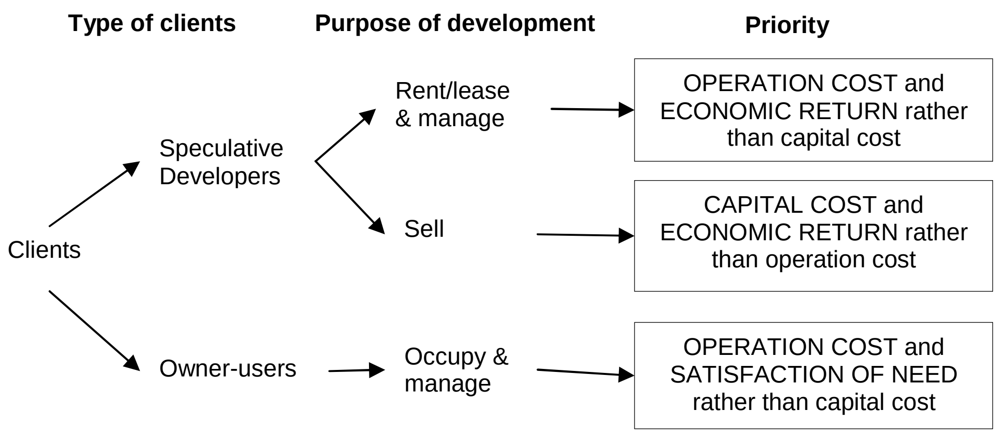

Figure 6.14: Economic priorities between different types of clients

Second is when developers/owners are absolutely certain that their property market/rental values would be much higher in the future. Unfortunately, the interviewees perceived that there has been no obvious relationship between sustainability and property market values in the Malaysian context, due to two reasons: (1) the lack of empirical demonstrations of the financial benefits of local green or sustainable case study buildings; and (2) the lack of knowledge amongst market participants about the benefits of sustainable design in general. Therefore, sustainable buildings are not yet explicitly offered and requested by the majority of the local market participants. In fact, there has been little representative empirical evidence published to date as researchers typically only describe the benefits and tried to illustrate this with some sample sustainable building projects. One of the empirical studies available was conducted by Kats *et al.* (2003) who produced a comprehensive and well-documented cost benefit analysis of sustainable buildings. They concluded that minimal increases in upfront costs of about 2% to support sustainable design on average would result in life cycle savings of 20% of total construction costs. It is believed that similar studies are needed to validate such finding in the Malaysian context, hence attract more local market participants to aboard the sustainability bandwagon.

Exacerbating this is the current belief of "less parking spaces means less marketability" among developer-owner group of stakeholders. From the viewpoint of regulators/policy makers group, they strongly asserted that car parking discounts have been offered as incentives for green or sustainable building developments particularly in Kuala Lumpur, depending on their proximity to the public transportation hub. If taken up, developers could save substantial cost by reducing the number of basement floors for parking spaces or generate more income by replacing such spaces with rentable areas. Other indirect benefits are reduced reliance of private transportation, hence reduced air pollution. Unfortunately, these incentives have rarely been taken by green building developers and owners in particular, and the practice of providing more than required parking spaces is still much preferred due to the perceived correlation between insufficient car parking spaces and reduced marketability or property market value.

Overall, the study highlights that the property market have yet to respond to the sustainability debate in terms of property pricings or valuations. Assimakopoulus *et al.* (2003) pointed out that valuation professionals require investor or client specific inputs for the calculation of worth. If these inputs do not comprise the client's wish to take advantage of the benefits of sustainable buildings, then property professionals will have no basis for including sustainability issues into their estimates of market value. Hence, it is sensible to suggest that at present, the local market has not yet accounted for property characteristics which add values to the user and the environment. This phenomenon is confirmed by Rahman (2011) who recently noted, in Malaysia, "the difference in rental rates between green and non-green buildings is not so much due to the green features, but more of supply and demand factors within the specific location."

In conclusion, it is obvious that the progress that has occurred in terms of developing the culture of sustainability among local building stakeholders is rather slow. Although the rise in concern for sustainability is now embedded in many government policies and initiatives (as discussed in Chapter Three), it is still not integrated into the Malaysian property development and investment practices. Whilst the last decade has seen progress towards 'green government buildings', there has not yet been a 'sea change' in market behaviour.

6.4.3 How Can a New Assessment Framework be Made an Acceptable and Integral Part of the Local Building Practice?

For a new assessment framework to be socially accepted and integrated in the local building practice, it must reflect the understanding of the national or regional conditions (Todd & Geissler, 1999). Therefore, this research explored the stakeholders' major concerns in terms of their current barriers in playing a better role, as well as their aspirations to promote sustainability in the construction industry. Apparently, the most frequently cited barrier for the stakeholders is simply the lack of interest among clients to demand for a sustainable built environment. In fact, the greatest barrier to implementation of sustainable buildings in the South-East Asian construction industry is the lack of understanding of the need for sustainable design due to the lack of awareness among stakeholders (Shafii & Othman, 2007). End users can affect demand directly through the commission of a building, or indirectly by choosing to buy speculatively developed sustainable buildings in more sustainable locations. However, this study indicates that either directly or indirectly, there seems to be little demand for sustainable buildings by their users.

The second most cited barrier is the lack of political will, explaining the lack of legislation to mandate energy efficiency or environmental preservation in building codes and standards. This means, sustainability rarely constitutes criteria or requirements for plan approval, land use or land-subdivision. Furthermore, Malaysian standards remain as guidelines with no means of legislative enforcement for non-compliance. Other barriers cited include lack of technical understanding among project team members, explaining the absence of sustainability consideration on their agenda. Exacerbating this is the non-sustainable practices among tenants in building operations and maintenance.

Clearly, most of the barriers mentioned so far are 'knowledge-related'. This implies that there is a skills and knowledge gap amongst key players, which needs to be addressed with some urgency. In fact, this gap has not gone unnoticed in Malaysia and the government has a number of initiatives in place to offer training, professional development and information in environmental issues for various levels of society including built environment professionals (Department of Environment Malaysia, 2007a). For example, Construction Industry Development Board (CIDB) Malaysia has organised several continuing education activities to systematically address and prioritise environmental needs in the construction sector (CIDB Malaysia, 2007c).

However, there are also practical barriers related to the availability of sustainable materials, products and technologies that need to be addressed. The vast majority of these products and technologies currently require importation, resulting in higher initial costs and perceived risks due to the lack of local technical support. Performance demonstration of such products is a major concern, as many of them do not offer a historic performance data set, are not familiar to consultants and practitioners, and/or demand substantial cultural or technological assimilation. These demand intense coordination among local/foreign manufacturers to promote the use and virtues of these products and technologies. There is also a need to stimulate demand for such products in order to increase supplies and make such technologies more mainstream in the local context. Efforts should also be undertaken to make construction and demolition materials more marketable in Malaysia (Megat Rus Kamarani, 2008). Related to this barrier is that of costs or perceived cost which was frequently pointed out as one of the major barriers for sustainable construction implementation within the country. It is argued in this research that in the Malaysian context, a sustainable building simply cannot cost more than a regular building. The current perception from the private sector, however, is that in most cases it does cost more, for many reasons (Shafii & Othman, 2007). Here, there is a need for better comparative information; otherwise, professional consultants or developers would be unlikely to take what they see as risks to achieve more sustainable outcomes.

These results offer some support to the notion that sustainable construction practices suffer wide gaps in emerging/developing countries in which construction sector still maintains a large share in total domestic production; however, cannot afford sustainability at any cost (Bon & Hutchinson, 2000). The question remained is what measures might be effective to move the industry players to close the current gaps of sustainable building practices and to reach significantly higher performance levels, and in a broader range of performance issues than just energy.

In total, the study identified 126 measures/actions related to the government and regulatory stakeholders, research and education sector, private sector and clients of the construction industry (in this order of priority). In terms of government-related actions, majority of the suggestions are associated with financial incentives, since a financial inducement is likely to be effective in an environment where financial return is a primary objective. Bon (2000) argued that market-oriented policies or economic measures, such as incentives and taxes, are much more effective in delivering sustainable construction than those which involve legal regulation and impositions. In this regard, it is also argued that in order to reverse the current barriers related to the availability of sustainable materials and products in the local market, importation facilitation and financing local, low-cost development of non-available or high-cost products and technologies, until local supply capacity is fully achieved should be part of the solutions (Gomes & Gomes da Silva, 2005).

There are also substantial amount of suggestions related to the research and education sector. Majority of them urged for environmental awareness and responsibility to be incorporated into schools' and universities' curricula as well as into continuous education programmes for the construction industry players. This raises the question as to whether local educational/training institutions have the relevant capacity. Previous studies related to architectural education for instance, found that existing architecture curricula in local universities are not readily accommodative to sustainability issues and there is a lack of sustainability exposure among fellow educators especially those with first-degree qualifications (Shari, *et al.*, 2006). In one case where the issues are included, it is currently fragmented, and only relying heavily upon individual efforts of educators who are familiar and inclined towards the subject matter (Ibrahim, 2008). With regard to the private sectors, most of the suggestions call for offering or creating demand for ecologically and socially responsible materials and services, and using more sustainable technologies and efficient building systems. In doing so, players on the demand side (investors and tenants) are suggested to be convinced of the advantages and need for improved building performance. All of the aforementioned actions will be an on-going matter of information and education.

From the foregoing discussion, it is sufficient to assert that it is not possible to use international assessment methodologies to assess sustainability and to encourage sustainable development locally. Certain development patterns from the developed world are not always applicable in the emerging/developing world (Gomes & Gomes da Silva, 2005; Theaker & Cole, 2001). Instead, more regional values that reflect the country's conditions highlighted earlier should be considered. Although emerging/developing countries have many conditions and issues in common, they have different climatic, cultural and economic conditions (Du Plessis, 2002). Furthermore, other countries' histories of success are not always replicable (Gomes & Gomes da Silva, 2005). This highlights the importance of regional characteristics to be reflected in assessment benchmarks and requirements, in order to make any assessment frameworks more socially acceptable and integral in the local construction industry.

6.5 Stage-1 MOBSA Framework

The findings and discussions in this chapter have implications for the formulation of the Stage-1 MOBSA framework, especially in terms of its assessment criteria. It should be noted however, that many of the suggestions to promote sustainability are too broad or inappropriate to be adopted for assessing the sustainability performance of an individual building or project; for example, fiscal incentives, regulation enforcement, research partnership and cooperation, and governmental internal housekeeping. Therefore, referring to 102 criteria listed in the tentative MOBSA framework proposed in Chapter Four, 65 were confirmed by the interview analysis, 4 were refined and the remaining 33 were not cited by the interviewees. The interview data analysis also revealed an additional 13 new criteria which were absent in the tentative framework. Subsequently, a Stage-1 MOBSA framework is formed, in which 115 (i.e. 102+13) criteria are grouped under 17 Sub-issues and further sub-divided into three Issues (Table 6.11). Sub-issues are organised in the order of importance based on the perceived sustainability barriers and aspirations to move forward; whereas, issues are arranged in the order of importance based on the findings on the stakeholders' view of sustainability.

Table 6.11: Stage-1 Malaysian Office Building Sustainability Assessment (MOBSA) Framework

Issue	Sub-Issue	Criteria	√ = Confirmed
SOCIAL			
	EDU: Education and Awareness		
		Increase participation of tenants in conserving energy and water as well as reducing waste	√
		Improve **knowledge on sustainable development issues among design team members**	√
		Improve **skills and knowledge of maintenance and operation staff**	√
		Improve **sustainable construction skills among construction workers**	√
		Provide **spaces for education**	√
	COH: Support for Social Cohesion		
		Support for **inter-disciplinary work** between architects, engineers, costing specialists, operation people and other relevant actors right from the beginning of the design process	√
		Provide **mixed uses within the project** to support active streetscape and to reduce the need for commuting transport	√
		Balance between provision of workspaces and **common spaces for social interaction**	√
		Increase **involvement of users** in development process to ensure users' requirements are met	Not cited
		Increase **participation of affected community** in development process	Not cited
	ACC: Accessibility		
		Maximize **personal safety and security** for users to access and use the building	√
		Select sites that are **easily accessible/walking distance to nearby services**	√
		Easy **access to building technical systems** for repair and maintenance	Not cited
		Adequate **access to communication technology**	Not cited
		Easy to clean the building facades and other elements or design	Not cited
	INC: Inclusiveness of Opportunities		
		Ease of **access for disabled** persons *Refined to:* Provide for **universal access**	√ Refined
		Provide **facilities for users to perform religious and spiritual quotient**	√
		Provide **facilities for users with children**	√
	HUM: Human Health and Well-being		

		Provide **separately ventilated and isolated areas/rooms which generate pollutants**	√
		Maximize level and quality of **fresh air** in the ventilation systems *Refined to:* Optimise level and quality of **fresh air** in the mechanically ventilation systems	√ Refined
		Appropriate **illumination level and lighting quality** in public and work areas	√
		Use interior finish **materials with low- or zero-pollutant off-gassing**	√
		Provide **recreational facilities**	√
		Provide **separately ventilated rooms/areas for tobacco smoking**	√
		Minimize **noise level** and provide satisfactory level of **acoustic performance**	√
		Adequate **monitoring of occupants' satisfaction** with indoor environmental quality	√
		Provide **carbon dioxide monitoring and control system** for main occupancy areas	√
		Use **low/zero pollutants cleaning and maintenance products and processes**	√
		Maximize **visual access to exterior views** or view to an atrium from workstations	√
		Adapt practices that **avoid construction accidents**	Not cited
		Prohibit tobacco smoking in the building	Not cited
		Minimize **glare conditions** in main occupancy areas	Not cited
		Maximize **openings and cross ventilation** in naturally ventilated spaces	Added
		Provide optimum **air movement for thermal comfort** in mechanically ventilated spaces	Added
		Increase the practice of **building flush-out** to reduce possible indoor air quality contamination after construction completion and prior to occupancy	Added
	CUL: Cultural and Heritage Aspects		
		Compatibility of urban design and building architecture with **local cultural values**	√
		Maintain the **heritage value of existing buildings** for refurbishment project	Not cited
		Preserve **characteristics of existing streetscapes**	Not cited
	LOC: Local People and Employment		
		Provide **training opportunities for local people** to be future skilled construction workers	√
		Increased use of **locally available materials**	√
		Use experienced **local design teams**	Not cited
		Use experienced **local contractors**	Not cited
		Use **local labour**	Not cited
		Linkage to **local service providers**	Not cited

Issue	**Sub-Issue**	**Criteria**	√ = Confirmed
ENVIRONMENTAL			
	ECO: Land Use and Impacts on Ecology		
		Minimize **ecological and other damage** to existing soil, water bodies and flora and fauna of the site or adjacent lands due to the construction process	√
		Maximize **potential for green/open spaces** on the site for informal recreation	√
		Improve **ecological value of natural landscape**	√
		Redevelopment of used/**brownfield site** rather than green field	√
		Select **sites that are within urban areas** with existing infrastructure	√
		Select **sites that have low ecological value or in non-sensitive areas**	Not cited
	SRM: Supports Resource Management		
		Increase use of **materials that have less environmental impact in producing them**	√
		Use **durable materials** that require less maintenance	√
		Increase use of **bio-based products and materials** obtained from managed/sustainable sources (e.g. certified wood)	√
		Increase use of **materials that can be recycled**	√
		I Increase use of **products and materials with recycled content**	√
	AIR: Emissions to Air		
		Select **sites that are near to public transport stops**	√
		Provide **connection from building to existing public transportation network**	√
		Provide only **minimum allowable parking spaces**	√
		Availability of **pedestrian access between building and basic services**	√
		Reduce **greenhouse gas emissions** from all energy used for **building operations**	Not cited
		Select **sites that are reasonably near residential zones**	Not cited
		Provide **more than minimum allowable motorcycle parking spaces** to discourage the use of cars	Not cited
		Minimize **air pollution from site workers' accommodation**	Added
		Provide **bicycles and/or bicycle parking spaces** for building users	Added
	LAN: Emissions to Land/ Solid Waste		
		Implement **construction waste management program** with sorting, reuse and recycling measures	√
		Provide **spaces for collection of recyclables**, recycling storage and staging areas in the building	√

		Reuse of suitable existing structure(s) on the site, as part of the new project	√
		Design for easy disassembly of components – so that they can be reused or recycled at the end of the service life of the components	√
		Increase use of **salvaged, refurbished or used materials** from off-site sources	√
		Increase the practice of treating **land-clearing debris as a resource**	Not cited
		Minimize **use of interior finishing materials** to minimize the direct and indirect consumption of resources	Not cited
		Design for repeatability and increase **use of standardized and prefabricated components** to reduce wastages	Added
		Minimize **land pollution from site workers' accommodation**	Added
		Maximize **inorganic wastes** sent to recycling facilities	Added
	EWA: Emissions to Water		
		Selection of **site with optimum distance from water body** to reduce the risk of water contamination	√
		Implement **stormwater management strategies** to control the quantity and quality of stormwater runoff, hence preventing flood and soil erosion	√
		Utilize **on-site wastewater treatment systems** using **grey water** for non-potable uses	√
		Utilize **on-site wastewater treatment systems** using **black water** (e.g. from toilets) for non-potable uses	Not cited
		Minimize **storm sewer or stream pollution from site workers' accommodation**	Added
	ADJ: Impacts on Adjacent Properties		
		Minimize **light spillage from exterior lightings** into the atmosphere	√
		Reduce possibility of **overshadowing adjacent properties**	Not cited
		Reduce **potential glare to adjacent properties**	Not cited
		Reduce impact of **excessive wind conditions** near the ground floor of high buildings	Not cited
	ENE: Non-renewable Energy Consumption		
		Use **energy efficient light fixtures and office appliances**	√
		Use **highly efficient ventilation and air-conditioning systems**	√
		Use **passive cooling strategies**	√
		Optimise daylighting in permanently occupied spaces *Refined to:* Use **integrated lighting concept**	√ Refined
		Reduce fossil fuel **energy consumption for building operations**	√
		Provide **on-site power generation systems**	√
		Use **dimmable** and/or **auto-sensored lighting system**	Not cited
		Install **energy sub-metering system** for each floor/section/tenancy to monitor energy consumption	Not cited
		Facilitate **personal control** of the lighting and thermal comfort systems by occupants	Not cited
		Minimize energy transmission through the building skin by a **tight, thermally resistant envelope**	Not cited
	WAT: Potable Water Consumption		
		Harvest rainwater for later re-use to reduce the potable water consumption	√
		Use **water efficient plumbing fixtures and appliances**	√
		Minimize use of **potable water for landscaping irrigation**	√
		Minimize use of **potable water for cooling system**	√
		Minimize use of **potable water for the testing of fire fighting system**	Not cited
		Install **water meters** for all major water uses in the project to monitor water consumption and to locate any leakages in the pipe lines	Not cited
Issue	**Sub-Issue**	**Criteria**	√ = Confirmed
ECONOMIC			
	TBL: Triple Bottom Line Accounting – Planet, People, Profit		
		Minimization of **payback period**	√
		Increased **rental/market value** or higher overall property **investment returns (ROI)**	√
		Consider both **capital/construction cost, along with long-term operational costs** for both tenant-occupied and leased office building	√
		Conduct **triple bottom line (TBL)** to the project *Refined to:* Conduct **Triple Bottom Line** before deciding to pursue with the project	√ Refined
		Conduct **Risk Analysis**	Not cited
		Increase the practice of referring to **Environmental Impact Assessment (EIA) report** prepared by environmental experts by the project team.	Added
		Assess and evaluate the **quality of workmanship** of construction works prior to hand over	Added
	EEF: Efficiency, Effectiveness and Flexibility		
		Develop and implement a **long-term maintenance management plan** for efficient building operation	√

Provide and operate an effective **facility management control system** to maximize the operational efficiency of building systems	√
Maximize workspace/directly functional area to total floor are ratio	√
Maximize **plot ratio** to generate denser development	√
Space planning for maximum flexibility for different users/requirements	√
Provide **building services systems with maximum flexibility** for different users/ requirements	Not cited
Structural design with maximum adaptability for new uses	Not cited
Adequate **floor-to-floor height** to offer high level of functionality for almost any occupancy	Added
Requirement of contracted **comprehensive commissioning, and post-occupancy commissioning** to be performed for all building services	Added

6.6 Conclusion

This chapter has presented the method of data collection and results of data analyses from 30 semi-structured interviews. Content analysis has been used to reveal the characteristics of data and to compare and summarise the different stakeholders' views on sustainability in general, and the extent of sustainable development practices in particular. Results were presented in Sections 6.3.1 to 6.3.2 respectively. The analysis also reviewed the stakeholders' current problems and challenges in playing a better role (see Section 6.3.3) and their aspirations or motivations to promote sustainable office building development (see Section 6.3.4). In Section 6.4, primary results have been summarised and discussed in order of importance with their possible explanations or speculations. Finally, in Section 6.5, Stage-1 MOBSA framework that reflects the local stakeholders' primary concerns in pursuing sustainable office building development and assessment has been proposed. 82 criteria in this framework were then brought into a focus groups discussion to be agreed upon and rated in terms of their relative importance which will be explained in detail in the next chapter. It should also be noted that findings from this exploratory study are valuable in defining the performance benchmarks for the criteria; hence, will be revisited in the final part of the thesis.

Chapter 7: Stage-2 MOBSA Framework – Focus Groups Discussion

7.1 Introduction

This chapter sets out to refine the Stage-1 MOBSA framework proposed in Chapter Six by means of a focus groups discussion, which is considered the second stage of the qualitative phase of this thesis. It aims to gather relevant experts from various backgrounds of the built environment to discuss, identify, clarify and define essential sustainable building criteria suitable to the Malaysian context, and to establish the performance benchmarks for the derived criteria. The procedure and results are presented and discussed and Stage-2 MOBSA framework is proposed at the end of this chapter.

7.2 Method

An overview of the focus group method and the sampling procedure has been provided in Chapter Five. This section explains in detail the focus groups composition and the running of the discussion.

7.2.1 Group Composition

According to Kitzinger (1995), focus group studies can consist of anything between half a dozen to over fifty groups, depending on the aims of the project and the resources available. Therefore, six focus groups were used, mainly based on six sustainability areas identified in the research in general and Stage-1 MOBSA framework in particular. These six areas are: 1) Site, Planning and Management; 2) Energy, Efficiency and System Management; 3) Indoor and Outdoor Environmental Quality; 4) Materials and Solid Wastes; 5) Water Efficiency and Liquid Waste; and 6) Social and Economic Issues. The strategy behind these group names was to ensure that each sub-issue specified in Stage-1 MOBSA framework could be fitted into one of the groups. Additionally, these group names were believed to ease the process of grouping the participants of which primarily based on their expert field.

A total of 50 building stakeholders were sent an invitation email to participate in the focus groups session. However, only 40 stakeholders agreed and further reduced to 38 on the day of the session. 10 of them were also the interviewees for this research as listed in the previous chapter. These 38 participants consist of 15 government officials/policy makers/regulators, 9 academicians, 7 design consultants, 3 contractors, 2 property developers, 1 project manager and 1 building materials supplier. Therefore, the average number of participants in a group is six (one of them was the group moderator). This number is conforming to Greenbaum (1998) who mentioned that it is most common to use "10 people for a full group and 5 or 6 for a minigroup". The use of small groups was preferred in this research because it was believed that more in-depth information from each individual can be gained. Table 7.1 is a summary of the profiles of the participants.

Table 7.1: Summary of the focus groups participants (N=38)

Profession and position of participants	Type of company	N
Private Sector		**14**
Design consultants:		
- Architect and Director	- Architectural consultant	4
- Mechanical Engineer	- M&E Engineering consultant	1
- Mechanical Engineer and Director	- Building environmental consultant	1
- Energy consultant	- Building environmental consultant	1
Developers / Owners:		
- Senior General Manager	- Major real estate contractor and developer	1
- Project Director	- Bank/ Building owner	1
Builders:		
- General Manager	- Major property contractor	3
Others:		
- Project Manager	- Lend lease company	1
- Manager	- Building materials supplier	1
Profession and position of participants	**Organisation**	**N**
Public Sector		**24**
Academicians:		
- Professor	- Local public university	1
- Associate Professor	- Local public university	2
- Lecturer (PhD)	- Local public university	6
Researchers:		
- Research Officer	- Research institute specialised in hydrology	2
- Manager	- Research institute specialised in construction	1
Government Projects Implementer:		
- Architect and Branch Assistant Director	- Public Works Department	1
- Former Branch Director (Retiree)	- Public Works Department	1
- Architect	- Public Works Department	3
Policy Makers/ Regulators:		
- Energy Mgt., Operation and Maintenance Consultant	- Malaysia Energy Centre, MEWC	2
- Programme Manager Building Energy Efficiency	- Malaysia Energy Centre, MEWC	1
- Technical Advisor Policy Development	- Malaysia Energy Centre, MEWC	1
- Senior Architect and Unit Director	- Town Planning and Heritage Unit, KLCH	1
- Senior Architect and Unit Asst. Director	- Town Planning and Heritage Unit, KLCH	
- Senior Manager	- Tech. and Innovation Dev. Sector, CIDB	1
- Principal Assistant Secretary	- Dept. of Irrigation and Drainage, MNRE	1
Total		**38**

Note:
MEWC = Ministry of Energy, Water and Communications; KLCH = Kuala Lumpur City Hall, Ministry of Federal Territories; CIDB = Construction Industry Development Board, Ministry of Works; MNRE = Ministry of Natural Resources and Environment

In terms of selection criteria, the participants must be the experts in several fields related to the built environment and knowledgeable in sustainable development in general and/or sustainable building in particular. This expertise was recognized by their contributions to the local construction industry; for instance, their green or sustainable building projects, sustainability-related research projects and/or publications, and involvements in the formulation of Malaysian Green Building Index (GBI), sustainability-related policies, guidelines or other relevant government initiatives.

Most researchers recommend aiming for homogeneity within each group in order to capitalise on people's shared experiences (Kitzinger, 1995). However, this research also took the advantage of bringing together a diverse group from a range of professions to maximise exploration of different perspectives within a group setting. In other words, each group was ensured to comprise people from the same area of expertise but at the same time diverse in terms of their individual profession (see Figure 7.1). Moderators were chosen based on their natural characteristics and their interpretive and communication skills. The six moderators were courteously called a few days before the session and subsequently briefed about objectives of the session, the intended flow of the discussion and their role in the discussion process. A workbook containing worksheets relevant to each group was then handed over to the moderators to facilitate any necessary preparation before the session.

GROUP 1: SITE PLANNING & MANAGEMENT	GROUP 2: ENERGY EFFICIENCY & SYSTEM MAINTENANCE	GROUP 3: INDOOR & OUTDOOR ENVIRONMENTAL QUALITY
MODERATOR: Design Consultant	MODERATOR: Policy Maker/ Energy Consultant (MECW)	MODERATOR: Design Consultant
8 MEMBERS: 2 Academicians 2 Policy Makers/Regulators (KLCH) 1 Design Consultant 1 Developer/Owner 1 Builder 1 Project Manager	4 MEMBERS: 2 Policy Makers/Regulators (MECW) 1 Design Consultant 1 Academician	6 MEMBERS: 2 Academicians 3 Government Project Implementers 1 Design Consultant

GROUP 4: MATERIALS & SOLID WASTES	GROUP 5: WATER EFFICIENCY & LIQUID WASTE	GROUP 6: SOCIAL & ECONOMIC ASPECTS
MODERATOR: Builder	MODERATOR: Design Consultant	MODERATOR: Academician
5 MEMBERS: 1 Building Materials Supplier 1 Policy Maker (CIDB) 1 Builder 1 Government Project Implementer 1 Researcher (Construction)	5 MEMBERS: 2 Researchers (Hydrology) 1 Policy Maker (MNRE) 1 Design Consultant 1 Government Projects Implementer	4 MEMBERS: 3 Academicians 1 Developer/Owner

Figure 7.1: Composition of focus groups participants (N=38)

7.2.2 Data Collection: Running the Focus Groups

The focus group session was conducted on the 21st of February 2009, and organised by the researcher together with her two colleagues and three research assistants from the Department of Architecture, Universiti Putra Malaysia (UPM). During this period, a research project titled “Testing the Adaptability of SBTool for Assessing the Sustainable Performance of Commercial Buildings in Malaysia” was being conducted by the researcher and her colleagues from UPM under E-Science research grant (Jaafar*, et al.*, 2009). As the E-Science research project was also aimed to develop the Malaysia specific sustainable building criteria and benchmarks – however, only using SBTool 07 as the basis – to avoid redundancy, the researcher adopted the existing criteria in the SBTool 07. However, additional criteria (mainly under the social and economic issues) from this research, as listed under Stage-1 MOBSA framework which are not covered by SBTool 07, were added.

As a result, a total of 146 criteria (i.e., 107 from SBTool 07 and 39 from Stage-1 MOBSA framework) were brought into the focus groups session and it was ensured that each group received roughly an equal number of criteria in order to avoid unfairness in terms of time spent for discussions. However, it was inevitable for the focus group of “Water Efficiency and Liquid Waste” to receive the least number of criteria compared to other focus groups. Refer to Appendix D-1 for the comparison between criteria from SBTool 07 and Stage-1 MOBSA frameworks and their groupings into six sections. It also shows clearly that certain criteria under SBTool 07 are not covered in the Stage-1 MOBSA framework (labelled as “Nil”). This is attributed to the fact that those criteria were not cited during the interview process as explained in the previous chapter. However, they would be added in the Stage-2 MOBSA framework if rated as important or very important by the focus groups.

The focus groups session began with a welcoming address and briefing of the research background as well as the procedure of the session. The session was conducted in a setting of six-round-table arrangement. Each table was labelled and supplied with a section of a workbook (at least 6 copies on each table) containing worksheets relevant to that particular group’s discussion. Figure 7.2 shows the six sections of the workbook, each prepared for and distributed to one particular focus group. For instance, the worksheets for participants within the group of “Materials and Solid Waste” differ from those within the group of “Water Efficiency and Liquid Waste.” The difference lays in the criteria indicated on the worksheets; however they are similar in terms of format.

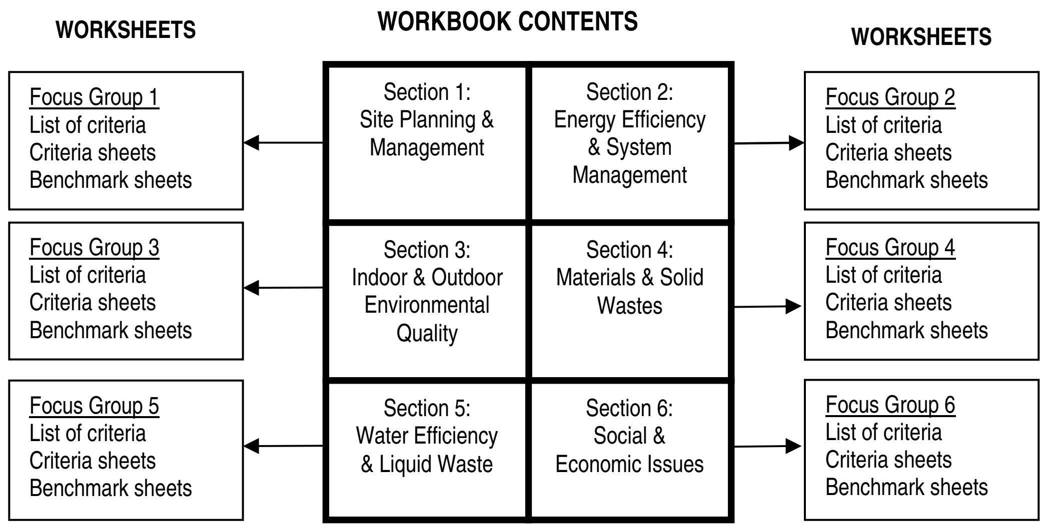

Figure 7.2: Workbook contents and distribution of sections to focus groups

There were three sets of worksheets in each section, given to each participant as the basis to guide the discussion process (arranged in order):

1. List of overall criteria relevant to the group. Refer example in Appendix D-2;
2. Criteria sheets – Each criteria sheet has a statement of intention, applicable phase of assessment, choice of actions and suggestion box. Refer example in Appendix D-3; and
3. Benchmark sheets (i.e. the performance targets for each criterion) – there are two types of benchmark sheets. The first type is for criteria covered in both SBTool 07 and Stage-1 MOBSA framework (see Appendix D-4), and the second is for criteria covered in the Stage-1 MOBSA framework only (see Appendix D-5).

The first set provides an overview of all the criteria to be discussed in a focus group. At the end of each list there were spaces for the group to suggest new criteria (if any), together with tick boxes to indicate the level of importance (i.e. "Less important," "Important" or "Very important") of the new suggested criteria. In other words, participants should not suggest additional criteria that are considered not important.

The second set consists of individual sheet for each criterion, printed on both sides. The front page of each sheet contains the meaning of the criterion as well as four tick boxes for the decision whether to accept or reject the criterion to be recorded. Each of these four boxes indicates "Not important, can be omitted", "Less important, may be omitted", "Important, can be included", and "Very important, must be included" respectively. The reason(s) for acceptance or rejection had to be written in the blank spaces provided. Participants were also given the opportunity to modify the criterion if necessary. All in all, whatever decision was made, participants were reminded to consider the following questions:

- Should the criteria be included? Or is it relevant enough?
- Should the texts be modified?
- Is a regional variation needed?
- What might be the best indicator of performance?
- Can the data be obtained at reasonable cost and effort?

The back page is the benchmark of the criterion which forms the third set of the worksheets. It provides an explanation of the performance indicator and performance benchmark for assessing the criterion. Based on the participants' expertise, the groups deliberated the best descriptions of each criterion's performance indicator and its benchmark. It is important to note that benchmarks are the basis for assigning scores for performance of a project. In many cases, they may be a regulation that is applicable, but in other cases they are determined based on local industry practices (Cole & Larsson, 1999). Original indicators and benchmarks from SBTool 07 were presented on the benchmark sheets as the basis of discussion and modification to suit local context. Since indicators and benchmarks for criteria listed in the Stage-1 MOBSA framework were not yet developed at the time of the session, participants were welcomed to suggest any, if time permitted. Participants were informed to ignore any benchmark sheets belonged to criteria which were considered "Not important, can be omitted." In other words, no benchmarks were developed for criteria which were decided not relevant.

The group discussion was divided into two two-hour sessions separated by one-hour lunch break and guided or chaired by the moderator. Ideally the group discussions should be tape recorded and transcribed (Bryman, 2008). However, as this was considered not possible, each group was then facilitated by a secretary (non-participant) to record the group's decisions on the worksheets electronically. Additionally, the group's moderator was also reminded that his or her worksheets should be treated as the master copy of the group's findings.

After the second session ended, a group reporting session was conducted in which each group leader or the moderator was given 10 minutes to present the summary of his or her group's findings and 5 minutes to answer any queries raised by participants from other groups. This particular session was digitally recorded to assist the data analysis. Finally, electronic files of the worksheets from all secretaries and master copies from all moderators were collected.

7.2.3 Data Analysis

The data from electronic files was compiled and analysed to inform on how the Stage-1 MOBSA framework should be refined. This data was constantly compared with the moderators' master copies for any discrepancies. Since each group's findings were based on consensus and distinctive, no statistical software programme was used in the analytical process. Below are the steps taken to refine the Stage-1 MOBSA framework:

1. Reword or refine the criteria as suggested by the focus groups;
2. Omit criteria which were rated as "Not important, can be omitted";
3. Add criteria which are covered in SBTool 07 but not in Stage-1 MOBSA framework and rated as "Very important, must be included" or "Important, can be included";
4. Add criteria suggested by the focus groups which are neither covered in SBTool 07 nor Stage-1 MOBSA framework, but rated as "Very important, must be included"; and
5. Retain other criteria which were agreed without any amendments and rated as "Very important, must be included" or "Important, can be included".

With regard to performance indicators and benchmarks agreed or modified by the focus groups, these will be recalled in the formulation of the Comprehensive MOBSA Framework in Chapter Nine.

7.3 Results and Stage-2 MOBSA Framework

Since there were a total of 146 criteria brought into the focus groups discussion, their results and place in the Stage-2 MOBSA framework are as follows:

- 89 criteria were rated as either "Very important, must be included" or "Important, can be included" hence considered relevant to the local context. These were <u>retained</u> in the Stage-2 MOBSA framework;
- Another 5 criteria which came solely from SBTool 07 framework, were also rated as "Very Important, must be included"; hence, <u>added</u> in the framework. Additional 2 new criteria which were not covered anywhere were suggested. These were also <u>added</u> as they were considered as "Very Important, must be included";
- Another 7 criteria were also rated as "Very important, must be included" or "Important, can be included", however these were modified or <u>refined</u> in terms of their wordings or intention. Subsequently, the suggested refinements were incorporated in the framework.

- 6 criteria suffered missing data i.e. not given any rating of importance. These criteria however were retained to be rated further by larger samples in the later stage;
- 9 criteria were rated as “Less important, may be omitted” but only 1 was given the reason(s) for such low rating. This criterion is “Reduce impact of excessive wind conditions near the ground floor of high buildings” and the reason being “Local wind speeds are not high”. This reason seems consistent with the Malaysian Meteorological Department (2009) which stated that the wind over the country is generally light and variable; hence, omitted from the framework. The rest of the criteria were retained to be rated further by larger samples;
- 5 criteria were rated as “Not important, can be omitted”, of which 1 was not given any reason(s) for their omissions i.e. “Reduce potential glare to adjacent properties”. This criterion was retained to be rated further by larger samples. As for other 4 criteria, the reason(s) given are as follows:
    - “Adequate access to communication technology” - reason being “May cause more energy use; already common even at home; may reduce productivity”. This criterion however was retained as it was doubted that the same result would be yielded if the number of participants were much larger;
    - “Provide spaces for education” – reason being “Education can be online; depending on the nature of businesses”. This criterion was also retained due to the same rationale stated above;
    - “Improve sustainable construction skills among construction workers” – reason being “Neither for design nor operation stage of assessment”. This reason seemed valid for the E-Science research project but not for this study as it covers criteria relevant to all phases of assessment, hence retained; and
    - “Preserve characteristics of existing streetscapes” – reason being “May have adjacent buildings that are already poor or there is already building control mechanism”. This means that the issue is already covered in local authorities’ planning approval guidelines, hence inappropriate to be included in the assessment framework. This criterion was finally omitted.
- The remaining 25 criteria were solely covered by SBTool 07 and rated either as “Not important, can be omitted” or “Less important, may be omitted”, hence not included in the framework of this study; and
- Most of the performance indicators and benchmarks agreed, modified or proposed are within the issue of “Environmental”, hence available to be the basis of taking the MOBSA framework to the next level (see Chapter Nine). This

means, many indicators and benchmarks for criteria within the issue of “Social” and “Economic” have to be refined or developed further.

Table 7.2 contains the breakdown of the above, hence forming the Stage-2 MOBSA framework comprising of 120 criteria in total. Detail results of the focus groups session were compiled in a report entitled “Technical Report: Benchmarking of Sustainable Building Criteria in Malaysia” by Jaafar *et al.* (2009) and subsequently distributed to the participants in June 2009.

Table 7.2: Summary of focus groups results (Stage-2 MOBSA Framework)

Note: 4 = “Very important, must be included”; 3 = “Important, can be included”; 2 = “Less important, may be omitted”; and 1 = “Not important, can be omitted”.

√ = Performance indicator and benchmarks for this criterion were decided and agreed by the focus groups;
X = Performance indicator and benchmarks for this criterion were not decided or agreed by the focus groups.

Issue	Sub-Issue	Criteria from the Stage-1 MOBSA Framework	Rele-vance	Retained/ Added/ Omitted/ Refined	Agreed with Bench-marks
SOCIAL					
	EDU: Education and Awareness				
		Improve **knowledge on sustainable development issues among design team members** *Refined to:* **Readiness and competency of design team members** on sustainable design and development issues	4	**Refined**	X
		Improve **skills and knowledge of maintenance and operation staff**	4	Retained	X
		Improve **sustainable construction skills among construction workers** *Reasons:* *Neither for design nor operation stage of assessment*	1 (with reason)	Retained	X
		Provide **spaces for education** *Reasons:* *Education can be online; depending on the nature of businesses*	1 (with reason)	Retained	X
		Increase participation of tenants in conserving energy and water as well as reducing waste	4	Retained	X
	COH: Support for Social Cohesion				
		Support for **inter-disciplinary work** between architects, engineers, costing specialists, operation people and other relevant actors right from the beginning of the design process	4	Retained	√
		Provide **mixed uses within the project** to support active streetscape and to reduce the need for commuting transport	4	Retained	√
		Balance between provision of workspaces and **common spaces for social interaction** *Refined to:* **Space planning for maximum social interaction**	4	**Refined**	X
		Increase **participation of users in development process** to ensure users’ requirements are met *Refined to:* Increase **participation of users in development process** to ensure users’ requirements are met	4	**Refined**	X
		Increase **participation of affected community in development process** *Refined to:* Increase **participation of affected community in development process** to avoid conflict and ensuring the sustainability of the development	4	**Refined**	X
	ACC: Accessibility				
		Maximize **personal safety and security** for users to access and use the building	4	Retained	X
		Select sites that are **easily accessible/walking distance to**	4	Retained	√

nearby services			
Easy **access to building technical systems** for repair and maintenance	4	Retained	X
Adequate **access to communication technology** *Reasons:* *May cause more energy use; already common even at home; may reduce productivity*	1 (with reason)	Retained	X
Easy to clean the building facades and other elements or design	4	Retained	X
INC: Inclusiveness of Opportunities			
Provide for **universal access**	4	Retained	√
Provide **facilities for users to perform religious and spiritual quotient**	4	Retained	X
Provide **facilities for users with children**	3	Retained	X
HUM: Human Health and Well-being			
Provide **separately ventilated and isolated areas/rooms which generate pollutants**	4	Retained	√
Appropriate **illumination level and lighting quality** in public and work areas	4	Retained	√
Use interior finish **materials with low- or zero-pollutant off-gassing**	4	Retained	Partial
Provide **recreational facilities**	2	Retained	X
Provide **separately ventilated rooms/areas for tobacco smoking**	4	Retained	√
Minimize **noise level** and provide satisfactory level of **acoustic performance**	3	Retained	√
Adequate **monitoring of occupants' satisfaction** with indoor environmental quality	Not indicated	Retained	√
Provide **carbon dioxide monitoring and control system** for main occupancy areas	Not indicated	Retained	√
Maximize level and quality of **fresh air** in the ventilation systems *Refined to:* Provide appropriate **air changes** to maximize level and quality of **fresh air** in the ventilation systems	3	**Refined**	√
Use **low/zero pollutants cleaning and maintenance products and processes**	3	Retained	√
Maximize **visual access to exterior views** or view to an atrium from workstations	4	Retained	√
Adapt practices that **avoid construction accidents**	3	Retained	X
Prohibit tobacco smoking in the building	4	Retained	√
Minimize **glare conditions** in main occupancy areas	4	Retained	√
Maximize **openings and cross ventilation** in naturally ventilated spaces	4	Retained	√
Provide optimum **air movement for thermal comfort** in mechanically ventilated spaces	4	Retained	X
Increase the practice of **building flush-out** to reduce possible indoor air quality contamination after construction completion and prior to occupancy	4	Retained	√
Select **sites that are walking distance to recreation areas** or facilities	4	**Added** (from SBTool)	√
CUL: Cultural and Heritage Aspects			
Compatibility of urban design and building architecture with **local cultural values**	4	Retained	√
Maintain the **heritage value of existing buildings** for refurbishment project	4	Retained	√
Preserve **characteristics of existing streetscapes** *Reasons:* *May have adjacent buildings that are already poor or there is already building control mechanism*	1 (with reason)	**Omitted**	X
LOC: Local People and Employment			
Increased use of **locally available materials**	4	Retained	√
Provide **training opportunities for local people** to be future skilled construction workers	4	Retained	X
Use experienced **local design teams**	4	Retained	X
Use experienced **local contractors**	4	Retained	X
Use **local labour**	4	Retained	X
Linkage to **local service providers**	4	Retained	X

Issue	Sub-Issue	Criteria from the Stage-1 MOBSA Framework	RELE-VANCE	RETAINED / ADDED/ OMITTED/ REFINED	AGREED WITH BENCH-MARKS
ENVIRONMENTAL					
	ECO: Land use and Impacts on Ecology				
		Minimize **ecological and other damage** to existing soil, water bodies and flora and fauna of the site or adjacent lands due to the construction process	Soil = 4 Natural features = 3	Retained	√
		Improve **ecological value of natural landscape**	2	Retained	√
		Redevelopment of used/**brownfield site** rather than green field	3	Retained	X
		Select **sites that are within urban areas** with existing infrastructure	Not indicated	Retained	X
		Maximize **potential for green/open spaces** on the site for informal recreation	4	Retained	√
		Select **sites that have low ecological value or in non-sensitive areas**	4	Retained	X
		Provide **greenery** within and/or on the rooftop of the building	4	**Added** (by focus group)	√
		Select **sites that have low risk of flooding**	4	**Added** (from SBTool)	√
	SRM: Supports Resource Management				
		Increase use of **bio-based products and materials** obtained from managed/sustainable sources	4	Retained	√
		I Increase use of **products and materials with recycled content**	4	Retained	√
		Use **durable materials** that require less maintenance	4	Retained	√
		Increase use of **materials that can be recycled**	4	Retained	√
		Increase use of **materials that have less environmental impact in producing them**	2	Retained	X
	AIR: Emissions to Air				
		Select **sites that are near to public transport stops**	4	Retained	√
		Provide **connection from building to existing public transportation network**	4	Retained	√
		Provide only **minimum allowable parking spaces**	4	Retained	√
		Availability of **pedestrian access between building and basic services**	4	Retained	√
		Reduce **greenhouse gas emissions** from all energy used for **building operations**	2	Retained	X
		Select **sites that are reasonably near residential zones**	4	Retained	√
		Provide **more than minimum allowable motorcycle parking spaces** to discourage the use of cars	2	Retained	X
		Minimize **air pollution from site workers' accommodation**	4	Retained	X
		Provide **bicycles and/or bicycle parking spaces** for building users	3	Retained	√
	LAN: Emissions to Land/ Solid Waste				
		Reuse of suitable existing structure(s) on the site, as part of the new project	3	Retained	√
		Design for easy disassembly of components – so that they can be reused or recycled at the end of the service life of the components	3	Retained	√
		Provide **spaces for collection of recyclables**, recycling storage and staging areas in the building	4	Retained	X
		Increase use of **salvaged, refurbished or used materials** from off-site sources	4	Retained	√
		Implement **construction waste management program** with sorting, reuse and recycling measures	4	Retained	√
		Increase the practice of treating **land-clearing debris as a resource**	4	Retained	√
		Minimize **use of interior finishing materials** to minimize the direct and indirect consumption of resources	3	Retained	√
		Design for repeatability and increase **use of standardized and prefabricated components** to reduce wastages	4	Retained	√
		Minimize **land pollution from site workers' accommodation**	Not indicated	Retained	X
		Maximize **inorganic wastes** sent to recycling facilities	4	Retained	√
		Save handling and storage of hazardous wastes on site	4	**Added** (from SBTool)	√
	EWA: Emissions to Water				
		Select **sites with optimum distance from water body** to reduce	3	Retained	√

		the risk of water contamination			
		Implement **stormwater management strategies** to control the quantity and quality of stormwater runoff, hence preventing flood and soil erosion	4	Retained	√
		Utilize **on-site wastewater treatment systems** using **gray water** for non-potable uses	3	Retained	√
		Utilize **on-site wastewater treatment systems** using **black water** for non-potable uses	3	Retained	X
		Minimize **storm sewer or stream pollution from site workers' accommodation**	3	Retained	X
	ADJ: Impacts on Adjacent Properties				
		Minimize **light spillage from exterior lightings** into the atmosphere	2	Retained	x
		Reduce possibility of **overshadowing adjacent properties** *Reasons: Not given*	1	Retained	X
		Reduce **potential glare to adjacent properties**	Not indicated	Retained	X
		Reduce impact of **excessive wind conditions** near the ground floor of high buildings *Reason:* *Local wind speeds are not high*	2 (with reason)	**Omitted**	X
		Adapt practices that **reduce noise pollution** from construction site	4	**Added** (by focus group)	X
	ENE: Non-renewable Energy Consumption				
		Reduce fossil fuel **energy consumption for building operations**	4	Retained	√
		Optimise daylighting in permanently occupied spaces *Refined to:* Use **integrated lighting concept**	4	Retained	√
		Use **passive cooling strategies**	4	Retained	Partial
		Use **highly efficient ventilation and air-conditioning systems**	4	Retained	X
		Provide **on-site power generation systems**	4	Retained	√
		Use **energy efficient light fixtures and office appliances**	4	Retained	√
		Use **dimmable** and/or **auto-sensored lighting system**	4	Retained	X
		Install **energy sub-metering system** for each floor/section/tenancy to monitor energy consumption	4	Retained	√
		Facilitate **personal control** of the lighting and thermal comfort systems by occupants	2	Retained	√
		Minimize energy transmission through the building skin by a **tight, thermally resistant envelope** *Refined to:* Design for a **tight, thermally resistant envelope** to prevent leakage of cool draft through building skin	4	Retained	X
		Minimize the **size of lighting system control zones** to optimize energy savings	4	**Added** (from SBTool)	√
	WAT: Potable Water Consumption				
		Minimize **use of potable water for landscaping irrigation**	4	Retained	X
		Use **water efficient plumbing fixtures and appliances**	4	Retained	X
		Minimize **use of potable water for cooling system**	4	Retained	X
		Harvest rainwater for later re-use to reduce the potable water consumption	4	Retained	X
		Minimize **use of potable water for the testing of fire fighting system**	3	Retained	X
		Install **water meters** for all major water uses in the project to monitor water consumption and to locate any leakages in the pipe lines	4	Retained	√

Issue	Sub-Issue	Criteria from the Stage-1 MOBSA Framework	RELE-VANCE	RETAINED / ADDED/ OMITTED/ REFINED	AGREED WITH BENCH-MARKS
ECONOMIC					
	TBL: Triple Bottom Line Accounting – Planet, People, Profit				
		Minimization of **payback period**	4	Retained	X
		Increased **rental/market value** or higher overall property **investment returns (ROI)** *Refined to:* High rate of occupancy and low rate of occupancy turnover	4	**Refined**	X
		Consider both **capital/construction cost, along with long-term operational costs** for both tenant-occupied and leased office building	4	Retained	X
		Conduct **Risk Analysis**	Not	Retained	X

Refined to: Conduct **Design Risk Analysis**	indicated		
Conduct **triple bottom line (TBL)** to the project *Refined to:* Conduct **Triple Bottom Line** before deciding to pursue with the project	4	**Refined**	X
Increase the practice of referring to **Environmental Impact Assessment (EIA) report** prepared by environmental experts by the project team.	2	Retained	X
Assess and evaluate the **quality of workmanship** of construction works prior to hand over	4	Retained	X
EEF: Efficiency, Effectiveness and Flexibility			
Maximize workspace/directly functional area to total floor are ratio	4	Retained	√
Maximize **plot ratio** to generate denser development	4	Retained	√
Space planning for maximum flexibility for different users/requirements	4	Retained	X
Provide and operate an effective **facility management control system** to maximize the operational efficiency of building systems	3	Retained	√
Provide **building services systems with maximum flexibility** for different users/ requirements	3	Retained	√
Structural design with maximum adaptability for new uses	4	Retained	√
Develop and implement a **long-term maintenance management plan** for efficient building operation	4	Retained	√
Adequate **floor-to-floor height** to offer high level of functionality for almost any occupancy	3	Retained	√
Requirement of contracted **comprehensive commissioning, and post-occupancy commissioning** to be performed for all building services	4	Retained	√
Provide **as-built drawings and equipment manuals** to operating staff and owners to ensure efficient operation	4	**Added** (from SBTool)	√

7.4 Conclusion

This chapter has presented the method of data collection and results of data analysis from six focus groups discussion. Criteria identified in the Stage-1 MOBSA framework were debated, agreed upon and even further added by experts if found missing. Additionally, in some cases, appropriate minimum performance targets or benchmarks were proposed. These benchmarks will be taken as the basis for developing the Comprehensive MOBSA framework in the later stage of this research (refer Chapter Nine). In Section 7.3, primary results were summarised and Stage-2 MOBSA framework was proposed as the outcome of the qualitative phase of this thesis. This outcome will then be used for modifying an instrument for the subsequent quantitative phase, which is the subject of the next chapter.

Chapter 8: Stage-3 MOBSA Framework – Questionnaire Survey

8.1 Introduction

This chapter sets out to further refining Stage-2 MOBSA framework developed in the previous chapter by means of a questionnaire survey. Its main aim was to survey local building stakeholders' opinions on the relative importance of the 120 sustainability criteria identified in the Stage-2 MOBSA framework and their expectations of MOBSA systems. The survey participants were among stakeholders/professionals currently involved in the construction industry in Kuala Lumpur (i.e. the capital city of Malaysia), Putrajaya (i.e. the new federal administrative centre of Malaysia) and Selangor (i.e. the most developed state in Malaysia).

The statistical analysis software SPSS Version 17 was used for data analysis. The graphical illustrations of survey results were created using Microsoft EXCEL version 2003 for Windows, and tables were established using Word version 2007 for Windows. A consistent format is used to illustrate the whole series of related questions so that information can be easily grasped (Salant & Dillman, 1994).

The findings from this survey are not only significant in reducing the criteria in the Stage-2 MOBSA framework and assigning the appropriate weighting levels to each of the finally selected criteria, but they also valuable in enlightening the appropriate direction of implementing assessment systems in Malaysia. The data collection method and results are presented and discussed and Stage-3 MOBSA framework is proposed before finally concluding the chapter.

8.2 Method

A survey research was designed and conducted among building stakeholders in Kuala Lumpur, Selangor and Putrajaya in order to further understand their perception and expectation of a MOBSA system in Malaysia. This study employed a mixed-mode data collection via mail, group administration, and dropping off method.

8.2.1 Instrumentation

8.2.1.1 Question design

In general, three research question areas were established to guide the design of the survey questions:

- Awareness and attitudes to the sustainability issues and building sustainability assessment systems;
- Preferences regarding the most important criteria to be considered in the building sustainability assessment system; and
- Expectations about the best approach of implementing a Malaysian office building sustainability assessment (MOBSA) system.

Structured questions are primarily used in the survey questionnaire, whereas open-ended questions are used occasionally to identify a range of possible answers. Some of the structured questions are presented with scaled responses when respondents are asked to evaluate the degree of importance of different assessment criteria. As discussed in Chapter Four (Section 4.5.5.5), it is necessary to establish weightings for assessment criteria and it is sensible for these to be based on consensus by using a simple ranking method. Therefore, specific questions were designed regarding relative importance (weightings) of sustainable building criteria. Considering the concept of sustainable building and its assessment keep on updating when more knowledge is gained over time, the time frames are mostly limited to the next five-year period (this survey was conducted in 2009) when asking stakeholders about their perceptions and preferences.

8.2.1.2 Questionnaire Design

According to Salant and Dillman (1994, p.101), “people are willing to respond to attractive questionnaires so non-response error is minimized...” It is a commonsense assumption that long questionnaires increase the burden on respondents and this leads to increased reluctance to participate; however, Dillman’s research with mail questionnaires shows that length seems to be less of concern in postal surveys of relevant topics in specialised populations (Dillman, 2000).

The questionnaire in this research survey consists of 11 pages; however, some strategies were taken to increase the response rate. For example, apart from appealing to the respondents’ goodwill and convincing them of the study’s significance, respondents were given a reward i.e. a CD containing selected articles on "Cities and Climate Change" as a token of appreciation for their participation. This small incentive was included with the initial questionnaire as it was more effective than those promised if the questionnaire was returned (Church, 1993). Nevertheless, in certain circumstances, this incentive was exchanged with a completed survey form instead. On top of presenting an incentive, light green coloured high-quality paper was used for printing the questionnaires and each questionnaire was made out 6 A4 sheets printed on both sides (Appendices E-1 and E-2).

8.2.1.3 Pilot Study

Once the questionnaire had been developed, a pilot study was conducted to evaluate each question and the questionnaire as a whole before final administration. Generally, the pilot study aimed to highlight problems and also test the viability of the questionnaire amongst a small group of people qualified to be part of the survey. Specifically, the objectives of the pilot study were to:

- check the effectiveness of the research design;
- test whether the questions concerned were clear and free from ambiguities; and
- estimate the cost and duration of the main study.

The pilot questionnaire was sent out via email in March 2009, to 15 people who resemble those to whom the questionnaire will finally be given. These 15 pilot-study samples comprised of 8 consultants/designers, 2 developers, 2 facility managers, 2 contractors, and 1 project manager. It is important to note that there was no intention to work out what proportion of the population would give a particular response but rather to obtain idea on the range of responses or ideas that people have. Therefore, the effort was focused in attempting to get a wide variety of respondent types in the sample without being too concern about whether each type was represented in its correct proportion.

11 completed questionnaires were received, in which 3 were from architects, 2 from engineers and 1 response from other group, representing a 73 percent response rate. The pilot group was asked to criticize the whole questionnaire from every aspect, suggest ways for improvement through deletions, additions, modifications and/or amendments. The feedback from the pilot study was analysed and some comments and criticisms were incorporated, leading to substantial changes to the original draft. The questionnaire was modified in the following ways:

- changing the overall layout of the questionnaire to suit the nature of the questions making it clearer and easier to follow;
- simplifying terms that were highlighted as too technical; and
- rewriting some questions and instructions that were highlighted as being unclear and/or too lengthy.

The purpose of these changes was to maximize the opportunity of obtaining quality information from the survey such as understanding the paramount sustainable building criteria as perceived by the building stakeholders. As a result, the revised questionnaire is divided into four parts, as explained below.

8.2.1.4 Question Content and Sequence

Dillman (1978, p.80) distinguished between five distinct types of question content: *behaviour, beliefs, knowledge, attitudes* and *attributes.* All these types of question content, except behaviour, are addressed in the questionnaire and explained below:

<u>Part I: Background</u>

Questions 1.1-1.5 are *attribute* questions designed “to obtain information about the respondents’ characteristics” (de Vaus, 2002, p95) including their profession, gender, highest level of educational qualification, organization type and number of years of professional experience. Answers to these questions are useful to facilitate the examination of whether these variables have correlation with stakeholders’ preferences and expectations.

<u>Part II: Sustainability Awareness</u>

Questions 2.1-2.3 are *attitude* questions formulated “to establish what they [survey respondents] think is desirable” (de Vaus, 2002, p.95) in terms of the ranking of sustainability issues and the incorporation of these issues in building development. Question 2.4 is a *knowledge* question of which respondents are asked about their knowledge of existing building performance assessment systems (BPASs) in the world. Answers to this question are used to measure respondents’ level of knowledge in the sustainable building field.

<u>Part III: Sustainability Preferences</u>

Questions 3.1-3.4 are to identify industry’s preferences regarding the most important criteria to be considered in the MOBSA systems. These questions aim at the weightings of the sustainability sub-issues and criteria (within each sub-issue) in Malaysia. 17 sub-

issues and 120 criteria covered in this part of the questionnaire are recalled from the Stage-2 MOBSA framework in the previous chapter. It is important to note that three of the criteria rated as “Not important can be omitted” by the relevant focus group (explained in Chapter Seven) are brought into this part of the questionnaire to have them rated by a larger sample to ensure the reliability of the results (Bryman, 2008). Findings identified in this questionnaire survey were also cross-checked against the interview findings in Chapter Six. Hence, the “overall tenor of the results of the combined use of the two research strategies was mutually reinforcing” (Bryman, 2008, p.611).

Throughout this part of the questionnaire, spaces were provided for respondents to insert additional criteria that they thought appropriate. However, only those mentioned by at least half of the respondents are considered in this study. The results form an important part in the Stage-3 MOBSA framework proposed at the end of the chapter.

<u>Part IV: Expectations of Malaysian Office Building Assessment (MOBSA) Systems</u>
Questions 4.1-4.4 are about respondents’ *belief* which focuses on “establishing what the respondent thinks is true rather than on the accuracy of their beliefs” (de Vaus, 2002, p.95). Specifically, these questions seek to identify what the survey respondents think about the best approach of implementing MOBSA systems. Question 4.5 gives respondents the opportunity to express additional thoughts.

All questions are in English or not translated in Malay, considering that the local professionals do speak English.

8.2.2 Target Population and Sampling Frame

In this study, research population comprises of building stakeholders including designers/consultants, developers/owners, policy makers/regulators, and other construction industry players. The different groups were targeted because they occupy the different positions in the construction value chain and their perspectives were needed for this research. Various stakeholder groups’ participation is considered important because the main purpose of the survey was to assign the appropriate weighting to each of the finally selected criteria. Cole (1998) reminded that the importance of certain criteria within BPASs is often the function of the interests of the people involved with its development. For instance, investors/developers tend to be very concerned with economic return; occupants are often concerned with the impacts of buildings on human health; maintenance and operations staff are concerned with operation and upkeep, and environmental advocates are usually concerned with natural resources and ecosystem impacts (Cole, 1998). Therefore, participation of a broad range of stakeholders is important to reduce the risk of bias. Nevertheless, since the MOBSA framework is focused more on its application to the design phase, emphasis was given to the views of the designers; however, without compromising the views of others.

The target population of the study was confined to stakeholders/professionals currently involved in construction in Kuala Lumpur (i.e. the capital city of Malaysia), Putrajaya (i.e. the new federal administrative capital of Malaysia) and Selangor (i.e. the most developed state in Malaysia). These areas were selected because many construction-related companies, which have projects throughout Malaysia, have their main offices located there (Zainul Abidin, 2010). Furthermore, these are areas where all federal government bodies are located.

In this study, there were four professional population frames comprising architects, engineers, planners, and developers. Each of these population frames consists of a sample with certain criteria which are explained in the following paragraphs.

Architects in Malaysia are grouped in three categories, namely: unregistered, graduate, and professional architects (the highest level) (Board of Architects Malaysia, 2005). Professional architects, who also the Corporate Members of the Malaysian Institute of Architects (PAM), have a relatively longer professional experience and have passed a series of accreditation exams including PAM Part 3 Professional exam, so have been proved as having more expertise in the architectural practice field than the other two groups. Therefore, it was considered appropriate, in terms of the purpose of the study, to select only the professional architects as the first sample frame[1] of this study. Samples were compiled from the membership lists of PAM, which had 1026 members (as of February 2009). These members worked in either private or public sector.

Engineers on the other hand, who involved in the construction industry, comprise of a variety of expert branches. These branches include civil/structural, mechanical, electrical, electronic, and etc. However, only engineers with qualifications in civil and mechanical branches of engineering are selected as the second sample frame because they had more experiences in building construction projects; hence, more informed about the topic of this research, compared to those who only specialised in infrastructure or civil engineering construction e.g. geotechnical engineers. It was believed that electrical and

[1] Sampling frame is the listing of units/persons in the population from which it is selected (Bryman, 2008, p.698).

electronic engineers could not provide appropriate data to this survey research as it covers much wider aspects of building performances and did not directly related to electrical and electronic engineering matters. Samples were selected from the membership listing provided by the Institute of Engineers Malaysia (IEM) which had 3500 members (as of February 2009), working in either private or public sector.

The third sampling frame was based on the members of the Malaysian Institute of Planners (MIP) which gave a total of 120 members (as of February 2009) from both private and public sectors. Because many planners are experienced with developing indicators for comprehensive planning and for other issues, they may be of assistance in identifying appropriate indicators of sustainability for BPASs, which is the data needed for this survey. The target population of developers was based on the members of the Real Estate and Housing Developers' Association Malaysia (REHDA). The list obtained consists of 365 private companies (as of February 2009).

Apart from views from the aforementioned professionals, views from the policy makers/regulators in the local construction industry were also considered relevant. As such, five federal ministries were identified as relevant for the study. However, within each ministry, only certain agencies/departments/sectors were selected based on their relevancy to office building developments, which is the focus of this study. Below are the breakdowns of the selected five ministries:

- Ministry of Federal Territories and Urban Wellbeing
  - Kuala Lumpur City Hall
  - Putrajaya Corporation
- Ministry of Housing and Local Government
  - Town and Country Planning Department
  - National Solid Waste Management Department
- Ministry of Public Works
  - Construction Industry Development Board
- Ministry of Natural Resources and Environment
  - Water Resources, Drainage and Hydrology Division
  - Environmental Conservation Division
  - Development Division
- Ministry of Energy, Water and Communications (currently known as Ministry of Energy, Green Technology and Water)
  - Water Services Sector
  - Energy Sector

Each Director of Department/Division/Sector was approached to explain the purpose of the study and ask his/her assistance in filling up the questionnaire form and distributing another form to his/her Deputy. Both were asked to answer from the perspective of policy maker/regulator in the construction industry. These high ranking personnel were chosen as participants because they are the most important persons in the organisation and play an important role in decision-makings. Since there were two representatives from each agencies/departments/sectors, a total of twenty policy makers/regulators were identified and invited to participate in the survey.

Lastly, it was also considered important to obtain views from the rest of the construction industry players. Due to the fact that compiling all of them into a single sampling frame would be extremely laborious, 150 members were selected comprising of 60 contractors, 40 project managers, and 50 others (i.e. facility managers, non-governmental organisation officers, interior designers, building materials suppliers, and quantity surveyors).

In order to draw a sample from each sampling frame, the study adopted the "systematic sample method with a random start" (Babbie, 1990, p.84). However, no sampling method was employed for government agency employees since all of the members identified were sampled. Detailed explanation on the required sample size from each sampling frame has been provided in Chapter Five.

8.2.3 Questionnaire Administration

Following the pilot study, an extensive questionnaire distribution was undertaken. This study adopted a mixed-mode data collection via group administration, mail and hand-delivery (later pick up) methods. Group-administered survey method was employed by taking the available opportunities to distribute the questionnaires at two separate built-environment-related conferences which occurred during the period of study. These conferences were attended by professional architects, engineers, planners from both private and public sectors, as well as developers and other construction industry players.

After gaining permission from both conferences' organising managers, questionnaires were handed over one day prior to the respective conference dates. The summaries of attendees' background information were also obtained from both organising managers. Below are the details of the conferences and the breakdown of the quantities of questionnaires distributed:

- 100 questionnaires with cover letters were distributed at a Conference on Landslide Risk Mitigation and Hill-slope Re-engineering Planning, organized by Institute Sultan Iskandar or Urban Habitat and Highrise, Universiti Teknologi Malaysia, held at Putra World Trade Centre, Kuala Lumpur on 19th March 2009.
- Additional 400 were distributed at an International Conference on World Class Sustainable Cities 2009 (WCSC09) which was jointly organized by Real Estate and Housing Developers' Association (REHDA), Malaysian Institute of Planners (MIP) and Malaysian Institute of Architects (PAM), held at Renaissance Hotel, Kuala Lumpur, on 24th March 2009.

Attendees were promised a complementary CD when they returned the completed survey form at the end of the conferences. They were also reminded by the conference organisers to complete the survey form before the session ended.

Subsequently, a self-administered survey method was employed. Additional 500 envelopes containing the questionnaire, a cover letter, a stamped return envelope and a complementary CD were sent out at the end of March 2009 in two groups to permit easy management. The first group (480) was sent by mail to architects, engineers, planners, and developers/owners; the second group (20) was delivered by hand to policy makers/regulators and then picked up in one week. Personal delivery was made to conform to the government protocol and to increase the rate of response. It is important to note that cautions were given to ensure that there was no overlap of participants between group-based and mailed-based questionnaire distribution modes.

A one-month period was allowed for the participants to complete and return the forms. Follow-up reminders were then sent to them two weeks after initial mailings (see Appendix E-3) and replacement survey forms were offered by request. Additional follow-ups by telephone calls were considered prohibitive due to the high cost (i.e. international call rates) involved. The questionnaire survey form is provided in Appendix E-4.

8.2.4 Total Response Rate

By early June 2009, a total of 206 valid questionnaires were received. Excluding those samples with missing data, 203 valid samples were identified. These 203 valid samples, as shown in Table 8.1, comprise of 59 architects (29.1% of the total), 60 engineers (29.5%), 26 planners (12.8%), 20 developers/owners (9.8%), 13 policy makers/ regulators (6.4%), and 25 others (12.3%).

Table 8.1: Distribution of the professions of survey participants

Responses	Population Group						Total Sent	Total Returned/Needed
	Arch	Eng	Plan	Dev	PM	Others		
Required to send	193*	200*	127*	177*	20	150	867	
Total Sent	**260**	**260**	**130**	**200**	**20**	**150**	**1000**	**-**
Needed	58*	60*	38*	53*	**	**	-	
Total returned	**59**	**60**	**26**	**20**	**13**	**25**	**-**	**203**
% of under-representation	N/A	N/A	12	33	N/A	N/A	-	-
% returned (out of group)	22.7	23.1	20.0	10.0	65.0	16.7	-	-
% returned (out of total)	29.1	29.5	12.8	9.8	6.4	12.3	-	100%

Note:
* As referred to Table 5.2
** As many as possible
Arch – Architects
Eng – Civil and Mechanical Engineers
Plan – Planners
Dev – Developers/Owners
PM – Policy Makers/ Regulators

Others – included Contractors, Project Managers, Facility Managers, NGO Officers, Interior Designers, Suppliers and Quantity Surveyors.

Out of the total 1000 questionnaires distributed, 4 were returned to the sender (unfilled) due to various reasons (e.g. deceased, retired, and not feeling eligible or wishing to participate). Subtracting 4 not available or not willing to participate from 1000 stakeholders leaves a sample population of 996 subjects equalling 100 percent. Accordingly, the final response rate was 20.4% (203/996=20.4% response rate), which is acceptable according to Akintoye (2000) who argued that the normal response rate in the construction industry for postal questionnaire is 20-30%. This seemed to be true in the current Malaysian context as Jaafar *et al.* (2007), Al-Tmeemy *et al.* (2010), Abdul-Aziz and Wong (2010), Ismail and Abdullah (2006), Abdul-Rahman *et al.* (2006) managed to obtain only 24%, 22.8%, 19%, 16.67% and 7.4% response rate respectively for their recent self-administered survey research in the Malaysian construction industry. Since the aim of this study was to obtain a general view of building professionals including representatives of private companies and government organisations, a small response rate is inevitable (Baruch, 1999). It was believed that the small response rate could be associated with the total length of the questionnaire and the fact that the economic climate was not particularly attractive, demanding the participants' effort and attention to their daily routines.

8.2.5 Notes about the Study

It is acknowledged that time, administrative, and financial imposed great constraints upon the study. As such, it is necessary to recall the aspects related to the response rate to explain the extent of sample generalizability. Despite efforts to boost the response rate (i.e. sending reminder letters out two weeks after initial mailings, making reminder announcements during the conferences, and offering token of appreciation for the completed survey forms returned) and collecting data by using more than one mode, the final response rate obtained is slightly above 20%. It is acknowledged that the above mentioned constraints prohibited further efforts to send more questionnaires out to raise the response rate (initial and follow-ups).

However, it must be noted that the "survey results do not pertain to people who are not in the list" (Salant & Dillman, 1994, p.16). This research surveyed only the professional architects, civil and mechanical engineers, planners, developers (the listed members of their respective professional organisations as of February 2009) and relevant policy-makers/regulators of the construction industry. Therefore, the conclusion reached from this study only holds true for this population.

In respect to cross-population generalizability or external validity, the survey is confined to two out of three federal territories (i.e. Kuala Lumpur and Putrajaya), and one out of thirteen states (i.e. Selangor), in Malaysia. Despite the fact that Malaysia has no different climatic zones, certain parts of the countries are drier or wetter than others depending on the months of the year. Other variations may include nature, economy and technological features, levels and styles. Therefore, the weightings developed in this survey are possibly applicable only to states or cities that are similar to the investigated ones. Otherwise, further research needs to be conducted to generate appropriate weightings.

8.2.6 Data Analysis

The analysis of data for the sustainability issues, sub-issues and criteria involved ranking based on their mean value of response. The analysis of data for issues and sub-issues also involved comparing the means for different groups of respondents (e.g. architects, contractors, developers) using one-way Analysis of Variance (ANOVA), which tests the null hypothesis that the mean of the dependent variable (e.g. individual sustainability issue) is equal in all the groups (Field, 2009). Specifically, one-way ANOVA was used to compare the relationships between several continuous variables (i.e. dependent variables e.g. three sustainability issues) with a categorical or nominal variable (i.e. independent variable e.g. profession) which has more than two groups (e.g. groups of architects, engineers and etc.). Any significant differences between these groups can be detected by the F values that are large.

The significance of the difference is measured by the p-value. There are two types of significant difference level i.e. $p < 0.01$ and $p < 0.05$, where $p < 0.01$ indicates a 99 percent confidence level and $p < 0.05$ indicates a 95 percent confidence level. In other words, the p-value is the probability of our assumptions being incorrect, hence, the lower the p-value the sounder the analysis. However, the p-value in this study is set at 0.05 ($p < 0.05$). According to Bryman (2008), this is the maximum level of statistical significance which is considered conventional among most social researchers. Additionally, de Vaus (2002) pointed out that the problem with using 0.01 consistently is that it can lead to Type II error (accepting the null hypothesis when it should be rejected) which is particularly likely with small samples; hence, recommended for small samples to use 0.05 instead.

8.3 Results and Discussion

8.3.1 Background

8.3.1.1 Profession and type of organization

Analysis of the returned questionnaires showed that the response rate of engineers and architects made up 59% whilst the remaining 41% were distributed among other professions (see Figure 8.1). However, professions do not directly predict the type of the organisation the respondents work for because an architect, for example, may work for a private consultancy firm, a construction company, a property development company or a government agency. Based on the returned questionnaires, the cross-tabulation of respondents' profession by the type of organisation they worked for is shown in Table 8.2.

The highest percentage of respondents consisted of those who worked in a design consultancy firm (31.5%), followed by those from a government agency/regulatory body (24.6%), property development/investment (21.7%), while the remaining 22.2% came from other types of organization i.e. project management, construction company, non-government organisation and trading company. In general, the majority (75.4%) of the sample is represented by practitioners from the private sector.

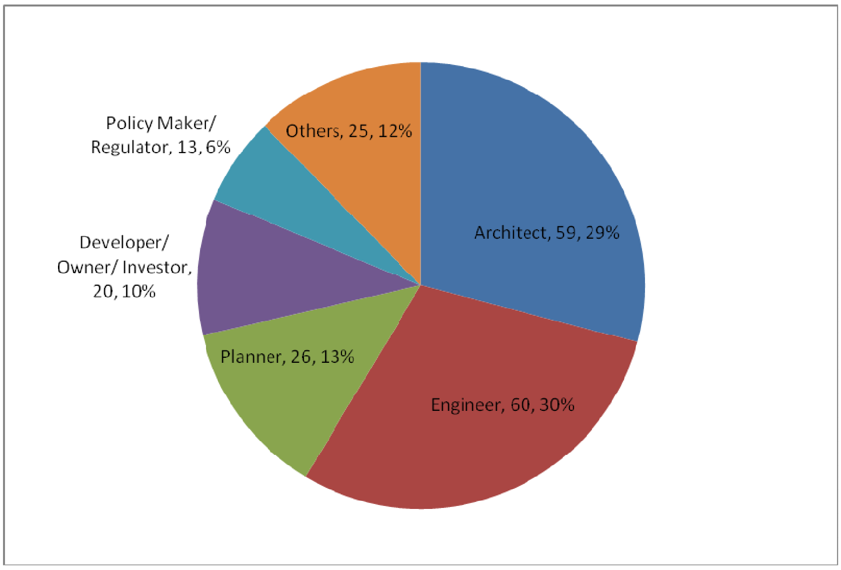

Figure 8.1: Distribution of respondents by professions (N_{all} = 203)

Table 8.2: Cross-tabulation of respondents' profession by the type of organisation

			Profession						
		Sector	**Arch**	**Eng**	**Plan**	**Dev**	**PM**	**Others**	**Total**
Type of organisation	Design Consultancy	Private	29	26	5	0	0	4	64 31.5%
	Government Agency/ Regulatory Body	Public	15	7	15	0	13	0	50 24.6%
	Property Development/ Investment	Private	10	11	2	20	0	1	44 21.7%
	Others*	Private	5	16	4	0	0	20	45 22.2%
	Total		59	60	26	20	13	25	203 100%

Note:
Arch – Architects
Eng – Civil and Mechanical Engineers
Plan – Planners
Dev – Developers/Owners
PM – Policy Makers/ Regulators

Others – included Contractors, Project Managers, Facility Managers, NGO Officers, Interior Designers, Suppliers, and Quantity Surveyors.

Others* - Project Management, Construction Company, NGO, and Trading Company.

8.3.1.2 Gender

Gender distribution shows that 71% of the respondents were male from all stakeholder groups. Female respondents came from all stakeholders groups with the exceptions of project managers and contractors. Although female participants in this survey are seriously under-represented, this is unsurprising as construction in Malaysia has always been a male dominated field. Recent statistical data revealed that in Malaysia, females employed in the construction industry only account for 8.4%; whereas female professionals and government personnel only account for 45.5% and 24.2% respectively (Malaysian Ministry of Women Family and Community Development, 2009). Therefore, the analysis of the survey results may predominantly represent opinions from the male building professionals but will not have a significant impact on the outcomes.

8.3.1.3 Educational qualification and working experience

Figure 8.2 shows that 97% of the survey respondents have completed at least undergraduate degrees and 57% have additional postgraduate qualifications. The survey also shows that 48% of the respondents have at least 10 years of working experience (see Figure 8.3). This means that the outcomes obtained from the survey represents the opinion of a group of building professionals with a good educational background and sufficient knowledge of, and experience in, building construction projects.

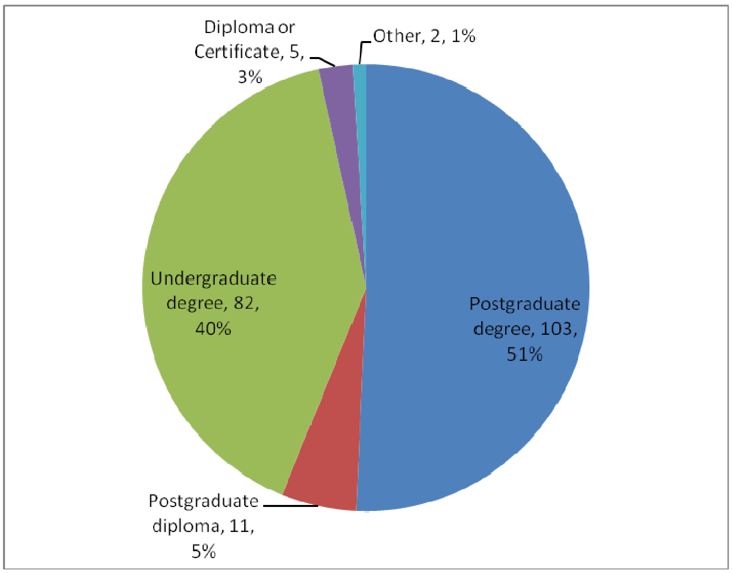

Figure 8.2: Distribution of respondents by educational qualification (N = 203)

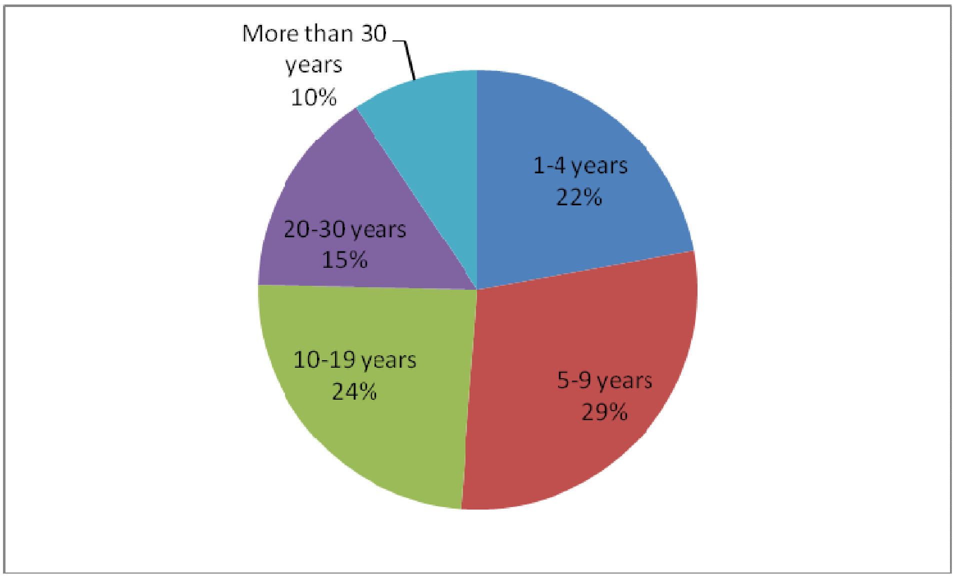

Figure 8.3: Distribution of respondents by years of working experience (Nall = 203)

8.3.2 Sustainability Awareness

Respondents were asked to rank five stages of building development (Question 2.2) which included pre-design, design, construction, operation, and refurbishment/demolition stages, to indicate the most suitable stage of project development to incorporate sustainability issues. They were asked to rank all the five stages on a scale of 5, where "1" to represent "the least suitable stage" and "5" to represent "the most suitable stage." Table 8.3 shows that "Pre-design/ inception stage" was considered as the most suitable stage to incorporate sustainability issues, followed by the "Design development stage." This indicates without doubt that sustainability issues are important and they have to be introduced at an early stage. This result supports the notion that "sustainability decisions made at the beginning of a project life cycle have a far greater influence than those made at later stages since design and construction decisions will influence the continuing operating costs and, in many cases, revenues over the building's lifetime" (Shafii & Othman, 2007),

Table 8.3: Total score of the most suitable stage to incorporate sustainability issues (N_{all} = 203)

	Arch	Engr	Planr	Dev	PM	Gov	Cont	Other	Total
Pre-Design/ Inception Stage	285	289	117	95	20	63	15	74	958*
Design Development Stage	256	261	107	80	17	56	13	80	870
Construction Stage	182	186	80	60	14	46	10	67	645
Operation Stage	160	157	83	48	14	34	7	55	558
Refurbishment/ Demolition Stage	149	124	67	39	13	24	4	45	465

Note:
The highest score indicates the most suitable stage
Arch = Architect; Engr = Engineer ; Planr = Planner; Dev = Developer/ owner/ investor; PM = Project manager; Gov = Government agency employee ; Cont = Contractor/builder

Respondents were then asked to rate the relative importance of three sustainability issues for sustainable building development and assessment in Malaysia (Question 2.3) on a scale of 4, where "1" is "Not important"; "2" is "Moderately important"; "3" is "Important"; and "4" is "Very important." Descriptive statistics of the results (Table 8.4) shows that the mean values of all the three sustainability issues are between 3 and 4, which means they are considered between "important" and "very important." Among them, "Environmental protection" was voted as the most important issue, which is closely followed by "Human well-being enhancement" and lastly by "Economic development."

Table 8.4: Descriptive statistics of the importance of sustainability issues (N_{all} = 203)

Sustainability Issues	**N**	**Mean**	**SD**	**Min. Mean** (Mean-SD)
Environmental protection	203	3.59	.61	2.98
Human well-being enhancement	203	3.52	.65	2.87
Economic development	203	3.13	.69	2.44

Note:
1 = Not important; 2 = Moderately important; 3 = Important; 4 = Very important

When the group means on the ratings of these issues are compared by profession, the results, as shown in Table 8.5, can be summarized as follows:

- the highest mean for "Environmental protection" was rated by "Others" (3.76) and the lowest by "Engineers" (3.42);
- the highest mean for "Human well-being enhancement" was rated by "Architects" (3.64), while the lowest by "Policy makers/ regulators" (3.31); and
- the highest mean for "Economic development" was rated by "Architects" and "Developers/owners" (3.25); whereas the lowest by "Others" (3.00).

Table 8.5: Group means and standard deviation on the ratings of three sustainability issues by profession

		Environmental protection		**Human well-being enhancement**		**Economic development**	
Profession	**N**	**Mean***	**SD**	**Mean***	**SD**	**Mean***	**SD**
Architects	59	3.66	.545	**<u>3.64</u>**	.550	**<u>3.25</u>**	.632
Engineers	60	**3.42**	.671	3.48	.651	3.02	.748
Planners	26	3.62	.571	3.62	.697	3.12	.711
Developers/owners	20	3.55	.510	3.35	.745	**<u>3.25</u>**	.639
Policy makers/regulators	13	3.69	.855	**3.31**	.855	3.23	.599
Others	25	**<u>3.76</u>**	.523	3.48	.586	**3.00**	.764
Overall	203	3.59	.610	3.52	.647	3.13	.694

Note:
* The group means represent the mean ranking of the respective groups (i.e. types of organization) of respondents according to a Likert scale of 1 (not important) to 4 (very important) with respect to sustainability issues.
Table entries in **<u>bold</u>** represent the largest group mean within the respondent groups, whereas table entries in **bold** represent the smallest group mean within the respondent groups.
Others = Project Management, Construction Company, NGO, and Trading Company.

One-way ANOVA (also called F-test) was then used to find out whether these differences between the means are sufficiently large as to reflect real population difference. Specifically, it tests the null hypothesis that the mean of the dependent variable (individual issue) is equal in all profession groups. The result in Table 8.6 shows that there are no statistically significant differences found among professions on the ratings of "Environmental protection" (F value = 1.639, p = 0.151), "Human well-being enhancement" (F value = 1.164, p = 0.328), and "Economic development" (F value =1.050, p = 0.390). This means that the differences between the mean ratings on all issues are small and likely to be due to sampling error; hence, no differences can be assumed in the population at large. This suggests that building stakeholders, irrespective of profession, generally have similar opinions regarding the ratings of the sustainability issues.

Table 8.6: One-way Analysis of Variance of ratings on three sustainability issues by profession

Source of variation	Sum of Squares	Degree of freedom (df)	Mean Square	F value	Sig. (p)
Environmental protection					
Between groups	3.005	5	.601	1.639	.151
Within groups	72.237	197	.355		
Total	75.241	202			
Human well-being enhancement					
Between groups	2.428	5	.486	1.164	.328
Within groups	82.222	197	.417		
Total	84.650	202			
Economic development					
Between groups	2.528	5	.506	1.050	.390
Within groups	94.881	197	.482		
Total	97.409	202			

The final question (Question 2.4) for this part of the questionnaire was designed to gauge respondents' knowledge about existing building performance assessment systems (BPASs). Frequent distribution of respondents' knowledge about existing BPASs, as shown in Table 8.7, indicates that 54% considered they did not know any existing BPASs. In finding out whether this pattern in the sample is likely to reflect the pattern in the population from which the sample was drawn, a Binomial significance test (for nominal variables with two categories i.e. dichotomous variables) shows that there is a 33% chance[2] that the 54/46 deviation from a 50/50 split is due to sampling error. In other words, stakeholders in the population are likely to "know" as "do not know" about existing BPASs.

Table 8.7: Frequent distribution of respondents' knowledge about existing BPASs (N_{all} = 203)

Answer	Frequency	Percent	Valid Percent
Yes	94	46.3	46.3
No	109	53.7	53.7
Total	203	100.0	100.0

Figure 8.4 shows that, among the respondents who claimed themselves as knowing some existing BPASs (94 in total), majority (62 or 34%) knew the Singapore's Green Mark, and some of them knew LEED (23%), BREEAM (20%), and Green Star (15%). 5% of respondents chose the "Other" answer and all of them specified Malaysia's Green Building Index (GBI). GBI was not listed as one of the existing BPASs in the questionnaire because it was not yet officially launched and implemented during the

[2] Knowledge about existing BPAS Binomial test: Test prop .50; Asymp. Sig. (2-tailed) .326

preparation and distribution of the questionnaires. The least known BPASs are GBTool/SBTool and CASBEE, which were both chosen by 2% of the respondents.

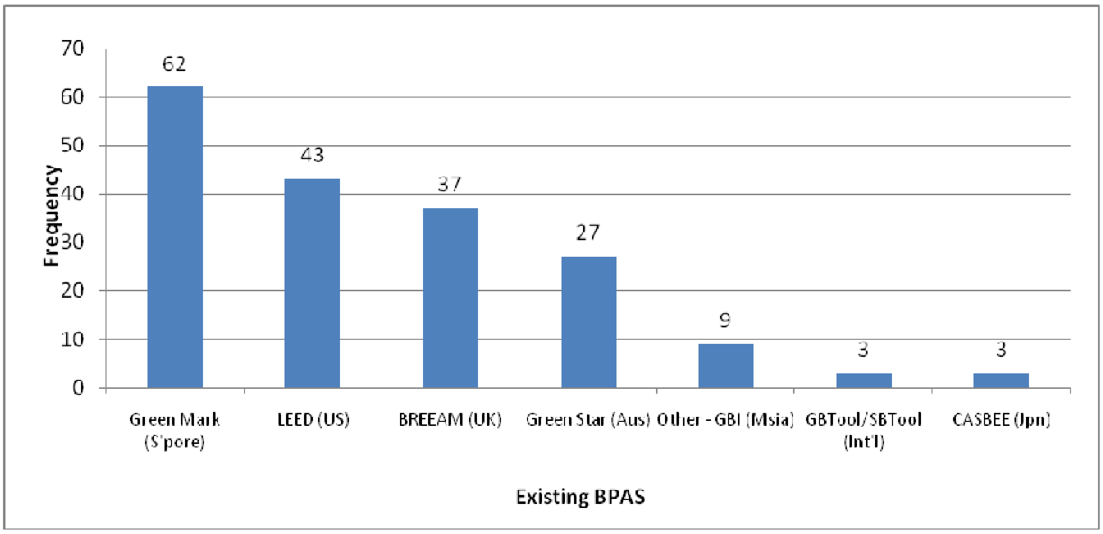

Figure 8.4: Frequent distribution of respondents' knowledge about existing BPASs

The cross-tabulation illustrates an association between the two variables, detected by different percentages across the different types of organisation (see Table 8.8). The coefficient of the nominal association of 0.236[3] was observed in the sample, which according to de Vaus (2002) is a "low to moderate relationship" that is likely to hold in the population from which the sample was drawn (statistically significant at the 0.010 level[4]). In summary, stakeholders who work for "Property development/investment" companies and "Design consultancy" firms are more likely to be knowledgeable about existing BPASs than those from other types of organisation. It would appear then that stakeholders from the private sector are more likely to be knowledgeable about existing BPASs than those from the public sector. No association between stakeholders' knowledge about existing BPASs and the amount of working experience or the level of educational qualification or even gender was detected from the statistical analysis.

It can be concluded that respondents considered sustainability issues and assessment as important for office building development; however, they do not know much about existing BPASs. This reveals that existing BPASs have neither been widely acknowledged among local building stakeholders nor been widely applied in building practices. However, it was found that the knowledge of existing BPASs can be predicted by the combination of working experience and educational qualification.

[3] "Knowledge about existing BPAS" (Nominal with 2 categories) and "type of organisation" (nominal with 3+ categories) Cramer's V: value .236; Approx. Sig .010

[4] "Knowledge about existing BPAS" (Nominal with 2 categories) and "type of organisation" (nominal with 3+ categories) Pearson Chi-Square: value 11.276; df 3; Asymp. Sig. (2-sided) .010

Table 8.8: Cross-tabulation of knowledge about existing BPAS and type of organisation

		Type of organisation			
		Design Consultancy	Property Development	Gov. agency/ Regulatory Body	Others
Knowledge	Know	**53.1%**	**61.4%**	30%	40%
about existing	Do not know	46.9%	38.6%	70%	60%
BPAS	N	64	44	50	45

8.3.3 Sustainability Preferences

Part Three of the questionnaire forms the core of this study. Question 3.1, 3.2, 3.3 and 3.4 are designed in the survey questionnaire to find out local stakeholders' perceptions about the relative importance of 17 sustainability sub-issues and 120 criteria identified in the previous chapter. It was acknowledged that assessing all the criteria listed in the questionnaire is an enormous task making the framework too complex to be useful in project assessment. Therefore, this part of the questionnaire aimed to reduce the number of criteria and only the 'important' ones will be incorporated into the MOBSA framework

Respondents were requested to rate the importance of criteria on a scale of one to four where a score of "1" represents "Not important and can be omitted"; "2" represents "Less important and may be omitted"; "3" represents "Important and should be assessed"; and "4" represents "Very important and must be assessed." The middle non-committal alternative (neither omit nor assess) was not provided; hence, respondents were asked to indicate the direction of their opinion and the questions stopped them from sitting on the fence. Throughout this part of the questionnaire, spaces were provided for respondents to suggest additional criteria that were not included. These additional criteria however, are only adopted in the framework if they were mentioned by at least half of the respondents.

Question 3.1 consists of 8 environmental sub-issues, whereas Questions 3.2 and 3.3 consist of 7 social and 2 economic sub-issues respectively. Then all 17 sub-issues are listed in question 3.4. These sub-issues are presented later in the questionnaire to allow the respondents to firstly aware of the criteria that fall under each sub-issue before they are asked to rate the importance of the sub-issues.

In determining the most important criteria, their mean values and standard deviations (SD) were obtained. Since the questionnaire incorporated a 4-point Likert scale, the midpoint is then 2.5. In other words, the criteria that should be included in the MOBSA framework must have a minimum mean of 2.5 or above, after taking into account their respective SD i.e. the result of the mean value minus the standard deviation must be equal or bigger than 2.5:

$$\text{Mean} - \text{SD} \geq 2.5 \text{ (rounded to 1 decimal point)}$$

Since SD measures how well a mean summarises a distribution (the higher the SD, the less well the mean represents what is typical), it is considered reasonable to select the most important criteria based on their mean values after taking into account their respective SD. Finally, the selected criteria are assigned with their respective weighting values and importance levels. These are explained at the end of the chapter.

8.3.3.1 Environmental-related Criteria

Under environmental issue, there are eight sub-issues: 1) Land Use and Impacts on Ecology (ECO); 2) Supports Resource Management (SRM); 3) Emissions to Air (AIR); 4) Emissions to Land/Solid Waste (LAN); 5) Emissions to Water (EWA); 6) Impacts on Adjacent Properties (ADJ); 7) Non-renewable Energy Consumption (ENE); and 8) Potable Water Consumption (WAT). Within each sub-issue, there are a number of criteria that the respondents were asked to rate (in Question 3.1).

8.3.3.1.1 Land Use and Impacts on Ecology (ECO)

The descriptive statistics of the relative importance of eight criteria in the ECO sub-issue are shown in Table 8.9. It shows that the most important criteria are: (1) “Damage to soil, water bodies and flora and fauna” (Mean 3.61); and (2) “Green/open space on the site” (3.30). It also shows that there are four criteria meet the stipulated condition to be included in the MOBSA framework i.e. Mean - SD ≥ 2.5. As highlighted in Chapter Three, construction activities are among the major causes of environmental impacts in Malaysia. This predicament is also consistent with qualitative findings in Chapter Six (Section 6.4.1.2) which revealed that environmentally destructive methods of construction are still considered a normal practice in the country. Hence, more efforts need to be undertaken to minimise these effects.

Table 8.9: Descriptive statistics of the importance of criteria under the ECO sub-issue (N_{all} = 203)

ECO: Land Use and Impact on Ecology						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Damage to soil, water bodies and flora & fauna	203	2	4	3.61	.51	3.1
Green/open space on the site	202	2	4	3.30	.64	2.7
Ecological value of natural landscape	202	1	4	3.22	.65	2.6
Sites that have low risk of flooding	203	1	4	3.25	.74	2.5
Redevelopment of existing/used site	203	1	4	3.10	.73	2.4
Sites that are within urban areas	200	1	4	3.00	.74	2.3
Sites that have low ecological value	197	1	4	2.94	.76	2.2
Greenery within and/or on the rooftop	203	1	4	2.80	.76	2.0
Valid N (listwise)	192					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

8.3.3.1.2 Support Resource Management (SRM)

The descriptive statistics of the relative importance of five criteria in the SRM sub-issue are shown in Table 8.10. Among them, “Materials that have less environmental impact” (Mean 3.35) and “Durable materials” (3.31) are considered the most important criteria. It also reveals that all of the criteria listed meet the condition to be included in the MOBSA framework. Undoubtedly, criteria within this sub-issue have gained the level of attention it warranted. It is important to note that the manufacturing processes of various building materials in Malaysia such as steel, concrete, bricks, aluminium, glass, cement etc. are highly energy dependent; and the required energy is basically from non-renewable energy sources (Mari, 2007, Shafii, 2006 #934). Therefore, the greater the amount of energy required to produce it, implying more severe ecological consequences (Kim & Rigdon, 1998).

Table 8.10: Descriptive statistics of the importance of criteria under the SRM sub-issue (N_{all} = 203)

SRM: Supports Resource Management						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Materials that have less environmental impact	201	1	4	3.35	.67	2.7
Durable materials	203	1	4	3.31	.71	2.6
Bio-based products and materials	199	1	4	3.21	.64	2.6
Materials that can be recycled	203	1	4	3.26	.69	2.6
Materials with recycled content	203	1	4	3.16	.65	2.5
Valid N (listwise)	197					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

8.3.3.1.3 Emissions to Air (AIR)

The descriptive statistics of the relative importance of nine criteria in the AIR sub-issue are shown in Table 8.11. It appears that only the three most important criteria are eligible to be included in the MOBSA framework, namely: 1) "Greenhouse gas emissions from building operations" (Mean 3.50); 2) "Pedestrian access to basic services" (3.34); and 3) "Connection to existing public transportation network" (3.29). It is also worth mentioning that the exclusion of "Minimum allowable parking spaces" (Min. Mean 1.8) is consistent with the interview results (Chapter 6, Section 6.4.2.3) which indicate that the practice of providing more than required parking spaces is still much preferred due to the correlation between insufficient car parking spaces and reduced marketability or property market value.

Table 8.11: Descriptive statistics of the importance of criteria under the AIR sub-issue (N_{all} = 203)

AIR: Emissions to Air						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
GHG gas emissions from building operation	203	2	4	3.50	.59	2.9
Pedestrian access to basic services	203	1	4	3.34	.65	2.7
Connection to public transportation network	202	1	4	3.29	.70	2.6
Proximity to public transport stops	203	1	4	3.09	.71	2.4
Air pollution from site workers' accommodation	202	1	4	3.11	.80	2.3
Proximity to residential zones	201	1	4	2.85	.72	2.1
Bicycles and/or bicycle parking spaces	203	1	4	2.80	.85	2.0
Minimum allowable parking spaces	200	1	4	2.68	.83	1.8
Maximum motorcycle parking spaces	203	1	4	2.53	.89	1.6
Valid N (listwise)	197					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

8.3.3.1.4 Emissions to Land/ Solid Waste (LAN)

The descriptive statistics of the relative importance of eleven criteria in the LAN sub-issue are shown in Table 8.12. Among them, "Hazardous wastes on site" is considered the most important criterion (Mean 3.55), followed by "Construction waste management program" (3.30). Additional four criteria eligible to be included in the MOBSA framework are "Space for collection of recyclables", "Recycling of office recyclables", "Land pollution from site workers' accommodation", and "Standardized and prefabricated components". These results support the argument developed in Chapter Three and qualitative findings in Chapter Six that better standards of waste management are highly important and urgently needed in the country.

Table 8.12: Descriptive statistics of the importance of criteria under the LAN sub-issue (N_{all} = 203)

LAN: Emissions to Land/ Solid Waste						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Hazardous wastes on site	197	1	4	3.55	0.58	3.0
Construction waste management program	202	1	4	3.30	0.66	2.6
Space for collection of recyclables	203	1	4	3.29	0.68	2.6
Recycling of office recyclables	203	1	4	3.20	0.71	2.5
Land pollution from site workers' accommodation	203	1	4	3.22	0.75	2.5
Standardized and prefabricated components	203	1	4	3.15	0.69	2.5
Easy disassembly of components	202	1	4	3.02	0.71	2.3
Reuse of suitable existing structure(s)	203	1	4	3.01	0.71	2.3
Land clearing debris as a resource	200	1	4	2.99	0.76	2.2
Salvaged, refurbished or used materials	203	1	4	2.93	0.75	2.2
Interior finishing materials	202	1	4	2.79	0.75	2.0
Valid N (listwise)	192					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

8.3.3.1.5 Emissions to Water (EWA)

The descriptive statistics of the relative importance of five criteria in the EWA sub-issue are shown in Table 8.13. Among them, "Water contamination to nearby water body" is considered the most important criterion (Mean 3.75), followed by "Stormwater management strategies" (3.59). All of the criteria meet the condition to be incorporated into the MOBSA framework, except "Black water treatment systems" (Min. Mean 2.1). One respondent wrote a comment on the usage of black water: "This is not a priority at the moment. Need to educate [the government agencies and developers] on the system using gray water first and will do this in stages" (Arch/Female/9).

Table 8.13: Descriptive statistics of the importance of criteria under the EWA sub-issue (Nall = 203)

EWA: Emissions to Water						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Water contamination to nearby water body	200	2	4	3.75	0.44	3.3
Stormwater management strategies	199	2	4	3.59	0.58	3.0
Sewer or stream pollution from workers' accommodation	195	1	4	3.26	0.69	2.6
Gray water treatment systems	199	2	4	3.21	0.67	2.5
Black water treatment systems	195	1	4	2.97	0.85	2.1
Valid N (listwise)	189					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

8.3.3.1.6 Impacts on Adjacent Properties (ADJ)

The descriptive statistics of the relative importance of four criteria in the ADJ sub-issue are shown in Table 8.14. It appears that the most important criterion is the only one that is eligible to be incorporated into the MOBSA framework, i.e. "Noise and vibration generated during construction" (Mean 3.36; Min. Mean 2.7). The exclusion of "Potential glare to adjacent properties" at this stage validates the decision made by the focus groups by rating it as "Not important and can be omitted."

Table 8.14: Descriptive statistics of the importance of criteria under the ADJ sub-issue (N_{all} = 203)

ADJ: Impacts on Adjacent Properties						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Noise and vibration generated during construction	200	1	4	3.36	0.64	2.7
Potential glare to adjacent properties	200	1	4	3.09	0.67	2.4
Light spillage from exterior lightings	200	1	4	3.02	0.71	2.3
Possibility of overshadowing adjacent properties	200	1	4	2.87	0.71	2.2
Valid N (listwise)	189					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

8.3.3.1.7 Non-renewable Energy Consumption (ENE)

The descriptive statistics of the relative importance of eleven criteria in the ENE sub-issue are shown in Table 8.15. All of the criteria are considered important but the top three most important criteria are: 1) "Energy efficient lighting fixtures and office appliances" (Mean 3.46); 2) "Efficient ventilation and air-conditioning systems" (3.48); and 3) "Passive cooling strategies" (3.47). The result also reveals that all of the criteria meet the condition to be included in the MOBSA framework, except "On-site power generation systems" (Min. Mean 2.4).

Table 8.15: Descriptive statistics of the importance of criteria under the ENE sub-issue (N_{all} = 203)

ENE: Non-renewable Energy Consumption						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Energy efficient lighting fixtures and appliances	200	2	4	3.46	0.58	2.9
Efficient ventilation and air-conditioning systems	200	1	4	3.48	0.60	2.9
Passive cooling strategies	200	2	4	3.47	0.60	2.9
Integrated lighting concept	200	1	4	3.46	0.64	2.8
Fossil fuel energy consumption for building operations	195	1	4	3.36	0.60	2.8
Size of lighting control zones	198	2	4	3.31	0.60	2.7
Tight, thermally resistant envelope	199	1	4	3.28	0.68	2.6
Dimmable and auto-sensored lighting	200	2	4	3.26	0.67	2.6
Energy sub-metering system	199	2	4	3.14	0.61	2.5
Personal control of the lighting and thermal comfort systems	200	2	4	3.20	0.67	2.5
On-site power generation systems	200	1	4	3.05	0.69	2.4
Valid N (listwise)	190					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

With regard to this omission, one respondent gave her justification: "Malaysia should take advantage of solar power, however hindrances are photovoltaics are costly now and electricity tariff is cheap" (Arch/Female/9). This was supported by Haw *et al.* (2007) who pointed out that BIPV system is still a technology with a very high investment cost, and in

Malaysia, it is still a major barrier for market penetration. One of the main reasons is the low tariff rate of electricity in comparison to other developed countries like Germany and Japan. This low tariff rate in Malaysia is due to heavy subsidy of electricity production by the Malaysian government (Haw*, et al.*, 2006).

8.3.3.1.8 Potable Water Consumption (WAT)

The descriptive statistics of the relative importance of six criteria in the WAT sub-issue are shown in Table 8.16. All of the six criteria are considered important but the most important criterion is “Rainwater harvesting” (Mean 3.48). This result supports the notion that rainwater harvesting is of paramount importance in the country to reduce the dependence of potable water and save the country a great deal amount of money when less money is needed for flood prevention or construction of new reservoir (Othman*, et al.*, 2007). The importance of water efficiency is further accentuated by the fact that all of the criteria within this sub-issue meet the condition to be included in the MOBSA framework, only with the exception of “Potable water for the testing of fire fighting system” (Min. Mean 2.4).

Table 8.16: Descriptive statistics of the importance of criteria under the WAT sub-issue (N_{all} = 203)

WAT: Potable Water Consumption						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Rainwater harvesting	202	2	4	3.48	0.60	2.9
Water efficient plumbing fixtures	201	2	4	3.42	0.61	2.8
Potable water for landscape irrigation	202	1	4	3.34	0.66	2.7
Potable water for cooling system	200	1	4	3.21	0.69	2.5
Water meters	200	1	4	3.16	0.70	2.5
Potable water for the testing of fire fighting system	199	1	4	3.15	0.72	2.4
Valid N (listwise)	196					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

8.3.3.2 Social-related Criteria

Under social issue, there are seven sub-issues: (1) Education and Awareness on Sustainable Development (EDU), (2) Support for Social Cohesion (COH), (3) Accessibility (ACC), (4) Inclusiveness of Opportunities to Use and Access the Building (INC), (5) Human Health and Well-being (HUM), (6) Cultural and Heritage Aspects (CUL); and (7) Local People and Employment (LOC). Within each sub-issue, there are a number of criteria that the respondents were asked to rate (Question 3.2).

8.3.3.2.1 Education and Awareness (EDU)

The descriptive statistics of the importance of five criteria in the EDU sub-issue are shown in Table 8.17. Among them, “Building occupants’ awareness” and “Readiness and competency of design team members” (Mean 3.53) are perceived to be the top two most important criteria. It appears that all of the criteria meet the condition to be incorporated into the MOBSA framework, except “Spaces for education” (Min. Mean 2.4). This exclusion validates the decision made by the focus groups by rating it as “Not important and can be omitted”. However, the inclusion of the rest of the criteria indicates the significance of education about the principles and concepts of sustainable building to all building stakeholders in mainstreaming sustainable construction in the country. Furthermore, education followed by technical trainings offers better understanding of sustainability issues to support implementations (Shafii & Othman, 2007). With these kinds of results, it is understandable why the interviewees of this study (discussed in Chapter Six) perceived knowledge-related barriers as the most important aspect to be overcome in order to expedite the construction industry’s progress in achieving sustainable development.

Table 8.17: Descriptive statistics of the importance of criteria under the EDU sub-issue (N_{all} = 203)

EDU: Education and Awareness						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Building occupants' awareness	202	1	4	3.53	0.59	2.9
Readiness and competency of design team	203	1	4	3.53	0.62	2.9
Skills and knowledge of operation and maintenance staff	202	1	4	3.49	0.61	2.9
Sustainable construction skills among construction workers	203	1	4	3.34	0.66	2.7
Spaces for education	202	1	4	3.16	0.77	2.4
Valid N (listwise)	202					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

8.3.3.2.2 Support for Social Cohesion (COH)

The descriptive statistics of the importance of five criteria in the COH sub-issue are shown in Table 8.18. Among them, “Inter-disciplinary work from the beginning of the design process” (Mean 3.57) is considered the most important criterion. All of the criteria meet the condition to be incorporated into the MOBSA framework. These findings are consistent with the status of sustainable building in Southeast Asia (Shafii & Othman, 2007, p.4) which highlighted the need “to encourage the use of holistic building concept or Integrated Design Process” and to emphasize “participatory approach to sustainable building.”

Table 8.18: Descriptive statistics of the importance of criteria under the COH sub-issue (N_{all} = 203)

COH: Support for Social Cohesion						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Inter-disciplinary work from the beginning of the design process	198	1	4	3.57	0.57	3.0
Mix-uses within the project	198	1	4	3.30	0.67	2.6
Space planning for social interaction	198	1	4	3.27	0.65	2.6
Participation of affected community in development process	197	1	4	3.19	0.67	2.5
Participation of users in development process	197	1	4	3.15	0.70	2.5
Valid N (listwise)	196					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

8.3.3.2.3 Accessibility (ACC)

The descriptive statistics of the importance of five criteria in the ACC sub-issue are shown in Table 8.19. All of these criteria are considered important but “Personal safety and security” (Mean 3.46) is perceived as the most important one; closely followed by “Ease of facades cleaning” (3.36). The result also reveals that all of the five criteria are eligible to be incorporated into the MOBSA framework.

Table 8.19: Descriptive statistics of the importance of criteria under the ACC sub-issue (N_{all} = 203)

ACC: Accessibility						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Personal safety and security	202	1	4	3.46	0.65	2.8
Ease of facades cleaning	203	2	4	3.36	0.64	2.7
Access to communication technology	202	1	4	3.26	0.62	2.6
Access to technical systems	202	1	4	3.18	0.69	2.5
Walking distance to basic services	202	1	4	3.22	0.74	2.5
Valid N (listwise)	202					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

Clearly, measures to maximize personal safety and security for building users are of paramount importance. One possible connection is the fact that Malaysia is ranked 33rd (out of 68 countries worldwide) in the list of burglaries crime statistics, and 50th (out of 82 countries) in the list of total crime statistics (United Nations Office on Drugs and Crime, 2002). This is considered an unfavourable position for a small country like Malaysia with only 26 million populations. In addition, it is interesting to notice that the eligibility of “Access to communication technology” to be included in the MOBSA framework is contradict with the decision made by the focus groups by rating it as “Not important and can be omitted”.

8.3.3.2.4 Inclusiveness of Opportunities (INC)

The descriptive statistics of the importance of three criteria in the INC sub-issue are shown in Table 8.20. All of these criteria are appropriate to be included in the MOBSA framework. This seems to be in line with the interview findings discussed in Chapter Six, Section 6.4.2.1 in the following two ways: 1) the progress in creating barrier-free built environment in Malaysia is too slow as universal design is still unpopular among many consultants; and 2) provisions of religious and day care facilities are among the mostly quoted social spaces to enhance local culture and religious belief in space planning.

Table 8.20: Descriptive statistics of the importance of criteria under the INC sub-issue (N_{all} = 203)

INC: Inclusiveness of Opportunities						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Universal access	198	1	4	3.47	0.64	2.8
Religious facilities	198	1	4	3.31	0.73	2.6
Facilities for users with children	197	1	4	3.22	0.72	2.5
Valid N (listwise)	197					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

8.3.3.2.5 Human Health and Well-being (HUM)

The descriptive statistics of the importance of eighteen criteria in the HUM sub-issue are shown in Table 8.21. Generally, all of these criteria are considered important, but the top two most important criteria are “Practices that avoid construction accidents” (Mean 3.60) and “Air changes and quality of fresh air” (3.48). On top of these criteria, eleven others also meet the stipulated condition to be included in the MOBSA framework. The study shows that the issue of construction accidents is a major concern among the respondents which is in line with the arguments developed in Chapter Three (see Section 3.3.2). Besides, respondents also emphasized the importance of health and well-being among building users which is well reflected on the number of criteria (i.e. three-quarter of the list) deemed appropriate to be included in the MOBSA framework. This emphasis offers some support to the notion that sick building syndrome (SBS) has become a common issue in Malaysia due to poor maintenance and services of air conditioning and ventilation system, resulting in the increasing of indoor air pollutants levels (Syazwan*, et al.*, 2009).

Table 8.21: Descriptive statistics of the importance of criteria under the HUM sub-issue (N_{all} = 203)

HUM: Human Health and Well-being						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Practices that avoid construction accidents	197	2	4	3.60	0.52	3.1
Air changes and quality of fresh air	198	2	4	3.48	0.59	2.9
Opening and cross ventilation	197	2	4	3.46	0.59	2.9
Noise and acoustic performance	197	2	4	3.38	0.56	2.8
Illumination and lighting quality	197	2	4	3.35	0.55	2.8
Prohibition of tobacco smoking	198	1	4	3.49	0.75	2.7
Low/zero pollutants cleaning and maintenance products and processes	196	2	4	3.33	0.60	2.7
Interior finish materials with low- or zero-pollutants off-gassing	197	1	4	3.37	0.65	2.7
Air movement for thermal comfort	198	1	4	3.33	0.63	2.7
Glare conditions	197	2	4	3.30	0.62	2.7
Practice of building flush-outs	197	1	4	3.28	0.63	2.7
Separately ventilated and isolated rooms which generate pollutants	197	1	4	3.25	0.68	2.6
Monitoring occupants' satisfaction with IEQ	197	1	4	3.13	0.67	2.5
Visual access to views	198	1	4	3.13	0.70	2.4
Carbon dioxide monitoring and control system	198	1	4	3.12	0.71	2.4
Separately ventilated rooms/areas for smoking	198	1	4	3.21	0.93	2.3
Recreational facilities	195	1	4	3.01	0.78	2.2
Walking distance to recreational areas	197	1	4	3.02	0.80	2.2
Valid N (listwise)	187					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

8.3.3.2.6 Cultural and Heritage Aspects (CUL)

The descriptive statistics of the importance of two criteria in the CUL sub-issue are shown in Table 8.22. It shows that only “Heritage value of existing buildings” (Min. Mean 2.5) is eligible to be included in the MOBSA framework. None of the respondents wrote any comments that may indicate the triviality of “Compatibility of urban design and building architecture with local cultural values” in local building assessment. This may indicate that it is a common and acceptable trend to adopt foreign architecture. If this is the case, then it is consistent with the interview results discussed in Chapter Six which revealed that nearly half of the interviewees believed that there are no characteristics of local office buildings that are distinctively Malaysian.

Table 8.22: Descriptive statistics of the importance of criteria under the CUL sub-issue (N_{all} = 203)

CUL: Cultural and Heritage Aspects						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Heritage value of existing buildings	199	1	4	3.27	0.72	2.5
Compatibility of urban design and building architecture with local cultural values	199	1	4	3.15	0.74	2.4
Valid N (listwise)	199					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

8.3.3.2.7 Local People and Employment (LOC)

The descriptive statistics of the importance of six criteria in the LOC sub-issue are shown in Table 8.23. Among all, “Training opportunities for local people” (Mean 3.49) is considered the most important criterion. All of the criteria meet the condition to be incorporated into the MOBSA framework, except “Local labour” (Min. Mean 2.3). The result indicates that the provision of training opportunities for unskilled local people (employed for the works) to be future semi-skilled or skilled workforce is a highly regarded social factor to be emphasized in the local construction industry.

Table 8.23: Descriptive statistics of the importance of criteria under the LOC sub-issue (N_{all} = 203)

LOC: Local People and Employment						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Training opportunities for local people	199	1	4	3.49	0.64	2.9
Locally produced materials	199	1	4	3.32	0.66	2.7
Linkage to local service providers	198	1	4	3.28	0.59	2.7
Experienced local design teams	199	1	4	3.29	0.74	2.5
Experienced local contractors	199	1	4	3.22	0.73	2.5
Local labour	199	1	4	3.07	0.76	2.3
Valid N (listwise)	198					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

However, as highlighted in Chapter Three, the industry relies more on foreign unskilled workers than skilled or local workers. Therefore, the industry should enforce the use of local semi-skilled and skilled workers (CIDB Malaysia, 2007b). It is also important for construction companies to use more unskilled workers among local people. These workers must then be given the opportunities to deepen their expertise to become semi-skilled or skilled workers through various trainings certified by the government. The result also indicates that it is imperative to use local expertises. According to Shafii (2006, p.34-35), “it is common for local contractors to operate only on small residential projects while the larger industrial and commercial projects are awarded to foreign-based construction firms.” This attribute owes much to the fact that the local training contracting industry is not sufficiently developed (Shafii*, et al.*, 2006). Undoubtedly, it is not only important to encourage the use of local expertise but also to support any collaboration work with foreign teams to improve local know-how.

8.3.3.3 Economic-related Criteria

Under economic issue, there are two sub-issues: (1) Efficiency, Effectiveness and Flexibility (EEF); and (2) Triple Bottom Line Accounting – Planet, People and Profit

(TBL). Within each sub-issue, there are a number of criteria that the respondents were asked to rate (Question 3.3).

8.3.3.3.1 Efficiency, Effectiveness and Flexibility (EEF)

The descriptive statistics of the importance of ten criteria in the EEF sub-issue are shown in Table 8.24. It shows that the top three most important criteria to be assessed in Malaysia are: (1) "Long-term maintenance management plan" (Mean 3.55); (2) "Facility management control system" (3.49); and (3) "As-built drawings and equipment manuals for operating staff and owners" (3.45). The fact that only one out of ten criteria (i.e. "Plot ratio") is excluded from the MOBSA framework, clearly explains the interest among respondents to see the on-going poor practices of building maintenance that minimize operational efficiency of building systems to recede.

Table 8.24: Descriptive statistics of the importance of criteria under the EEF sub-issue (N_{all} = 203)

EEF: Efficiency, Effectiveness and Flexibility						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Long-term maintenance management plan	203	2	4	3.55	0.54	3.0
Facility management control system	202	2	4	3.49	0.54	3.0
As-built drawings and equipment manuals for operating staff and owners	201	2	4	3.45	0.56	2.9
Space planning for maximum flexibility	203	1	4	3.38	0.60	2.8
Building services with maximum flexibility	202	1	4	3.36	0.63	2.7
Comprehensive commissioning	202	2	4	3.33	0.59	2.7
Structural design with maximum adaptability	201	1	4	3.28	0.67	2.6
Floor-to-floor height to offer high level of functionality	201	1	4	3.25	0.64	2.6
Net lettable area	201	1	4	3.23	0.67	2.6
Plot ratio	202	1	4	3.00	0.65	2.4
Valid N (listwise)	198					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

The improvements in building maintenance management is inextricably linked to economic benefits because according to Pollo (2005), "the costs of maintenance activities during building service life financial are often more expensive than the erection itself" if effective maintenance is not given the level of attention it warranted. Poor building maintenance is also one of the major concerns among interviewees (refer to discussion section in Chapter Six); hence, there is a need to establish fully its importance and bring it forward as a development issue worthy of proper consideration.

8.3.3.3.2 Triple Bottom Line Accounting – Planet, People, Profit (TBL)

The descriptive statistics of the importance of seven criteria in the TBL sub-issue are shown in Table 8.25. The top two most important criteria are "Practice of referring to Environmental Impact Assessment (EIA) report" (Mean 3.42) and "Access quality of workmanship" (3.39).

Table 8.25: Descriptive statistics of the importance of criteria under the TBL sub-issue (N_{all} = 203)

TBL: Triple Bottom Line Accounting – Planet, People, Profit						
Criteria	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Practice of referring to EIA report	201	2	4	3.42	0.61	2.8
Assess quality of workmanship	198	2	4	3.39	0.61	2.8
Consider both capital and long-term operation costs	200	1	4	3.37	0.60	2.8
Conduct Triple Bottom Line	200	1	4	3.28	0.64	2.6
Conduct Design Risk Analysis	200	2	4	3.26	0.67	2.6
Payback period	202	1	4	3.12	0.71	2.4
Rate of occupancy and occupancy turnover	201	1	4	3.10	0.67	2.4
Valid N (listwise)	193					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

8.3.3.4 Additional Recommended Criteria

The importance of sustainability aspects in building development is further reflected on the number of additional criteria suggested by the respondents which were not covered in the questionnaire, as shown in Table 8.26. Despite the huge number, it is important to note that these criteria are not included in the MOBSA framework because none of them was mentioned by at least half of the respondents. To be precise, each of these criteria was suggested only by at least two respondents; hence, do not have a strong basis for their inclusion. However, some of the suggestions indicated a need to refine some of the criteria in terms of their wordings; hence adopted where necessary.

Table 8.26: Additional recommended criteria under all sub-issues

Sub-Issue	Additional criteria:	Rating of importance
ECO	Look at added value of other spaces for community/recreational spaces, indirect returns apart from maximizing efficiency of work spaces	4
	Select site that are compatible with adjacent developments	4
	Replace old buildings with added greens	4
	Reduction of hardscape/scaling of ground surface	4
	Proper planning of road infrastructures to minimize cannibalization of allocated green areas/fields	4
	Site with overcrowding activities	3
	Access to the site without damage to the environment	3
	Population density before/after	3
SRM	Natural resource inventory to precede long term availability or price stabilization	4
AIR	Heat built-up to the city/environment	4
	Review usage of generator set for buildings	4
	Minimize heat emissions from air-conditioning and chillers	4
	In-built restrictions to use fuel based vehicles	3

LAN	Carbon monoxide emission from construction equipment and vehicles	4
	Competent person to look after the environment issues on site	3
EWA	Implement Environmental Management/Monitoring Plan (EMP) effectively	4
ADJ	Allow sufficient buffers	4
	Help increase value of adjacent properties	4
	Minimize traffic congestion during construction	4
	Location of services e.g. rubbish collection, air-conditioning etc. do not cause irritation to adjoining uses/properties	4
	Enforce the construction hours and to blacklist persistent offenders	4
	Maintenance of access routes to site	4
	Minimize view pollution during construction	3
	Rigid policy on gaps between buildings	3
ENE	Provide merits or incentives by authorities for building operators who operate in a green manner	4
	Proper public street lighting e.g. use solar energy	3
WAT	Nil	
EDU	Nil	
COH	Ongoing consultation/participation pre/during/post construction	4
ACC	Treatment of transitional zones (i.e. spaces between building and roads) as sidewalks, pedestrian waiting space for transport pick-up, food kiosks, newsstands and etc. to encourage street activity/liveliness	4
	Maintain privacy by avoiding overlooking to neighbours' houses e.g. living rooms, gardens etc.	3
INC	Suitability of spaces/location of facilities especially praying rooms	4
	Facilities of Wi-Fi	3
HUM	Sick room/bay in the building	4
	Resting area i.e. napping room for siesta	3
CUL	Restoration of heritage façade/buildings although redeveloping old buildings	4
	Cater for multicultural use/symbol	4
LOC	Support any collaboration work with foreign teams to improve local know-how	4
EEF	Nil	
TBL	Nil	

Note:
3 = Important and should be assessed; 4 = Very important and must be assessed

8.3.3.5 Overall Sub-Issues

The respondents were also requested to rate the degree of importance of 17 sustainability sub-issues according to the four-point Likert scale where a score of "1" represents "Not important"; "2" represents "Less important"; "3" represents "Important"; and "4" represents "Very important" (Question 3.4). Descriptive statistics of the importance of sub-issues are summarized in Table 8.27, arranged in descending order of minimum means.

Table 8.27: Descriptive statistics of the importance of sub-issues (N_{all} = 203)

Sub-Issues	**N**	**Min**	**Max**	**Mean**	**SD**	**Min. Mean** (Mean – SD)
Environmental:						
ECO: Land Use & Impact on Ecology	202	2	4	3.53	.55	2.98
AIR: Emissions to Air	202	2	4	3.50	.57	2.93
EWA: Emissions to Water	201	1	4	3.51	.58	2.93
LAN: Emissions to Land	202	1	4	3.49	.59	2.90
SRM: Supports Resource Management	202	2	4	3.26	.62	2.64
WAT: Potable Water Consumption	199	1	4	3.26	.63	2.63
ENE: Non-Renewable Energy Consumption	201	1	4	3.27	.68	2.59
ADJ: Impacts on Adjacent Properties	201	1	4	3.15	.63	2.52
Social:						
HUM: Human Health & Well-being	202	2	4	3.52	.56	2.96

ACC: Accessibility	202	2	4	3.46	.56	2.90
EDU: Education & Awareness	202	1	4	3.46	.60	2.86
LOC: Local People & Employment	199	1	4	3.25	.63	2.62
INC: Inclusiveness of Opportunities	202	1	4	3.23	.62	2.61
COH: Support for Social Cohesion	202	1	4	3.12	.65	2.47
CUL: Cultural & Heritage Aspects	202	1	4	3.04	.70	2.34
Economic:						
EEF: Efficiency, Effectiveness & Flexibility	202	2	4	3.54	.55	2.99
TBL: Triple Bottom Line Accounting	201	2	4	3.32	.65	2.67
Valid N (listwise)	195					

Note: 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed**.** Sub-issues within each issue are arranged in descending order of minimum means.

Clearly, within environmental sub-issues, respondents rated the assessment of ECO, AIR and EWA as being the most important in determining the sustainability performance of office building development in Malaysia. There is no doubt that building construction is the main cause of land erosions during heavy rains (UN Malaysia & EPU, 2005). The man-made carbon dioxide emissions associated with building energy consumption degrades the air quality (International Atomic Energy Agency [IAEA], 2006) and water run-off from building sites is one of the main pollutants of underground water and rivers (UN Malaysia & EPU, 2005). It is clear that these sub-issues should be given the highest weights among other environmental sub-issues.

Subsequently, within social sub-issues, respondents rated the assessment of HUM, ACC, and EDU as being the most important. This appears to be consistent with the interview results in Chapter Six where majority of the interviewees cited indoor environmental quality as important criteria for a ‘good’ office building. Additionally, most of interviewees also quoted education to update knowledge and improve competency level as one of the strategies to achieve a ‘good’ office building. Finally, between two economic sub-issues, EEF was rated as being more important than TBL. Since under each sub-issue there is at least one criterion that is eligible to be incorporated into the Malaysia specific framework, none of these sub-issues are excluded for the MOBSA framework.

It is considered important to compare the group means on the ratings of these 17 sub-issues by the type of organisation that the respondents worked for (each type has various professions). The overall results are shown in Table 8.28 with the largest and smallest group means highlighted for comparisons. Overall, respondents who worked for “Government agency/regulatory body” rated roughly all sub-issues higher than respondents who worked in “Design consultancy”, “Property development/investment” and “Others” types of firms. However, based on one-way ANOVA, the result shows that there are statistically significant differences in opinion found among respondents from different types of organisation on their ratings of all sub-issues, with the exception of WAT (F value = 1.919, p = 0.128), LOC (F value = 1.377, p = 0.251) and EEF (F value = 2.463, p = 0.064) sub-issues. This suggests that stakeholders who work for “Government agency/regulatory body” are more likely to regard sustainability sub-issues as more important than those from other types of organisations. However, all stakeholders, regardless of the type of organisation they work for, generally have similar opinions regarding the relative importance of WAT, LOC, and EEF sub-issues.

Table 8.28: Group means and standard deviations on the ratings of sub-issues by the type of organisations that the respondents worked for

Sub-issues	Type of organisations				Total
	Design Consultancy	Property Development/ Investment	Gov. Agency/ Regulatory Body	Others	
	n=63	n=44	n=50	n=45	N=203
	Mean* SD	Mean* SD	Mean* SD	Mean* SD	Mean* SD
Environmental:					
ECO: Land use & Impact on Ecology	3.44	**3.25**	**3.74**	3.69	3.53
	.590	.534	.443	.468	.548
SRM: Support Resource Management	3.16	**3.02**	**3.48**	3.40	3.26
	.574	.628	.505	.688	.619
AIR: Emissions to Air	3.35	**3.34**	3.64	**3.69**	3.50
	.600	.568	.485	.514	.566
LAN: Emissions to Land	3.37	**3.30**	3.62	**3.69**	3.49
	.630	.553	.602	.468	.592
EWA: Emissions to Water	3.39	**3.30**	**3.70**	3.69	3.51
	.610	.509	.580	.514	..584
ADJ: Impacts on Adjacent Properties	3.21	**2.91**	**3.26**	3.20	3.15
	.604	.603	.565	.726	.633
ENE: Non-Renewable Energy	**3.10**	3.18	3.38	**3.47**	3.27
Consumption	.718	.620	.667	.661	.684
WAT: Potable Water Consumption	3.19	**3.12**	3.33	**3.40**	3.26
	.618	.504	.625	.720	.627
Social:					
EDU: Education and Awareness	**3.24**	3.30	**3.74**	3.62	3.46
	.640	.594	.443	.535	.599
COH: Support for Social Cohesion	3.00	**2.93**	**3.38**	3.18	3.12
	.762	.545	.567	.576	.651
ACC: Accessibility	3.38	**3.32**	**3.78**	3.33	3.46
	.580	.518	.418	.564	.556
INC: Inclusiveness of Opportuntiies	**3.08**	3.09	**3.50**	3.29	3.23
	.630	.563	.544	.661	.623
HUM: Human Health & Well-being	3.51	**3.30**	**3.72**	3.56	3.52
	.592	.509	.454	.586	.557
CUL: Cultural & Heritage Aspects	**2.89**	2.91	**3.30**	3.11	3.04
	.764	.640	.544	.745	.700
LOC: Local People & Employment	**3.17**	3.18	**3.40**	3.27	3.25
	.708	.582	.574	.585	.625
Economic:					
EEF: Efficiency, Effectiveness &	**3.43**	3.48	**3.66**	3.64	3.54
Flexibility	.615	.549	.479	.484	.547
TBL: Triple Bottom Line Accounting	**3.14**	3.30	**3.51**	3.38	3.32
	.692	.632	.545	.650	.647

Note:
* The group means represent the mean ranking of the respective groups (i.e. types of organization) of respondents according to a Likert scale of 1 (not important) to 4 (very important) with respect to sustainability issues.
Table entries in **bold** represent the largest group mean within the respondent groups, whereas table entries in **bold** represent the smallest group mean within the respondent groups.
Others = Project Management, Construction Company, NGO, and Trading Company.

8.3.4 Expectations of MOBSA Systems

The following questions (Question 4.1-4.4) are designed to understand the necessity for establishing, and expectations of the best approach in implementing, MOBSA systems.

8.3.4.1 Necessity of MOBSA Systems

The frequent distribution of stakeholders' perception on the necessity of MOBSA systems is shown in Table 8.29. The result indicates that the absolute majority (96%) of local building stakeholders deemed it necessary to establish MOBSA systems. A number of respondents gave short comments or briefly explained the reasons for their answers. These reasons and comments are summarized in Table 8.30.

Table 8.29: Frequent distribution of respondents' perception regarding the necessity of MOBSA systems (N_{all} = 203)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	195	96.1	96.1	96.1
	No	4	2.0	2.0	98.0
	Yes but not now	4	2.0	2.0	100.0
	Total	203	100.0	100.0	

Table 8.30: Reasons and comments attached to the "Yes", "No" and "Yes, but not now" answers to Question 4.1. Note: Respondents who explained their choices in Question 4.1 = 71, (N_{all} = 203)

Answers	Reasons and Comments	Response N	Response %
Yes	- To reflect Malaysia specific conditions	14	21.2
	- To set up control and standard for sustainable office building design and development	14	21.2
	- Concerned about the environmental and social sustainability	9	13.7
	- Concerned about the urgency of establishing and implementing the sustainable office building assessment system	7	10.6
	- Concerned about the economic implications of implementing sustainable office building assessment system	7	10.6
	- Concerned about the government's ability to carry forward	5	7.6
	- To improve environmental performance of office buildings	5	7.6
	- To remain competitive with advanced countries	3	4.5
	- Concerned about the lack of awareness among building stakeholders	2	3
	Total respondents	**66**	**100**
No	- It is sufficient to adopt existing assessment systems developed by other countries	2	100
	Total respondents	**2**	**100**
Yes, but not now	- Malaysia needs its own assessment systems when it becomes competitive, with human capital that generates ideas and products that are accepted worldwide.	1	33.3
	- Not until the authorities who approve projects are operating at an efficiency level that can match international standards and the rules and regulations are consistent.	1	33.3
	- We are not ready for it at the moment. Physical backbone and general awareness are not there yet.	1	33.3
	Total respondents	**3**	**100**

All together, 40% of respondents explained reasons or gave comments for their answers to Question 4.1. These explanations provide additional information about local building stakeholders' perceptions regarding the need for establishing MOBSA systems. Table 8.30 shows that the major reasons that local building stakeholders support (choose the "Yes" answer) establishing MOBSA systems include: they want the systems to reflect Malaysia specific conditions (21.2%); they want the systems to set up control and standard for sustainable office building design and development (21.2%); and they are concerned about the environmental and social sustainability (13.7%). Four respondents chose the "No" answer but only two of them explained their reasons: it is sufficient to adopt existing BPASs developed by other countries. Only three out of four respondents who chose the "Yes, but not now" answer explained their reasons. All of them were sceptical about the current readiness of the country in implementing the MOBSA systems.

8.3.4.2 Implementation of MOBSA Systems

Frequent distribution of local building stakeholders' perception regarding the best approach for the Malaysian construction industry to implement MOBSA systems (Table 8.31) shows that about half (47.3%) of the respondents preferred "Mandatory by the Government" (Question 4.2). 40.9% of them preferred "Incremental from voluntary to mandatory" and only 11.8% of them chose "Voluntary basis".

Table 8.31: Frequent distribution of respondents' perception regarding the best approach for the Malaysian construction industry to implement MOBSA systems

	Frequency	Percent	Valid Percent	Cumulative Percent
Mandatory by the Government	96	47.3	47.3	47.3
Voluntary basis	24	11.8	11.8	59.1
Incremental from voluntary to mandatory	83	40.9	40.9	100.0
Total	203	100.0	100.0	

When investigated whether this pattern in the sample is likely to reflect the pattern in the population from which the sample was drawn, the result from the one-sample chi-square test (for nominal variables with three or more categories) shows that stakeholders in general are more likely to prefer the mandatory approach than other approaches ($p = .0005$). In other words, there is no chance that the highest percentage of preference for "Mandatory by the Government" observed among the sample of stakeholders is simply due to sampling error. Based on the calculation of the likely margin of error in the sample figure, the result shows that there is a 95% chance that population percentage of

[5] Best approach One-sample chi-square: value 43.517; df 2; Asymp. Sig. .000

preferring the mandatory approach is 47.3% ±7%. That is, the true population percentage of preferring the mandatory approach is likely to be somewhere between 40.3% and 54.3%. However, there is no obvious relationship identified between the preference for the best approach and respondents' background variables.

Respondents were then asked to rank four phases of project development (Question 4.3) to indicate the most important phase to implement the MOBSA system if Malaysia adopts a mandatory approach in its implementation within the next five years (2009-2013). They were asked to rank all the four phases on a scale of 4, where "4" to represent "the most important phase", then so on down to "1" to represent "the least important phase." Table 8.32 shows that "Planning approval phase" was considered as the most important phase to implement MOBSA system, followed by the "Building approval phase." This indicates without doubt that MOBSA systems are important and they have to be introduced at an early phase.

Table 8.32: Total score of the most important phase to implement MOBSA systems if Malaysia adopts a mandatory approach (N_{all} = 203)

	Arch n=59	**Eng** n=60	**Planr** n=26	**Dev** n=20	**PM** n=13	**Others** n=25	**Total** N=203
Planning Approval Phase	223	218	103	73	52	92	761
Building Approval Phase	208	211	90	65	43	88	705
As Built/Post-construction Phase	157	135	64	51	35	68	510
Operation Phase	138	114	59	51	28	59	449

The second last question (Question 4.4) in the questionnaire is an open-ended question which provides the local building stakeholders to indicate their opinion on the key drivers that could encourage the industry to take up the MOBSA system if Malaysia adopts a voluntary approach in its implementation within the next five years (2009-2013). Altogether, 69% of the respondents gave their answers to Question 4.4. Since the respondents were asked to indicate more than one key driver (but not all did so), there are 200 key drivers suggested and their categories are shown in Table 8.33.

A large proportion of respondents (43.5%) believed that fiscal incentives by the Government is the key driver to encourage the industry to take up the assessment system if Malaysia adopts a voluntary approach in its implementation within the next five years (2009-2013). Other top most recommended key drivers include: strong political will and support from the local authorities and other government bodies and agencies (9.5%); and higher rental or market value of properties rated by a BPAS (9%). All of them emphasized the importance of having the sustainable office building practices to be controlled by government, regulations and laws.

Table 8.33: Category of answers to Question 4.4
Note: Respondents who gave their opinion in Question 4.4 = 140, (N_{all} = 203)

Category of key drivers that could encourage the industry to take up assessment system if Malaysia adopts a voluntary approach		Response N	Response %
1	Fiscal incentives by the Government	87	43.5
2	Strong political will and support from local authorities and other government bodies and agencies	19	9.5
3	Higher rental/market value of the rated properties	18	9
4	Marketing advantage for the organization's business	15	7.5
5	Support from public and industry players	14	7
6	Sustainable-building-related education and trainings	8	4
7	Rewards and recognitions for exemplary developments	8	4
8	Voluntary approach won't work. It should be controlled by government, regulations and laws.	8	4
9	Public awareness programs on sustainability	7	3.5
10	Government to initiate sustainable office building projects	4	2
11	Corporate branding and increase competitive edge	2	1
12	Others	10	5
Total		**200**	**100**

8.3.5 Additional Comments about MOBSA

The last question (Question 4.5) in the questionnaire provides local building stakeholders the chance to express additional opinions and comments regarding MOBSA system generally or particular criteria to be assessed in the system. The results were analysed by content analysis[6] method which is particularly well suited to answer the question of communication research (Babbie, 1995). In this study, the question is about "what do local building stakeholders say about MOBSA."

It was revealed that only about 16% of the respondents gave their comments probably due to the length of the questionnaire. Altogether, 9 categories are established through close examination during analysis as shown in Table 8.34. The analysis by "subject matter" reports a significant proportion (45.5%) of comments dealing with the MOBSA system itself, in which 18% of them indicate the need and importance of sustainable-building-related education for public and professionals as well as intensive trainings for future assessors. About 27% concern about the government's roles in sustainable building development and assessment, in which 6% suggested for all local authorities in Malaysia to have Technical Committee consisting of sustainable building experts; and another 6% concerned with the corrupted politicians and civil servants who played the role in the lack of enforcement of laws and regulations related to the construction industry. 15% concern about developers, in which 9% sceptical that developers would undertake assessment if implemented voluntarily due to their concern about cost; and

[6] Content analysis is "a research technique for the objective, systematic and quantitative description of the manifest content of communication" (Berelson, 1971, p.18).

6% suggested incentive policies to encourage developers to aboard the sustainability bandwagon.

Table 8.34: Summary of comments (N_{all} = 203)

Category of Local Stakeholders' Comments about Assessment in Malaysia			Response	
			N	**%**
About MOBSA system itself			**15**	**45**
1	-	Mention the need and importance of related education for public and professionals	6	18
	-	Intensive trainings for future assessors		
2	-	Ensure not so many elements are considered	5	15
	-	Must be simple and workable		
3	-	Implement assessments during pre-design and operation phases	4	12
About government			**9**	**27**
4	-	Technical Committee in all local authorities should consist of sustainable building experts	2	6
	-	Local authorities are still not ready to monitor the implementation		
5	-	The main obstacle is corrupted politicians and civil servants	2	6
	-	Concern about the lack of enforcement		
6	Other comments about the government:		5	15
	-	Need strong regulatory bodies for the implementation		
	-	Need strong political will to support and push the implementation		
	-	Government to spend money on branding and marketing		
	-	Promote holistic approval to development		
	-	Certain parts could be included in the building regulations		
About developers			**5**	**15**
7	-	If the system is introduced on a voluntary basis, clients might not want to undertake it due to the cost factor, unless the consultants could convince them on long-term benefits of going for the assessment.	3	9
	-	Developers are one of the biggest obstacles to sustainability in the construction industry		
8	-	Incentive policy needs to be established to improve developers awareness and enhance their enthusiasm for sustainable building development	2	6
About sustainable building in general			**4**	**12**
9	-	The future for sustainable building in Malaysia is bright	4	12
	-	Good practice towards achieving sustainable development		
	-	This is a new approach which will elevate Malaysia in sustainable building aspect.		
	-	The market in Malaysia is becoming more aware of green buildings		
Total number of respondents who give comments			**33**	**100**

8.4 Stage-3 MOBSA Framework

Figure 8.5 shows the comparison of total number of criteria under each sustainability issue before and after the survey questionnaires being analysed. It shows that out of 120 criteria listed in the questionnaire, only 88 of them are eligible to be included in the MOBSA framework, of which 8 were further refined. Subsequently, these criteria are presented as the Stage-3 MOBSA framework in Table 8.35. It is acknowledged that the chosen criteria might be different if the sample size was different or larger.

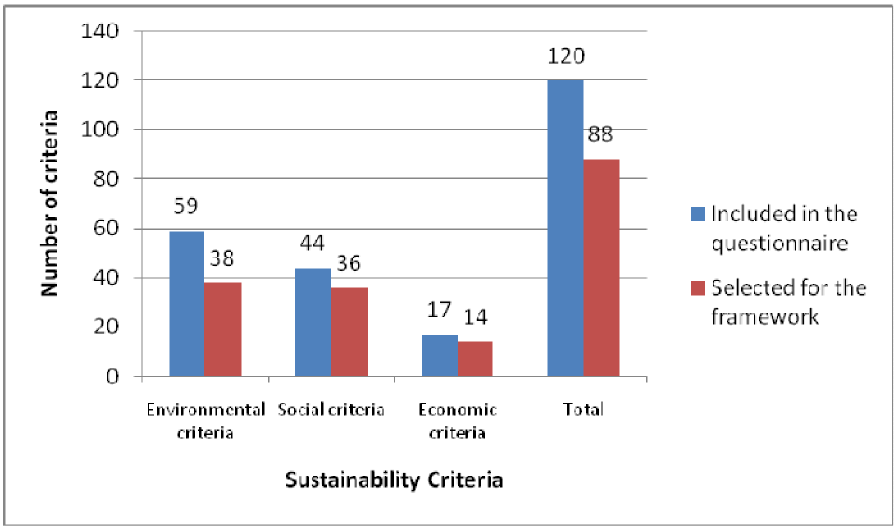

Figure 8.5: Summary of the total number of criteria selected for the MOBSA framework

The Stage-3 MOBSA framework also indicates the weighting value of each issue, sub-issue and criterion. The weighting value is the relative importance index (RII) constructed reflecting the level of importance of each issue, sub-issues or criteria using the formula (Chinyio*, et al.*, 1998; Kumaraswamy & Chan, 1998; Shash, 1993; Tam*, et al.*, 2002; Tam*, et al.*, 2007):

$$RII = \frac{\sum w}{AN}$$

where *w* is the weighting given to each issue, sub-issue or criterion by the respondent, ranging from 1 to 4 in which "1" is 'not important' and "4" is 'very important'; *A* = the highest weighting, in this study *A* = 4; *N* the total number of samples; and RII the relative important index 0 ≤ RII ≤ 1. Put differently, RII is calculated by dividing the mean of the weightings assigned by the respondents with the highest weighting i.e. 4:

$$RII = \frac{\text{Mean}}{4}$$

However, since minimum means (mean minus the standard deviation) were used instead of means as the basis of ranking the issues and sub-issues, as well as selecting the most important criteria (as explained in the result section), they are also used here to determine the RII of each issue, sub-issue and criteria. These are shown in Table 8.35 below. By using mean values, the resulted RII values can then be transformed into three important levels: high (H) (0.8 ≤ RII ≤ 1), medium (M) (0.5 ≤ RII ≤ 0.8), and low (L) (0 ≤ RII ≤ 0.5) (Tam*, et al.*, 2007). Since minimum means were used in this study, the three important levels adopted are: high (H) (0.7 ≤ RII ≤ 1), medium (M) (0.5 ≤ RII ≤ 0.7), and low (L) (0 ≤ RII ≤ 0.5).

Table 8.35: Stage-3 MOBSA Framework

Issue	Sub-Issues	Criteria	Min. Mean (Mean-SD)	Weights (RII)	Important level
SOCIAL			**2.9**	**0.73**	**H**
	EDU: Education and Awareness		**2.9**	**0.73**	**H**
		Increase awareness of building occupants in conserving energy and water as well as reducing waste (refined)	2.9	0.73	H
		Readiness and competency of design team members on sustainable design and development issues	2.9	0.73	H
		Improve **skills and knowledge of maintenance and operation staff**	2.9	0.73	H
		Improve **sustainable construction skills among construction workers**	2.7	0.68	M
	COH: Support for Social Cohesion		**2.5**	**0.63**	**M**
		Support for **inter-disciplinary work** between architects, engineers, costing specialists, operation people and other relevant actors right from the beginning of the design process	3.0	0.75	H
		Provide **mixed uses within the project** to support active streetscape and to reduce the need for commuting transport	2.6	0.65	M
		Space planning for maximum social interaction	2.6	0.65	M
		Increase **participation of affected community in development process** to avoid conflict and ensuring the sustainability of the development	2.5	0.63	M
		Increase **participation of users in development process** to ensure users' requirements are met	2.5	0.63	M
	ACC: Accessibility		**2.9**	**0.73**	**H**
		Maximize **personal safety and security** for users to access and use the building	2.8	0.70	H
		Easy to clean the building facades and other elements or design	2.7	0.68	M
		Adequate access to **communication technology**	2.6	0.65	M
		Easy access to **building technical systems** for repair and maintenance	2.5	0.63	M
		Select sites that are **easily accessible/walking distance to nearby services**	2.5	0.63	M
	INC: Inclusiveness of Opportunities		**2.6**	**0.65**	**M**
		Provide for **universal access**	2.8	0.70	H
		Provide **religious facilities** at appropriate location and with appropriate size and design (refined)	2.6	0.65	M
		Provide **facilities for users with children** in the building and neighbouring blocks if demand is sufficient to enhance workers' quality of life (refined)	2.5	0.63	M
	HUM: Human Health and Well-being		**3.0**	**0.75**	**H**
		Adapt practices that **avoid construction accidents**	3.1	0.78	H
		Provide appropriate **air changes** to maximize level and quality of fresh air in the ventilation systems	2.9	0.73	H
		Maximize **openings and cross ventilation** in naturally ventilated spaces	2.9	0.73	H
		Minimize **noise level** and provide satisfactory level of **acoustic performance**	2.8	0.70	H
		Appropriate **illumination level and lighting quality** in public and work areas	2.8	0.70	H
		Prohibit tobacco smoking in the building	2.7	0.68	M
		Use **low/zero pollutants cleaning and maintenance products and processes**	2.7	0.68	M
		Use interior finish **materials with low- or zero-pollutant off-gassing**	2.7	0.68	M
		Provide optimum **air movement for thermal comfort** in mechanically ventilated spaces	2.7	0.68	M
		Minimize **glare conditions** in main occupancy areas	2.7	0.68	M
		Increase the practice of **building flush-out** to reduce possible indoor air quality contamination after construction completion and prior to occupancy	2.7	0.68	M

		Provide **separately ventilated and isolated areas/rooms which generate pollutants and odour** (refined)	2.6	0.65	M
		Adequate **monitoring of occupants' satisfaction** with indoor environmental quality	2.5	0.63	M
	CUL: Cultural and Heritage Aspects		**2.3**	**0.58**	**M/L**
		Maintain the **heritage value of existing buildings** for refurbishment project	2.5	0.63	M
	LOC: Local People and Employment		**2.6**	**0.65**	**M**
		Provide **training opportunities for local people** to be future skilled construction workers	2.9	0.73	H
		Increased use of **locally available materials**	2.7	0.68	M
		Linkage to **local service providers**	2.7	0.68	M
		Use experienced **local design teams**	2.5	0.63	M
		Use experienced **local contractors**	2.5	0.63	M

Issue	Sub-Issues	Criteria	Min. Mean (Mean-SD)	Weights (RII)	Important level
ENVIRONMENTAL			**3.0**	**0.75**	**H**
	ECO: Land use and Impacts on Ecology		**3.0**	**0.75**	**H**
		Minimize **ecological and other damage** to existing soil, water bodies and flora and fauna of the site or adjacent lands due to the construction process	3.1	0.78	H
		Maximize **potential for green/open spaces** on the site for informal recreation	2.7	0.68	M
		Improve **ecological value of natural landscape**	2.6	0.65	M
		Select **sites that have low risk of flooding**	2.5	0.63	M
	SRM: Supports Resource Management		**2.6**	**0.65**	**M**
		Increase use of **materials that have less environmental impact in producing them**	2.7	0.68	M
		Use **durable materials** that require less maintenance	2.6	0.65	M
		Increase use of **bio-based products and materials** obtained from managed/sustainable sources	2.6	0.65	M
		Increase use of **materials that can be recycled**	2.6	0.65	M
		Increase use of **products and materials with recycled content**	2.5	0.63	M
	AIR: Emissions to Air		**2.9**	**0.73**	**H**
		Reduce **greenhouse gas emissions** from all energy used for **building operations**	2.9	0.73	H
		Availability of **pedestrian access between building and basic services** or Provide in-house **eating facilities** at appropriate location to reduce the need for commuting transport (refined)	2.7	0.68	M
		Provide **connection from building to existing public transportation network**	2.6	0.65	M
	LAN: Emissions to Land/ Solid Waste		**2.9**	**0.73**	**H**
		Save handling and storage of hazardous wastes on site	3.0	0.75	H
		Implement **construction waste management program** with sorting, reuse and recycling measures	2.6	0.65	M
		Provide **spaces for collection of recyclables**, recycling storage and staging areas in the building	2.6	0.65	M
		Maximize **recycling of office recyclables** e.g. paper, glass bottles, plastic, aluminium cans, cardboard	2.5	0.63	M
		Minimize **land pollution from site workers' accommodation**	2.5	0.63	M
		Design for repeatability and increase **use of standardized and prefabricated components** to reduce wastages	2.5	0.63	M
	EWA: Emissions to Water		**2.9**	**0.73**	**H**
		Reduce the **risk of water contamination to nearby water body**	3.3	0.83	H
		Implement **stormwater management strategies** to control the quantity and quality of stormwater runoff, hence preventing flood and soil erosion	3.0	0.75	H
		Minimize **storm sewer or stream pollution from site workers' accommodation**	2.6	0.65	M
		Utilize **on-site wastewater treatment systems** using **gray water** for non-potable uses	2.5	0.63	M
	ADJ: Impacts on Adjacent Properties		**2.5**	**0.63**	**M**
		Reduce **noise and vibration** generated during the construction of the project	2.7	0.68	M
	ENE: Non-renewable Energy Consumption		**2.6**	**0.65**	**M**
		Use **energy efficient light fixtures and office appliances**	2.9	0.73	H

Issue	Sub-Issues	Criteria	Min. Mean (Mean-SD)	Weights (RII)	Important level
		Use **highly efficient ventilation and air-conditioning systems**	2.9	0.73	H
		Use **passive cooling strategies** (refined)	2.9	0.73	H
		Use **integrated lighting concept**	2.8	0.70	H
		Reduce fossil fuel **energy consumption for building operations**	2.8	0.70	H
		Minimize the **size of lighting system control zones** to optimize energy savings	2.8	0.70	H
		Design for a **tight, thermally resistant envelope** to prevent leakage of cool draft through building skin	2.6	0.65	M
		Use **dimmable** and/or **auto-sensored lighting system**	2.6	0.65	M
		Install **energy sub-metering system** for each floor/section/tenancy to monitor energy consumption	2.5	0.63	M
		Facilitate **personal control** of the lighting and thermal comfort systems by occupants	2.5	0.63	M
	WAT: Potable Water Consumption		**2.6**	**0.65**	**M**
		Harvest rainwater for later re-use to reduce the potable water consumption	2.9	0.73	H
		Use **water efficient plumbing fixtures and appliances**	2.8	0.70	H
		Minimize **use of potable water for landscaping irrigation**	2.7	0.68	M
		Minimize **use of potable water for cooling system** (refined)	2.5	0.63	M
		Install **water meters** for all major water uses in the project **to monitor water consumption** and to locate any leakages in the pipe lines	2.5	0.63	M
ECONOMIC			**2.4**	**0.60**	**M**
	TBL: Triple Bottom Line Accounting – Planet, People, Profit		**2.7**	**0.68**	**M**
		Increase the practice of referring to **Environmental Impact Assessment (EIA) report** prepared by environmental experts by the project team	2.8	0.70	H
		Assess and evaluate the **quality of workmanship** of construction works prior to hand over	2.8	0.70	H
		Consider both **capital/construction cost, along with long-term operational costs** for both tenant-occupied and leased office building	2.8	0.70	H
		Conduct **Triple Bottom Line** before deciding to pursue with the project	2.6	0.65	M
		Conduct **Design Risk Analysis**	2.6	0.65	M
	EEF: Efficiency, Effectiveness and Flexibility		**3.0**	**0.75**	**H**
		Develop and implement a **long-term maintenance management plan** for efficient building operation	3.0	0.75	H
		Provide and operate an effective **facility management control system** to maximize the operational efficiency of building systems and to save energy and water (refined)	3.0	0.75	H
		Provide **as-built drawings and equipment manuals** to operating staff and owners to ensure efficient operation	2.9	0.73	H
		Space planning for maximum flexibility for different users/requirements	2.8	0.70	H
		Provide **building services systems with maximum flexibility** for different users/ requirements	2.7	0.68	M
		Requirement of contracted **comprehensive commissioning, and post-occupancy commissioning** to be performed for all building services	2.7	0.68	M
		Structural design with maximum adaptability for new uses	2.6	0.65	M
		Adequate **floor-to-floor height** to offer high level of functionality for almost any occupancy	2.6	0.65	M
		Maximize workspace/directly functional area to total floor area ratio	2.6	0.65	M

8.5 Conclusion

This chapter has presented the process of identifying the most important criteria to be incorporated into the MOBSA framework and assigning their appropriate weighting level. It was based on views from limited stakeholders by means of a questionnaire survey. However, the same method could be used if more accurate quantitative results based on industry consensus (i.e. larger samples covering larger demographic areas) are desired. The weightings within the framework could also serve as a reference when developing weightings for BPASs for other part/state of Malaysia than those focused in this research (i.e. Kuala Lumpur, Selangor and Putrajaya).

The summary of the results has been presented in Section 8.4 in a form of a Stage-3 MOBSA Framework. This chapter has also revealed that the implementation of such system within the next five years (2009-2013) is believed to be more effective if made mandatory by the government, instigated at an early stage of project development and supported by fiscal incentives. However, a number of respondents believed that the implementation would be more effective if issues such as follows are addressed: 1) education on sustainability for public and professionals; and 2) the government's role in sustainable building development and assessment, especially the capacity within the local authorities.

The subsequent part of the thesis is the synthesis part of the research. In the next chapter, the quantitative results of this chapter will be integrated with the qualitative results to reveal the relevant form of the MOBSA framework and subsequently validated by local building experts. How the validated framework may be applied in real life will be discussed in Chapter Ten.

Chapter 9: Validation of the Comprehensive MOBSA Framework

9.1 Introduction

The final outcome of Part II of this thesis is the Stage-3 MOBSA framework proposed based on field studies as presented in the previous chapter. In Part III, the framework is brought into the next level by a process of validation and application, which is the subject of Chapter Nine and Ten respectively. These two chapters aim to address the following research question: How do the qualitative and quantitative data together reveal the relevant form (i.e. structure, performance benchmarks, applicable life-cycle phase(s) of assessment for each criterion, and the system of implementation) of a MOBSA framework?

The validation process of Stage-3 MOBSA framework involved a group of experts in the Malaysian construction industry; however, performance benchmarks/targets, applicable assessment phase(s) for each criterion, and the system of implementation need to be further developed beforehand. In this chapter, tentative performance benchmarks are first proposed by integrating the qualitative and quantitative results of this thesis. In doing so, the product of quantitative phase i.e. Stage-3 MOBSA framework is integrated with performance benchmarks derived from the qualitative findings, namely: (1) agreed benchmarks by focus groups in Chapter Seven; and (2) interview data in Chapter Six and additional literature including local and international codes and standards. Subsequently, the resulting framework was then presented to relevant experts in the Malaysian construction industry for validation. The outcome is the Validated Comprehensive MOBSA Framework, applicable to all phases of project assessment, which is proposed at the end of this chapter.

9.2 Proposing Local Office Building Performance Benchmarks

The most common method of applying an assessment system is by having a specific method of assigning a score for each criterion (Todd & Geissler, 1999). Typically, building assessment systems use performance benchmarks as the basis to measure and indicate how well or poorly a case study building is performing, or is likely to perform.

Therefore, each performance benchmark is normally assigned with a number of points so that the overall performance score of a case study building could be calculated.

Before performance benchmarks could be proposed, it is important to determine the applicable phase(s) of assessment for each criterion. There are four phases of assessment, namely: 1) “Pre-design phase” assessment which intend to indicate the future potential sustainable performance of the project, based on the information available at the end of that phase; 2) “Design phase” assessment which intend to indicate the future potential sustainable performance of the project, based on the information available at the end of the design phase; 3) “Construction and Commissioning phase” assessment which intend to provide a relatively factual assessment based on performance indicators available at the end of the construction and commissioning phase, but before occupancy; and 4) “Operations phase” which intend to provide an objective and factual indication of the Actual performance of the project. It is recommended that projects should be fully operated and completely fine-tuned before an operations phase assessment is carried out.

Performance benchmarks for each criterion were proposed to suit its applicable phase(s) as one particular criterion may be applicable to be used for assessments in a particular phase, but may not be in others. For example, criterion “Increase awareness of occupants in conserving energy and water as well as reducing waste” may only be applicable to the operation phase; hence, its appropriate performance benchmarks can include practices which shall be undertaken during the operation phase of the building life-cycle. Some other criteria are applicable to more than one phase of assessment; for example, “Minimise noise level and provide satisfactory level of acoustic performance” which may be applicable to pre-design, design and operation phases. For pre-design phase assessments, evidence may be required to show that the required performance is included in the client’s project brief. Whilst, for design phase assessments, evidence may be required to show that the designs conform to or exceed the criterion’s benchmarks. For operation phase assessments however, evidence may be required to show that the building is actually performed as intended. As highlighted by Hyde *et al.* (2007, p.558), “it is important that benchmarking becomes more strategic, that is, based on a number of sources of information drawn from both design and operation conditions” and “the method of validating performance is a crucial indicator of rigour, since it establishes the credibility of the standard” (2007, p.554).

There are two basic types of benchmarks: those that can be expressed as numeric values which are easily quantifiable (e.g. kWh per year of energy consumed), and others that are best described in text form which require more subjective assessments (e.g. how adaptable is this building to new uses). In the framework, a numeric form was established for as many criteria as possible and the issue of textual definition of conditions that can be related to a specific score was dealt with care, but ambiguities are still inevitable. As Cole (2001, p.359) pointed out that "if building environmental assessment is to progress it must accept the inevitability of a greater number of qualitative criteria".

In defining appropriate benchmarks, quantifiable issues (e.g. energy and water use) are assumed to be either minimum code requirements or standard practice, depending on access to reliable data. The data may be the regulation that is applicable, but in other cases, determination can be made based on local industry practices. For many of the qualitative criteria considerable judgments are required. The benchmarks for these are simply a declaration of what would be considered to be a typical condition or typical practice for office building in Malaysia. This "typical" or "average" performance becomes the baseline for assessment and any performance which is better than industry norm is considered a "good" or "outstanding" practice. However, it is acknowledged that this type of benchmark is extremely difficult to both define and score across all assessment criteria in a consistent manner (Cole, 1998). Therefore, in this study, a typical performance was mainly defined for quantitative criteria for which reliable data such as codes and standards are accessible.

Good practice represents an improvement over the industry benchmark performance or above standard practice that are achievable locally given economic, political-administrative or social constraints (Todd & Geissler, 1999). This is important since in Malaysia, the assessment system should aim to encourage participation by building stakeholders to change towards achieving better than standard performances. On the other hand, outstanding practice – defined to achieve the highest score – represents a performance target that is considerably in advance of current practice, potentially achievable with current technologies, even if no local buildings have achieved that level yet or appears to be unattainable at the present time (Todd & Geissler, 1999). This provides a target for improvement and a direction towards which the building sector should be moving since the intent of the assessment framework developed from this study is not only to compare and rate local office buildings but also intended as an agent of change by pushing the local building sector towards better performance.

Benchmarks can be derived theoretically, empirically and by expert opinion (Hair, 2005). According to Hyde *et al.* (2007) and Sallam (2007), validity and robustness of the approaches to defining benchmarks are of paramount importance and asserted that 'triangulation' methodology by using a combination of data sources, should be used to derive information for creating valid benchmarks. Hyde *et al.* (2007) further argued that this approach to benchmarking seems to result in a better understanding of the design and operation of the buildings and this would lead towards "achieving the overall objective of benchmarking, which is to create a framework of change within organisations to achieve sustainability." Therefore, this study attempts to use a combination of approaches. As a starting point, the performance benchmarks proposed by the expert focus groups (see Chapter Seven) for some of the criteria were used. These include performance benchmarks for typical, good and outstanding practices for each performance criterion. Most of the context-specific benchmarks proposed by the focus groups were immediately adopted but others were further refined based on literature and interview data. For those criteria without any benchmarks developed earlier, benchmarks were defined based on literature and interview data (i.e. theoretically and by expert opinion). References or adaptations from foreign sources were treated with caution as to reflect the local conditions as cited by interviewees discussed in Chapter Six. All benchmarks, either proposed based on theory or local industry practices were validated by local practitioners or experts; hence they were further modified, which is discussed in the next section. Finally, these benchmarks were refined empirically by testing them on an environmentally certified local case study project.

The testing of the benchmarks explains the actual intention of proposing them in the beginning. Without having the performance benchmarks proposed, there would be no basis of testing the assessment framework to demonstrate its appropriateness to the local context, given the potential risk of lack of input data or difficulties in obtaining them to complete the assessment. This is due to the fact that poor data acquisition will erode the rigour of the benchmarking process (Hyde*, et al.*, 2007). Therefore, it was anticipated that the whole processes involved in proposing appropriate local performance benchmarks would improve the robustness of the framework, if adopted in reality. However, it is important to note that the proposed benchmarks in this thesis are by no means definitive or conclusive. If this framework were to be adopted, these performance benchmarks should gradually be revisited or updated over time as local capabilities and understanding of issues evolves. As many of the benchmarks are context dependent, they should also be adjusted if adopted in different areas or regions. The sources of reference (i.e. focus groups, literature and interview data) of the proposed performance benchmarks are shown in Table 9.1. It is important for this table to be read in conjunction with Table 9.3 to grasp their meanings.

Table 9.1: Sources of reference of tentative local office building performance benchmarks

Issue	Sub-Issues	Criteria	Reference		
			Focus groups*	Literature	Interview data (Section in Chapter 6)**
S: SOCIAL					
	EDU: Education and Awareness				
	S-EDU-1	**Increase awareness of building occupants** in conserving energy and water as well as reducing waste	-	AS1, B7, P8	6.3.1.1 6.3.2.2.2 6.3.2.2.6 6.3.3.6
	S-EDU-2	**Readiness and competency of design team members** on sustainable design and development issues	-	B1, B7	6.3.1.2 6.3.2.1.3 6.3.3.4 6.3.4.1
	S-EDU-3	Improve **skills and knowledge of maintenance and operation staff**	√	B7	6.3.1.2 6.3.3.3
	SO-EDU-4	Improve **sustainable construction skills among construction workers**	-	AS1, GOV6	6.3.1.2 6.3.2 6.3.2.2.2 6.3.2.2.7
	COH: Support for Social Cohesion				
	S-COH-1	Support for **inter-disciplinary work** between architects, engineers, costing specialists, operation people and other relevant actors right from the beginning of the design process	√	B1	6.3.1.2 6.3.2.2.2
	S-COH-2	Provide **mixed uses within the project** to support active streetscape and to reduce the need for commuting transport *Refined to:* Planning to **support active streetscape** and provisions for community	√	P13	6.3.1.2
	S-COH-3	**Space planning for maximum social interaction**	-	P5, P6	6.3.1.2 6.3.2 6.3.2.1.2
	S-COH-4	Increase **participation of affected community in development process** to avoid conflict and ensuring the sustainability of the development	-	B7	6.3.1.2
	S-COH-5	Increase **participation of users in development process** to ensure users' requirements are met	-	B7, B10	6.3.1.2
	ACC: Accessibility				
	S-ACC-1	Maximize **personal safety and security** for users to access and use the building	-	B1, B2, B3, B4, B11	6.3.1.2
	S-ACC-2	**Easy to clean** the building facades and other elements or design *Refined to:* Convenient and safe **maintenance access for building facades** and other elements or design	-	B8	6.3.1.2
	S-ACC-3	Adequate access to **communication technology** to support informal communication and reduce requirements for travel and space	-	B9, P7	6.3.1.2
	S-ACC-4	Easy access to **building technical systems** for repair and maintenance *Refined to:* Convenient and safe **maintenance access for all building services installations**	-	OD, B11	6.3.1.2
	S-ACC-5	Select sites that are **easily accessible/walking distance to nearby services** *Refined to:* **Easy access to nearby services**	√	P13	6.3.1.2
	INC: Inclusiveness of Opportunities				

	S-INC-1	Provide for **universal access**	√	S2	6.3.1.2 6.3.2.1.5
	S-INC-2	Provide **facilities for users to perform religious obligations** at appropriate location and with appropriate size and design	-	-	6.3.1.2 6.3.2.1.2
	S-INC-3	Provide **facilities for users with children** in the building and neighbouring blocks to enhance workers' quality of life	-	-	6.3.1.2 6.3.2.1.2
	HUM: Human Health and Well-being				
	S-HUM-1	Adapt practices that **avoid construction accidents**	-	GOV3	-
	S-HUM-2	Provide appropriate **air changes** to maximize level and quality of **fresh air** in the ventilation systems *Finally refined to:* Optimise the level and quality of **fresh air** in mechanically ventilation systems	√	S6, B11	6.3.1.2 6.3.2.1.1
	S-HUM-3	Maximize **openings and cross ventilation** in naturally ventilated spaces	√	S6	6.3.1.2
	S-HUM-4	Minimise **noise level** and provide satisfactory level of **acoustic performance**	√	B5	6.3.1.2
	S-HUM-5	Appropriate **illumination level and artificial lighting quality** in public and work areas *Refined to:* Appropriate **illumination level** and **artificial lighting quality**	√	S1, AS1, B7, B11	6.3.1.2 6.3.2.1.1
	S-HUM-6	**Prohibit tobacco smoking** in the building	√	OD	6.3.1.2 6.3.2.1.2
	S-HUM-7	Use **low/zero pollutants cleaning and maintenance products and processes**	√	B7	6.3.1.2
	S-HUM-8	Use interior finish **materials with low- or zero-pollutant off-gassing**	√	AS1, AS2	6.3.1.2 6.3.2.2.5
	S-HUM-9	Provide optimum **air movement for thermal comfort** in mechanically ventilated spaces	-	S1, OD	6.3.1.2 6.3.2 6.3.2.1.1
	S-HUM-10	Minimise **glare conditions** in main occupancy areas	√	B7	6.3.1.2
	S-HUM-11	Increase the practice of **building flush-out** to reduce possible indoor air quality contamination after construction completion and prior to occupancy	√	G2	6.3.1.2 6.3.2.2.5
	S-HUM-12	Provide **separately ventilated and isolated areas/rooms which generate pollutants and odour**	√	OD	6.3.1.2 6.3.2.1.2
	S-HUM-13	Adequate **monitoring of occupants' satisfaction** with indoor environmental quality	√	AS2	6.3.1.2 6.3.2.2.2 6.3.2.1.4
	CUL: Cultural and Heritage Aspects				
	S-CUL-1	Maintain the **heritage value of existing buildings** for refurbishment project *Refined to:* Enhance or maintain the heritage **significance of the building** or adjoining/nearby heritage buildings	√	GOV1	6.3.1.2
	LOC: Local People and Employment				
	S-LOC-1	Provide **training opportunities for local people** to be future skilled construction workers *Refined to:* Provide **training opportunities for unskilled local people (employed for the works)** to be future semi-skilled or skilled construction workers	-	GOV6	-
	S-LOC-2	**Increased use of locally available materials and products**	√	B7	6.3.1.2 6.3.1.1 6.3.3.7
	S-LOC-3	**Linkage to local service providers**	-	GOV6	-
	S-LOC-4	Use experienced **local design teams**	-	GOV6	-
	S-LOC-5	Use experienced **local contractors**	-	GOV6	-

Issue	Sub-Issues	Criteria	Reference		
			Focus groups*	Literature	Interview data (Section in Chapter 6)**
EN: ENVIRONMENTAL					
	ECO: Land use and Impacts on Ecology				
	EN-ECO-1	Minimise **ecological and other damage** to existing soil, water bodies and flora and fauna of the site or adjacent lands due to the construction process	√	GOV2	6.3.1.2 6.3.2 6.3.2.2.2
	EN-ECO-2	Maximize **potential for green/open spaces** on the site for	√	OD	6.3.1.2

	informal recreation *Refined to:* Maximize potential for **landscape spaces** on the site			6.3.2.1.2
EN-ECO-3	Improve **ecological value of natural landscape**	√	B7	6.3.1.2
EN-ECO-4	Select **sites that have low risk of flooding**	√	G5	6.3.1.2
SRM: Supports Resource Management				
EN-SRM-1	Increase use of **materials that have less environmental impact in producing them**	√	OD	6.3.1.2
EN-SRM-2	Use **durable materials** that require less maintenance *Refined to:* **Design building for maximum durability**	-	B8, AS4, OD	6.3.1.2
EN-SRM-3	Increase use of **bio-based products and materials** obtained from managed/sustainable sources	√	AS1	6.3.1.2 6.3.2.2.4 6.3.2.2.5
EN-SRM-4	Increase use of **materials that can be recovered or recycled**	√	P9	6.3.1.2 6.3.2.2.3 6.3.2.2.4
EN-SRM-5	Increase use of **products and materials with recycled content**	√	AS1	6.3.1.2 6.3.2.2.3 6.3.2.2.4
AIR: Emissions to Air				
	Reduce **greenhouse gas emissions** from all energy used for **building operations** (omitted[1])	-	-	-
	Provide **connection from building to existing public transportation network** (e.g. footbridge, covered walkway etc.) (combined with criterion below)	-	-	-
EN-AIR-1	Availability of **pedestrian access between building and basic services** (e.g. shops, banks, eating outlets) *Finally refined to:* Provide **pedestrian access to basic services and connect to existing public transportation network**	√	B7, P13	6.3.1.1 6.3.1.2
LAN: Emissions to Land/ Solid Waste				
EN-LAN-1	**Save handling and storage of hazardous wastes on site**	√	S3	6.3.1.2 6.3.2.2.7
EN-LAN-2	Implement **construction waste management program** with sorting, reuse and recycling measures	√	AS1, AS2	6.3.1.2 6.3.2.2.4
EN-LAN-3	Provide **spaces for collection of recyclables**, recycling storage and staging areas in the building	√	AS1, B11	6.3.1.2 6.3.2.2.6
EN-LAN-4	Maximize **recycling of office recyclables**	√	B7	6.3.1.2 6.3.2.2.6
EN-LAN-5	Minimise **land pollution from site workers' accommodation**	-	AS2	6.3.1.2
EN-LAN-6	Design for repeatability and increase **use of standardized and prefabricated components** to reduce wastages	√	GOV4	6.3.1.2 6.3.2.2.4
EWA: Emissions to Water				
	Reduce the **risk of water contamination to nearby water body** (combined with "minimise ecological and other damage")	√	-	-
EN-EWA-1	Implement **stormwater management strategies** to control the quantity and quality of stormwater runoff, hence preventing flood and soil erosion	√	G5, B6	6.3.1.2
EN-EWA-2	Minimise **storm sewer or stream pollution from site workers' accommodation**	-	AS2	6.3.1.2
EN-EWA-3	Utilize **on-site wastewater treatment systems** using **grey water** for non-potable uses	√	B7	6.3.1.2 6.3.2.2.2
ADJ: Impacts on Adjacent Properties				
EN-ADJ-1	Reduce **noise and vibration** generated during the construction of the project	-	G4	6.3.1.2
ENE: Non-renewable Energy Consumption				
EN-ENE-1	Use **energy efficient light fixtures and office appliances**	√	S1	6.3.1.1 6.3.1.2
EN-ENE-2	Use **highly efficient ventilation and air-conditioning systems**	-	G3	6.3.1.2 6.3.2.2.2

[1] This criterion was omitted due to the fact that the amount of carbon-dioxide-equivalent emissions from non-renewable energy used for annual operations of the occupancy is predicted or calculated based on the amount of operational energy consumed. The reduction in the amount of operational energy consumption has already been addressed in another criterion in the framework, namely "Reduce fossil fuel energy consumption for building operations". Therefore, the criterion related to the resulted greenhouse gas emissions was deleted to avoid redundancy or double-counting. 6 criteria were further refined whereas 6 others were combined to become three.

Issue	Sub-Issues	Criteria	Reference: Focus groups*	Reference: Literature	Reference: Interview data (Section in Chapter 6)**
	EN-ENE-3	Use **passive cooling strategies**	-	S1, P3, B7	6.3.1.1 6.3.1.2 6.3.2 6.3.2.2.2
	EN-ENE-4	Use **integrated lighting concept**	√	AS2, B7	6.3.1.2
	EN-ENE-5	Reduce fossil fuel **energy consumption for building operations**	√	S1, P3	6.3.1.2 6.3.2
	EN-ENE-6	Minimise the **size of lighting system control zones** to optimize energy savings *Refined to:* Optimise the size of **building systems control zones**	√	AS1, B11	6.3.1.2
		Design for a **tight, thermally resistant envelope** to prevent leakage of cool draft through building skin (later deleted (combined with "passive cooling strategies" above)	-	-	-
	EN-ENE-7	Use **auto-sensored lighting system** *Refined to:* Use **automatic lighting control system**	-	B7, B11	6.3.1.2
	EN-ENE-8	Install **energy sub-metering system** for each floor/section/tenancy to monitor energy consumption	√	AS1, AS2	6.3.1.2
	EN-ENE-9	Facilitate **personal control** of the lighting and thermal comfort systems by occupants	√	AS2	6.3.1.2
	WAT: Potable Water Consumption				
	EN-WAT-1	**Harvest rainwater** for later re-use to reduce the potable water consumption	-	AS2	6.3.1.2 6.3.2.2.2
	EN-WAT-2	Use **water efficient plumbing fixtures and appliances**	-	B7	6.3.1.2 6.3.2.2.2
	EN-WAT-3	Minimise **use of potable water for landscaping irrigation**	-	AS1, AS2, B7	6.3.1.2
	EN-WAT-4	Minimise **use of potable water for cooling system**	-	AS1	6.3.1.2 6.3.2.1.1
	EN-WAT-5	Install **water meters** for all major water uses in the project **to monitor water consumption** and to locate any leakages in the pipe lines	√	AS1, AS2	6.3.1.2
Issue	**Sub-Issues**	**Criteria**	Focus groups*	Literature	Interview data (Section in Chapter 6)**
EC: ECONOMIC					
	TBL: Triple Bottom Line Accounting – Planet, People, Profit				
	EC-TBL-1	Increase the practice of referring to **Environmental Impact Assessment (EIA) report** prepared by environmental experts by the project team	-	-	6.3.1.2 6.3.2.2.2
	EC-TBL-2	Assess and evaluate the **quality of workmanship** of construction works prior to hand over	-	GOV5	-
	EC-TBL-3	Consider both **capital/construction cost, along with long-term operational costs** for both tenant-occupied and leased office building	-	B7	6.3.1.2 6.3.2.3.2
	EC-TBL-4	Conduct **Triple Bottom Line** before deciding to pursue with the project	-	B7, P4	-
	EC-TBL-5	Conduct **Design Risk Analysis** *Refined to:* **Manage the performance risks** associated with new and untested sustainable building products and technologies	-	P1, P2	6.3.1.2
	EEF: Efficiency, Effectiveness and Flexibility				
	EC-EEF-1	Develop and implement a **long-term maintenance management plan** for efficient building operation	√	P12	6.3.1.2 6.3.2
	EC-EEF-2	Provide and operate an effective **building management control system** to maximize the operational efficiency of building systems and to save energy and water	√	B1, B4	6.3.1.2
	EC-EEF-3	Provide **as-built drawings and equipment manuals** to operating staff and owners to ensure efficient operation *Refined to:* Provide **comprehensive building records** to operating staff and owners	√	AS1	6.3.1.2
	EC-EEF-4	**Space planning for maximum flexibility** for different users/requirements *Refined to:* **Spatial flexibility** for different users/requirements	-	P10, P11	6.3.1.2 6.3.2
	EC-EEF-5	Provide **building services systems with maximum flexibility** for different users/ requirements	√	OD	6.3.1.2

Issue	Sub-Issues	Criteria	Reference: Focus groups*	Reference: Literature	Reference: Interview data (Section in Chapter 6)**
	EC-EEF-6	Requirement of contracted **comprehensive commissioning, and post-occupancy commissioning** to be performed for all building services	√	G1, AS1, AS2	6.3.1.2 6.3.2
	EC-EEF-7	**Structural design with maximum adaptability** for new uses	√	OD, P10	6.3.1.2
	EC-EEF-8	Adequate **floor-to-floor height** to offer high level of functionality for almost any occupancy	√	OD, P10	6.3.1.2
	EC-EEF-9	**Maximize workspace/directly functional area to total floor are ratio**	√	-	6.3.1.2 6.3.2
INN: INNOVATION					
	INN-1	**Innovative strategies and technologies**	-	AS1	-
	INN-2	**Exceeding MOBSA benchmarks**	-	AS1	-

Note:
* The symbol "√" under focus groups means that the performance benchmark(s) for the criterion were agreed upon based on customizing the benchmarks specified in SBTool assessment tool to suit local context, as discussed in Chapter Seven; whereas "-" means that the performance benchmark(s) for the criterion were not agreed upon (as shown in Stage-2 MOBSA Framework in Chapter Seven). Hence, literature and/or interview data were referred to instead.
** The symbol "-" under interviewees means that the performance benchmark(s) for the criterion were not cited by any interviewees but the interviewees may have cited the general criterion wordings. Whether or not the interviewees cited the general criterion, is already indicated in Stage-1 MOBSA Framework in Chapter Six.

Standards
S1 = MS 1525:2007 (Department of Standards Malaysia, 2007)
S2 = MS 1184:2002 (Department of Standards Malaysia, 2002)
S3 = MS 14001:2004 (Department of Standards Malaysia, 2005)
S4 = ASHRAE 129-1997 (ASHRAE, 1997)
S5 = ASHRAE 62.1-2010 (ASHRAE, 2010)
S6 = ASHRAE 55-2004 (ASHRAE, 2004)

Codes and Guidelines
G1 = ASHRAE 0-2005 (ASHRAE, 2005) and ASHRAE 1.1-2007 (ASHRAE, 2008)
G2 = Codes of Practice on Indoor Air Quality (Department of Occupational Safety and Health Malaysia, 2005)
G3 = Energy Efficiency and Conservation Guidelines.. (Malaysia Energy Centre, 2007)
G4 = Planning Guidelines for Environmental Noise Limits and Control (Department of Environment Malaysia, 2007b)
G5 = Urban Stormwater Management Manual for Malaysia (Department of Irrigation and Drainage Malaysia, 2000)

Building Performance Assessment Systems
AS1 = Green Star Rating Tool (GBCA, 2008a)
AS2 = Green Building Index (GSB, 2009a)
AS3 = Green Mark Scheme (BCA Singapore, 2008)
AS4 = BREEAM (BRE, 2008b)

Books
B1 = ASHRAE GreenGuide (ASHRAE, 2006)
B2 = Building Security (Nadel, 2004)
B3 = Safety and Security (Sinnott, 1985)
B4 = Environmental Design of Urban Buildings (Medved, 2006)
B5 = Practical Guide to Noise and Vibration Control for HVAC Systems (Schaffer, 2005)
B6 = Sustainable Urban Drainage Systems (SUDS) (Hall, 2008)
B7 = The HOK Guidebook to Sustainable Design (Mendler*, et al.*, 2006)
B8 = Staining of Facades (Chew & Ping, 2003)
B9 = Managing Distances and Differences in Geographically Distributed Work Groups (Armstrong & Cole, 2002)
B10 = Green Buildings Pay (Edwards, 1998)
B11 = Mechanical and Electrical Equipment for Buildings (Grondzik*, et al.*, 2010)

Government Documents/Publications
GOV1 = Draft Kuala Lumpur City Plan 2020 (Kuala Lumpur City Hall, 2004b)
GOV2 = Erosion and Sediment Control (CIDB Malaysia, 2008a)
GOV3 = Overview of OSHMS (CIDB Malaysia, 2008b)
GOV4 = Manual for IBS Content Scoring System (CIDB Malaysia, 2006a)
GOV5 = Quality Assessment System for Building Construction Work (CIDB Malaysia, 2006b)
GOV6 = Construction Industry Master Plan Malaysia 2006-2015 (CIDB Malaysia, 2007b)

Papers
P1 = Emerging risks of green construction (Brinson & Dolan, 2008)
P2 = Green building: Assessing the risks (MARSH, 2009)
P3 = Development of an energy rating system for office buildings (Kannan, 2007)
P4 = Environmental initiatives: Towards triple-bottom line reporting (Raar, 2002)

P5 = An evaluation of the impact of the office environment on productivity (Haynes, 2008)
P6 = Workplace technology's impact on individual privacy and productivity (Peterson & Beard, 2004)
P7 = Evaluating video as a technology for informal communication (Fish*, et al.*, 1992)
P8 = An assessment of attitudes of environmentally sustainable options available to occupants (Oluwoye*, et al.*, 2002)
P9 = Recycling of construction materials and the reuse of building components (Elias-Ozkan, 2002)
P10 = Adaptable office buildings: Theory and practice (Arge, 2005)
P11 = Design for flexibility (Habraken, 2008)
P12 = Sustainability evaluation and maintenance in the building process (Pollo, 2005)
P13 = Identifying and measuring urban design qualities related to walkability (Ewing*, et al.*, 2006)

Online Database
OD = CRISP (CRISP, 2005)

Table 9.1 also indicates an addition of "Innovation" issue, which is absent in frameworks developed in previous chapters. The addition of two criteria under this issue is mainly to encourage and recognise pioneering initiatives in sustainable design, process or advocacy as well as projects that achieve social, environmental or economic benefits in excess of the current MOBSA framework benchmarks. Referring to 88 criteria listed in the Stage-3 MOBSA framework, 66 were retained, 15 refined, another 6 combined (to become 3), and 1 omitted. As 2 "Innovation" criteria were added, the final total of criteria ready to be presented to relevant stakeholders for validation is 86 (i.e. 75+6+3+2). These criteria together with their tentative performance benchmarks were presented in a form of tentative Comprehensive MOBSA framework.

9.3 Method: Validation Process

The validation process required for the tentative Comprehensive MOBSA framework was done through obtaining feedbacks and comments from the previous interviewees and/or focus groups participants who are the key industry players. A total of forty building stakeholders were randomly selected and emailed in early January 2010 to get feedback on any part of the framework, particularly the set performance benchmarks, which are relevant to their area of expertise. The main question posted was: are these benchmarks realisable within current practice? Stakeholders were also informed that the tentative framework would still be refined when necessary as criteria not mentioned or not relevant at this stage may become more relevant in the future, hence may need to be included in the framework. Therefore, they were made aware that at this stage, no additional or omission of any criteria is necessary.

After sending a courtesy reminder email, 17 out of 40 stakeholders replied and agreed to prepare their comments within two weeks; however, only 9 of them actually did. These individuals comprise of 3 architects, 3 government officials, 1 engineer/supplier, 1 facility manager and 1 contractor who were also involved in participating other parts of this research i.e. as the interviewee, or the attendee of the focus groups discussion, or both (see Table 9.2).

This means that the stakeholders who involved in validating the developed framework were those who had followed through this research from the beginning. The feedbacks from them were obtained in either one of these two ways: (1) verbal and/or written comments via face-to-face communication; and (2) electronic communication. The choice was decided by the stakeholders to suit their preference and convenience. Eventually, four stakeholders preferred the former means of communication, and the rest preferred the latter. The incorporation of their feedbacks and comments into the tentative framework is discussed below.

Table 9.2: Summary of the stakeholders involved in the validation process and other parts of the research (N=9)

Profession and position of participants	**Type of company**	**Interview**	**Focus Groups**	**Validation technique****	**N**
Private Sector					**5**
Design consultants:					
- Architect and Director	- Architectural consultant	√	-	1	2
- Architect and Director	- Architectural consultant	√	-	2	
Builders:					
- General Manager	- Major property contractor	√	√	2	1
Facility Manager:					
- Chief Executive Officer & former President of ASHRAE Malaysia Chapter	- Facility management	√	-	2	1
Other:					
- Engineer and Manager	- Building materials supplier	-	√	2	1
Profession and position of participants	**Organisation**				**N**
Public Sector					**4**
Academician:					
- Professor	- Local public university	-	√	1	1
Researcher:					
- Assistant Director & former President of ASHRAE Malaysia Chapter	- Independent, non-profit making research organisation	√	-	2	1
Policy Makers/ Regulators:					
- Technical Advisor Policy Development	- Malaysia Energy Centre, MEWC	√	√	1	1
- Senior Manager	- Technology and Innovation Development Sector, CIDB	√	√	1	1
Total					**9**

Note:
**1= face-to-face; 2= electronic
MEWC = Ministry of Energy, Water and Communications
CIDB = Construction Industry Development Board, Ministry of Works

9.4 Results: Validated Comprehensive MOBSA Framework

The feedback from nine stakeholders was analysed and some comments and criticisms were incorporated, leading to substantial changes to the original draft of the tentative Comprehensive MOBSA framework. The framework was adjusted in the following ways:

1) Rewriting some of the qualitative benchmarks that were highlighted as being imprecise or too subjective to be used as the basis to assign performance scores;
2) Adjusting some of the numeric benchmarks to reflect what is technically feasible in the local context given economic, political-administrative, or social constraints; and
3) Adding more performance benchmarks to some of the criteria which are considered relevant and important.

Additionally, there were also suggestions to consider assigning higher scores to performance benchmarks that were highlighted as very essential in contributing to sustainability in a long term, and lower to those that are considered as short-term benefits. In other words, distinction between critical performance issues and less significant ones were suggested to be made clear. These suggestions will be recalled and incorporated in the next chapter.

After all the necessary adjustments to the tentative framework had been made, the result can now be presented as the Validated Comprehensive MOBSA Framework, consisting of 86 criteria applicable to all phases of assessment. Due to the length of this framework, this chapter only shows the proposed benchmarks applicable to the design phase of assessment and these are referred to as Validated MOBSA Framework for the Design Phase (see Table 9.3). A table showing criteria applicable by phase of assessment and the complete version of the Validated Comprehensive MOBSA Framework are provided in Appendices F-1 and F-2[2] respectively.

[2] Validated MOBSA Frameworks for the Pre-Design, Construction & Commissioning, and Operation Phase are provided in Appendices F-3, F-4, and F-5 respectively.

Table 9.3: An Extract from the Validated Comprehensive MOBSA Framework i.e. Validated MOBSA Framework for the Design Phase

Issue	Sub-Issues	Criteria & Benchmarking	Assessmt. Phase	Spatial Scale
S: SOCIAL				
	EDU: Education and Awareness			
	S-EDU-1	**Increase awareness of building occupants**		O
		N.A.		
	S-EDU-2	**Readiness and competency of design team members**		O
		At least one of major design companies used has a valid ISO 14001 Environmental Management System (EMS) accreditation throughout the project development.	Dsn	
	S-EDU-3	**Improve skills and knowledge of maintenance and operation staff**		O
		Tender Specification clearly specifies the requirements for appropriate and effective trainings to be arranged by Contractors and Suppliers for the future operating staff, to allow them to familiarize themselves with the building design philosophy, as well as the strategies and methods for the operation of various building facilities and building services systems. *<u>Note:</u> Scope of training shall be appropriate to the scale of the building and the complexity of the building services installations and building facilities. The training shall cover but not limited to the following information:* - *Building design philosophy and characteristics;* - *Usage and provisions provided in the building;* - *Operation, troubleshooting and maintenance of all building facilities, systems and equipment.*	Dsn	
	S-EDU-4	**Improve sustainable construction skills among construction workers**		O
		Accreditation to the ISO 14001 Environmental Management System is specified as one of the requirements in the tender pre-qualification of major contractor companies.	Dsn	
	COH: Support for Social Cohesion			
	S-COH-1	**Support for inter-disciplinary work right from the beginning of the design process**		O
		A credible detailed plan exists for the implementation of a high quality Integrated Design Process (IDP) to identify functional and environmental priorities at the initiation of the Project, evaluate options and develop the design. *<u>Elements of IDP:</u>* • *Ensure that as many of the interested parties as possible are represented on the design team as early as possible;* • *Inter-disciplinary work right from the beginning of the design process;* • *Discussion and documentation by the owners and the design team of the relative importance of various performance and cost issues and the establishment of a consensus on these matters between client and designers and among the designers themselves;* • *Provision of a design facilitator (or environmental design consultant) to suggest strategies for the team to consisted, as well as a commissioning authority to raise*	Dsn	

	performance issues throughout the process and to bring specialized knowledge to the table; • *Addition of an energy specialist to test various design assumptions through the use of energy and daylight simulations throughout the process, to provide relatively objective information on a key aspect of performance;* • *Addition of subject specialists (e.g. for daylighting, thermal storage) for short consultations with the design team;* • *Clear articulation of performance targets and strategies to be updated throughout the process by the owner and the design team.*		
S-COH-2	**Planning to support active streetscape and provisions for community**		C
	Design documentation indicates that the building ground floor or podium level will support active streetscape during and after office hours because the following provisions are designed to serve the community: - Communal and social service provisions such as healthcare, gallery, library, recreational and leisure facilities; - Convenient commercial service provisions such as restaurant/cafe and retail shops. OR Acceptable evidence is available to demonstrate that adequate amenity provisions are provided in the immediate neighbouring sites to serve the existing local communities as well as the new building. If there is no existing streetscape or the project is developed on a green site with limited close neighbourhood, amenity provisions shall be designed to serve the building occupants and users. *Note: The extent of amenity provision covers various supports for elderly, youth, students, passer-by, building occupants and people from outside the building. Support should be in form of those not addressed by other criteria e.g. healthcare, retail shops, restaurant/cafe, library, leisure & recreational facilities, gallery. Additions to the existing inadequate supports or amenities can be provided in the new building, rather than repeated within the neighbourhood context.*	Dsn	
	ADDITIONAL: Design documentation indicates that the building will provide spaces for vending machines for food and drinks, post box and cash machine to serve building occupants, users and community.		
S-COH-3	**Space planning for maximum social interaction**		B
	For a multiple-tenancies building: The design provides a break-out and group workspace/meeting spaces for every tenancy or at least on every 3 floors, whichever is smaller. OR For an owner-occupier building: The design provides a break-out and group workspace/meeting spaces for every 3 floors. *Note: A break-out space is a quiet area away from the bustle of the workplace which functions as temporary relaxation zone and to hold less formal client or internal meetings. A group workspace is an area within the zone of individual workspaces to facilitate team cohesiveness and collaboration.*	Dsn	
S-COH-4	**Increase participation of affected community in development process**		O
	N.A.		
S-COH-5	**Increase participation of users in development process**		O
	Representative of clients and/or future users have involved in the design process (workshops/ meetings with models and large format drawings). If the prospective occupants are unknown during the design phase (e.g. for speculative development), this credit is 'Not applicable'.	Dsn	
ACC: Accessibility			

S-ACC-1	**Maximize personal safety and security**		B
	Suitable security design measures have been taken to prevent unauthorised entry, impede the removal of stolen goods, and reduce vandalism directed against the building. For example, - Plan buildings to eliminate dark cul-de-sacs and unnecessary recess space; - Provision of wide and open staircases; - Design buildings to provide unobstructed view of people approaching controlled areas and around the buildings; - Minimise vehicle access points; and - Plan building to restrict entry to specific zones to selected persons (i.e. depending on the level of security needed in the zone).	Dsn	
	ADDITIONAL: The design provides reasonable quantities of passive security facilities to suit the scale and complexity of the building will be provided, such as access barrier/gate, security fence, fence and barrier for access to the slope, exposed pipes and cables, etc.		
	ADDITIONAL: The design provides reasonable quantities of active security facilities to suit the scale and complexity of the building will be provided, such as: - Electronic Access Control Systems; - Closed-circuit television (CCTV) Surveillance System; - Anti-theft Security and Alarm System; - Communication (intercom) system; - Security guards.		
S-ACC-2	**Convenient and safe maintenance access for building facades and other elements or design**		B
	Design documentation indicates that the building is designed with self-cleaning facades, skylight, and/or roof; OR Design documentation showing the access paths for inspection, cleansing and maintenance indicates that window, atria and roof glazing cleaning will be capable to be carried out safely and without undue disturbance to staff due to the provisions of the following facilities: - Permanent window cleaning and maintenance access systems (e.g. cat ladders, roof top support systems for elevating platforms, external shadings that also function as platform for cleaning and maintenance); OR - Sufficient space for platform transportation and erection, and full-coverage of gondola tracks (if movable maintenance platforms and gondolas are to be used). For buildings over 9 m and up to 30 m high, facilities for either manual or power operated gondolas/suspended access are provided; whist above this height must have the facility for power operated gondolas; AND - A suitable form of restraint – if a cleaner requires to stand on a ladder or other object or lean out of the window in order to carry out the cleaning process; and ladder restraints – if windows are to be cleaned from an external ladder.	Dsn	
S-ACC-3	**Adequate access to communication technology**		B
	Every workstation in the building, as indicated by design documentation, will have access to telephone and internet/email to allow occupants to conduct telephone/computer/video-conferencing over the internet e.g. via skype.	Dsn	
S-ACC-4	**Convenient and safe maintenance access for all building services installation.**		B
	Convenient and safe access of HVAC delivery systems for repair and maintenance, as indicated by design documentation, will be assisted by ALL of the followings: - Convenient access for maintenance to cable containment, air ducts and pipes where feasible; - Sufficient access doors and panels to services shafts; - Simplified, well-marked signage to clearly indicate purpose, source and destination of specific sections of the delivery system; - Sufficient access platform, or space for temporary maintenance platform erection (for services mounted outdoors);	Dsn	

	- Minimization of duct run lengths and elbows (with the intent of minimizing pressure losses, reducing surface area and difficulty for ease of cleaning); - Sufficient and convenient maintenance access, such as access panel and cleansing eye to allow cleansing of all sections of air ducts; and access to each straight air duct and damper.		
S-ACC-5	**Easy access to nearby services**		C
	Where evidence provided demonstrates that the building is located within 500m of the following accessible local amenities: a. Grocery shop/supermarket and/or food outlet b. Post office c. Bank d. Clinic and pharmacy If ALL of the above amenities are designed to be integrated in the development or provided in the building (as addressed by criterion S-COH-2), this credit is 'Not applicable'. *Note: The distance must be measured via safe pedestrian routes e.g. pavements and safe crossing points or, where provided, dedicated pedestrian crossing points.*	Dsn	
INC: Inclusiveness of Opportunities			
S-INC-1	**Provide for universal access**		B
	<u>CASE 1: The Local Authority does not make mandatory in the use of MS1184 Code of Practice on Access for Disabled People to Public Buildings:</u> Spaces are designed to enhance the connectivity for all types of occupants and users, such as disabled and elderly persons as well as healthy people, - in addition to the current minimum requirements of MS1184; OR - in accordance with the minimum requirements of MS1184 <u>CASE 2: The Local Authority makes mandatory in the use of MS1184 Code of Practice on Access for Disabled People to Public Buildings:</u> Spaces are designed to enhance the connectivity for all types of occupants and users, such as disabled and elderly persons as well as healthy people, in addition to the current minimum requirements of MS1184. *<u>Note:</u> Effective inclusion will harmonize all building occupants and users, irrespective whether they are of healthy or disabled, children, adult or elder persons.*	Dsn	
S-INC-2	**Provide facilities for users to perform religious obligations**		B
	<u>Moslem:</u> The design provides a facility to pray/common prayer room (separate spaces and ablution areas for ladies and gentlemen staff); and in each room, the direction of Kiblat will be clearly indicated; AND The facility is located at appropriate location as follows: - podium/first floor, if no eating outlet is provided on upper floor; OR - the same floor as and adjacent to washrooms and eating outlet or amenity space. AND <u>Other religions:</u> Having one gathering room per building (may also be served as multi-purpose room or a meeting room)	Dsn	
S-INC-3	**Provide facilities for users with children**		B

	The design provides a crèche area and a mother's room to cater for building users (and if necessary, users of neighbouring blocks) to enhance their quality of life. *<u>Note:</u> Solve the issue of emergency escape for children especially for when the first few floors are car parks and the facilities have to be provided on the upper floor.*	Dsn	
HUM: Human Health and Well-being			
S-HUM-1	**Adapt practices that avoid construction accidents**		B
	Accreditation to the occupational health and safety management system – OSHMS MS1722:2005 and/or OHSAS 18001:2007 – is specified as one of the requirements in the tender pre-qualification of major contractor companies.	Dsn	
S-HUM-2	**Optimize the level and quality of fresh air in mechanically ventilated spaces**		B
	An analysis of proposed ventilation systems in mechanically ventilated areas of the occupancy indicates that sufficient fresh air will be provided in the interior of the building and the air change effectiveness (ACE), as determined by ASHRAE 129-1997, is: ≥95% OR 89-94% *<u>Note:</u> All fresh air intakes shall be located away from pollutant sources, which included, but not limited to building exhaust air louvers and exhaust outlet from adjacent buildings, air exhaust openings of refuse collection room, enclosed/semi-enclosed car park and public transport terminal, smoke discharge openings, and gas discharges exhaust from toilets and kitchens plumbing vents, etc. Fresh air intake openings shall be protected from rain entrainment and covered by a screen to prevent entry of birds, rodents and extraneous articles. ASHRAE 62.1-2010 Ventilation for Acceptable Indoor Air Quality can be referred as design guidelines.*	Dsn	
	ADDITIONAL: Design documentation indicates that carbon dioxide sensors will be installed in occupied zones to maintain sufficient ventilation at the times of different occupancy; hence, addressing the balance of fresh air supply and energy efficiency.		
S-HUM-3	**Maximize openings and cross ventilation in naturally ventilated spaces**		B
	The building or part of the building (e.g. toilets, carparks, lobby) is naturally ventilated.	Dsn	
	ADDITIONAL: Evidence is provided to demonstrate that the opening area in naturally ventilated space is adequate to comply with the natural ventilation requirements of ASHRAE 62.1-2007.		
S-HUM-4	**Minimise noise level and provide satisfactory level of acoustic performance**		B
	The system design follows the ASHRAE's Practical Guide to Noise and Vibration Control for HVAC Systems resulting in ambient noise levels (with all engineering services operating normally but with no activity in the area) not exceeding the following: - Cellular offices, interview rooms, first aid rooms, conference rooms : 40 dB(A) - Open plan offices : 45 dB(A)	Dsn	
S-HUM-5	**Appropriate illumination level and artificial lighting quality**		B
	The office lighting design has a maintained illuminance level of no more than specified in MS1525:2007 for 90% of NLA as measured at the working plane (900mm AFFL).	Dsn	
	ADDITIONAL: Provision is made for task lighting in each 15m² or less.		
	ADDITIONAL: High frequency ballasts are installed in fluorescent luminaries over a minimum of 90% of NLA.		

S-HUM-6	**Prohibit tobacco smoking in the building**		B
	The design does not provide dedicated rooms or areas because such activities are prohibited in the building; OR The design provides separate and separately ventilated rooms or areas for tobacco smoking in the building. *Note: Smoking substantially increases the perceived pollution burden (to 2-6 times). The deterioration in air quality caused by smoking can only be compensated by substantially increased ventilation. According to international research results 100 m3 fresh air is needed to eliminate the effect of one cigarette smoked.*	Dsn	
S-HUM-7	**Use low/zero pollutants cleaning and maintenance products and processes**		B
	N.A.		
S-HUM-8	**Use interior finish materials with low- or zero-pollutant off-gassing**		B
	Tender Specification clearly specifies the use of low- or zero-emission finishing materials; AND According to design documentation, Paints Zero or low VOC paint and coating are used on 95% of all painted surfaces; OR No paint is used in the project. Carpets Only zero or low VOC carpets are used; OR Where no carpet has been installed in the project and projects wish to use low-VOC flooring, all flooring installed in the project meet the emissions limits. Adhesives and sealants 95% of all adhesives and sealants have zero or low VOC content; OR No adhesives or sealants are used. Wood products All composite wood products (including exposed or concealed applications) either contain low-emission formaldehyde or contain no formaldehyde. If no engineered wood products are used within the project, this credit is "Not Applicable".	Dsn	
S-HUM-9	**Provide optimum air movement for thermal comfort in mechanically ventilated spaces**		B
	The air movement/ air velocity of 95% of the NLA are designed in accordance with MS1525:2007 (i.e. 0.15 m/s – 0.5 m/s). *Note: Ventilation effectiveness accounts for the path that supply air moves through an occupied space and reaches an exhaust or return; directness of delivery of ventilation air to the occupants, i.e., diffuser type and location; and placement of obstructions to air movement such as partitions and acoustic barriers.*	Dsn	
S-HUM-10	**Minimise glare conditions in main occupancy areas**		B
	According to design documentation, internal (e.g. screens, blinds, light shelves) AND external (fixed or movable, horizontal or vertical) shading devices will be fitted to all glazing and atriums that eliminate all direct sun penetration. ADDITIONAL: Motorized blinds on photocell controllers will be used in areas where individual control is not desired.	Dsn	

S-HUM-11	**Increase the practice of building flush-out**		B
	Evidence suggests that permanent air flushing system of at least 10 airchanges/hour operation will be provided. OR Tender Specification clearly specifies the requirements for air duct cleanliness and building flush out at building handover stages.	Dsn	
S-HUM-12	**Provide separately ventilated and isolated areas/rooms which generate pollutants and odour**		B
	According to design documentation, ALL rooms and spaces in this occupancy that contain equipment or activities generating chemical pollutants and odour (e.g. copier rooms, waste storage areas, janitorial rooms, pantries) are designed with dedicated exhaust air ducts to extract polluted air from these rooms/areas to the outdoors; and isolated from other occupied spaces.	Dsn	
S-HUM-13	**Adequate monitoring of occupants' satisfaction with indoor environmental quality**		B
	N.A.		
CUL: Cultural and Heritage Aspects			
S-CUL-1	**Enhance or maintain the heritage significance of the building or adjoining/nearby heritage buildings**		B
	For existing non-heritage building in a heritage zone (adaptive reuse): The entire building, or a large portion (minimum 50%) of the building, such as building envelope, courtyard is reused; AND The design of external and internal features enhances or maintains the heritage significance of the building, and new features, systems and materials are so well integrated into the existing fabric; OR Only the design of external features enhances or maintains the heritage significance of the building, and new features, systems and materials are so well integrated into the existing fabric. For new building on a vacant site in a heritage zone: The design of external features enhances or maintains the heritage significance of adjoining/nearby buildings, and new features, systems and materials are so well integrated into the existing fabric. AND If the immediate adjacent building(s) are having cultural heritage value, the building foundation and structure of the new building are designed to minimize any adverse structural and environmental impacts towards the adjacent building(s) with cultural heritage value during construction process.	Dsn	
LOC: Local People and Employment			
S-LOC-1	**Provide training opportunities for unskilled local people (employed for the works) to be future semi-skilled or skilled construction workers**		C
	N.A.		
S-LOC-2	**Increased use of locally available materials and products**		C
	The percentage (by weight), of the aggregate, sand, concrete, masonry, steel and glass used in the project produced within the greater urban region is: ≥80% OR 50-79%. ADDITIONAL: ≥80% of finishes (based on cost) are made in the country.	Dsn	

Issue	Sub-Issues	Criteria & Benchmarking	Assessmt. Phase	Spatial Scale
		ADDITIONAL: ≥80% of fittings (based on cost) are made in the country		
	S-LOC-3	**Linkage to local service providers**		C
		N.A.		
	S-LOC-4	**Use experienced local design teams**		C
		At least 80% of design teams (including planners, architects, engineers, landscape architects, interior designers and environmental consultants) appointed for the project are local companies who have had good track records in designing similar type of projects; OR Collaborative work with foreign design teams to improve local know-how only on specialised knowledge where local talent is not available.	Dsn	
	S-LOC-5	**Use experienced local contractors**		C
		Experienced local contractor who have good track records in constructing similar type of projects is specified as one of the requirements in the tender pre-qualification of major contractor companies.	Dsn	
Issue	**Sub-Issues**	**Criteria & Benchmarking**	**Assessmt. Phase**	**Spatial Scale**
EN: ENVIRONMENTAL				
	ECO: Land use and Impacts on Ecology			
	EN-ECO-1	**Minimise ecological and other damage to existing soil, water bodies and flora and fauna of the site or adjacent lands**		S
		A total Erosion and Sedimentation Control Plan (ESCP) during construction process (which covers planning considerations, vegetative stabilisation, physical stabilisation, diversion on runoff, flow velocity reduction and sediment trapping/filtering) for all construction activities associated with the project is captured in the tender for the works.	Dsn	
		ADDITIONAL: The Designers have conducted a field survey to existing trees within the site; and designated all existing healthy trees with high amenity value for preservation and/or transferred to other site for reuse. This credit is “Not Applicable” for projects built on a used site with no existing trees or tress with high amenity value.		
	EN-ECO-2	**Maximize potential for landscape spaces on the site**		S
		According to design documentation, land that is allocated as landscape space for project users, has an area, expressed as a percent of the total site area, of: ≥20% OR 17-19% This credit is “Not Applicable” for urban infill projects or projects built on a confined site with no external areas.	Dsn	
		ADDITIONAL: Design documentation indicates that a reasonable scale of landscape area (relative to the scale of the building) will be provided within the building and/or on the rooftop, such as courtyard gardens, podium roof and sky gardens, to improve the working environment. *Note: Landscape, in the form of greenery, water features, hard landscape and fixed furniture are recommended in communal open space, podium garden, skygarden, slope,*		

	retaining wall and semi-enclosed area. Hard and soft landscape or solely soft landscape is acceptable for both credits.		
EN-ECO-3	**Improve the ecological value of natural landscape**		S
	The percentage of landscaped area (including on roof if present) planted with non-invasive plantings that are considered as endemic to the area or low irrigation demand, as per landscaping plans and specifications, is: 100% OR 70-99% If there is no landscaping, or landscaping represents less than 1% of the site area, this credit is "Not Applicable".	Dsn	
EN-ECO-4	**Select sites that have low risk of flooding**		C
	The height of the minimum elevation of the site above the elevation of the 100-year flood plain is 2.5m and comply to MASMA guidelines OR …1m…	Dsn	
SRM: Supports Resource Management			
EN-SRM-1	**Increase use of materials that have less environmental impact in producing them**		G
	The predicted embodied energy for materials used in the structure and building envelope, as determined an acceptable LCA-based estimating method, is: 2.0 GJ/m² or 27 MJ/m²/year; OR 2.8 GJ/m² or 37 MJ/m²/year *Note: This indicator assesses the estimate of embodied primary energy used for structure, envelope (excl. glazing), and major interior components, as determined by a program designed to estimate embodied energy and emissions through Life Cycle Analysis; also, estimate of lifespan.*	Dsn	
EN-SRM-2	**Design building for maximum durability**		B
	Drawings and specifications indicate that all building envelope materials are durable (i.e. require less maintenance, repair and replacement) that can withstand sunlight, temperature and humidity changes, and condensation.	Dsn	
	ADDITIONAL: All building materials used in high pedestrian traffic areas (i.e. main entrance, public areas and thoroughfares i.e. corridors, lifts, stairs, doors etc) are durable and low-maintenance that can withstand wear-and-tear.		
	ADDITIONAL: Internal and external areas of the building where vehicular, trolley and pedestrian movement occur have been identified; AND Suitable durability and protection measures or design features have been specified to prevent damage to the vulnerable parts of these building areas from such traffic. This must include, but not be limited to: - Protection from the effects of high pedestrian traffic in main entrances, public areas and thoroughfares (corridors, lifts, stairs, doors etc). - Protection against any internal vehicular/trolley movement within 1m of the internal building fabric in storage, delivery, corridor and kitchen areas. - Protection against, or prevention from, any potential vehicular collision where vehicular parking and manoeuvring occurs within 1m of the external building façade for all car parking areas and within 2m for all delivery areas.		
	ADDITIONAL: Details roof and wall sections, and other critical aspects such as roof overhangs show that effective measures have been incorporated to limit water entry and migration of moisture (e.g. continuity of air/vapour barrier, exterior detailing weather membranes etc.)		

EN-SRM-3	**Increase use of bio-based products and materials obtained from managed/sustainable sources**		B
	According to technical specifications and/or drawings, timber products used for permanent construction (e.g. permanent framing, flooring, finishes, partitions) are sourced from any combination of the following: - Forest Stewardship Council (FSC) or Malaysia Timber Certification Council (MTCC) Certified Timber - post-consumer recycled timber (must have 50% post-consumer recycled content) - Re-used timber And the percentage (by cost) of these timber products is: ≥75% or 50-74% If the material cost of timber represents less than 0.1% of the project's contract value, this credit is "Not Applicable".	Dsn	
EN-SRM-4	**Increase use of materials that can be recovered or recycled**		B
	Percentage (by cost) of building materials that can be recovered or recycled is: 30% OR 20% *Note: Example of building materials that can be recovered or recycled are:* - *Bricks and concrete used for clean-fill;* - *Timber to be salvaged for new structural or material use; timber waste ground into mulch or garden compost;* - *Crushed concrete used as road-base;* - *Plasterboard crushed for soil container or for use in the manufacture of new plasterboard;* - *Steel, aluminium and other metals for reuse in the manufacture of new metal products.*	Dsn	
EN-SRM-5	**Increase use of products and materials with recycled content**		B
	Concrete: According to design report, technical specifications and/or drawings, ≥10% (by weight/volume) of all aggregates used for structural purposes are recycled; AND 100% of aggregates used in non-structural uses are recycled. If the material cost of new concrete represents less than 1% of the project's contract value, this credit is "Not Applicable".	Dsn	
	ADDITIONAL: Steel: ≥80% of all steel, by weight/volume, in the project has a post-consumer recycled content greater than 50%; OR ≥50% of all steel, by weight/volume, in the project has a post-consumer recycled content (i.e. product composition that contains some percentage of material diverted from the product user's waste stream). If the material cost of steel represents less than 1% of the project's contract value, this credit is "Not Applicable". *Note: The cycled content of materials shall be determined by dividing the weight/volume of recycled content in the item by the total weight/volume of all materials in the item.*		
AIR: Emissions to Air			
EN-AIR-1	**Provide pedestrian access to basic services and connect to existing public transportation network**		C

<table>
<tr><td></td><td>The distance between the nearby public transport interchange and the building entrances is:
≤300m OR
≤100m</td><td>Dsn</td><td></td></tr>
<tr><td></td><td>ADDITIONAL:
The design provides a safe, convenient and comfortable on-site footpaths (elevated, continuous and sheltered walkways OR a pavement along a street), connecting the building to nearby buildings/basic services and public transportation network or local transport nodes.</td><td></td><td></td></tr>
<tr><td colspan="4">LAN: Emissions to Land/ Solid Waste</td></tr>
<tr><td>EN-LAN-1</td><td>Save handling and storage of hazardous wastes on site</td><td></td><td>S</td></tr>
<tr><td></td><td>There is a detailed and credible plan to minimise the danger of improper storage of hazardous wastes on the site in accordance with EMS 14001:2004.
OR
There is a credible plan to minimise the danger of improper storage of hazardous wastes on the site.</td><td>Dsn</td><td></td></tr>
<tr><td>EN-LAN-2</td><td>Implement construction waste management program with sorting, reuse and recycling measures</td><td></td><td>B</td></tr>
<tr><td></td><td>Design specification and relevant contact documents clearly indicate the requirement for an effective implementation of construction and demolition waste management plan by the Contractor;
AND
The Contractor has formulated a comprehensive Waste Management Plan that, at a minimum identifies the salvageable materials to be diverted from landfills and whether the salvageable materials are sorted on site or commingled;
AND
The percentage (by mass) of all demolition and construction wastes that are reused (on or off site) and/or transferred to a recovery factory, as predicted in the construction waste management plan, is:
≥70% OR
50-69%

<u>Note:</u> Salvageable materials include inert waste, such as metals, bricks and tiles, as well as non-inert waste such as timber, paper and plastic. Waste management plan shall include, but not limited to key types of waste to be reduced, waste reduction targets, waste reduction programmes, packaging waste management and waste disposal procedures. Apart from that, effective implementation is required to ensure strategies (e.g. in the form of educational basis, instructions or guidelines) are applicable to all site workers and cover the entire site area, including site office.</td><td>Dsn</td><td></td></tr>
<tr><td>EN-LAN-3</td><td>Provide spaces for collection of recyclables, recycling storage and staging areas in the building</td><td></td><td>B</td></tr>
<tr><td></td><td>The Design provides a centralised space for sorting and storage of office recyclables generated by building occupants and users and it is:
- adequately sized in accordance with table below:
<table><tr><th>GFA (m²)</th><th>Min area of recyclable storage space (% of GFA)</th></tr><tr><td>≤500</td><td>1.50%</td></tr><tr><td>1,000</td><td>0.80%</td></tr><tr><td>5,000</td><td>0.35%</td></tr><tr><td>10,000</td><td>0.25%</td></tr><tr><td>≥20,000</td><td>0 15%</td></tr></table>- located in the same level as the loading dock with a clearly marked, sign-posted, convenient and guaranteed access route within one of the following walking distances:
o 20m of the exit used for recycling pick-up; OR
o 20m of the lift core serving all floors; OR</td><td>Dsn</td><td></td></tr>
</table>

	o 3m of the shortest route connecting the lift core serving all floors and the exit used for recycling pick-up. *<u>Note:</u> A centralised space can improve the delivery process for large amount of waste and it could be allocated for each building or for the whole development.* ADDITIONAL: The Design provides designated space(s) and facilities per floor for sorting and storage of recyclable and non-recyclable waste.		
EN-LAN-4	**Maximize recycling of office recyclables**		B
	A detailed and comprehensive municipal waste management plan exists to collect, store and send at least 90% of office recyclables to recycling facilities; OR A detailed plan exists to collect, store and send at least 60% of office recyclables to recycling facilities. *<u>Note:</u> The municipal waste management plan should suit the managed building. Apart from that, effective implementation is required to ensure strategies (e.g. in the form of management procedures, instructions or guidelines) are applicable for all building occupants and property management staff of the building.*	Dsn	
EN-LAN-5	**Minimise land pollution from site workers' accommodation**		S
	N.A.		
EN-LAN-6	**Design for repeatability and increase use of standardized and prefabricated components**		B
	Design documentation indicates that any combination of the following items will be used in the building construction to enhance buildability and minimize environmental impacts: - Precast structure (such as precast slab, staircase, column and beams); - Standardised components (such as services riser, refuse chute, standardised door leaf, window etc); - Full precast module (such as modular office) and/or integrated services module (such as prefabricated toilet unit, plant room unit, bathroom unit, which completed with full building services equipment, pipes, ducts and cable containments). AND The design has been assessed using IBS Content Scoring System (IBS Score) by the Malaysia CIDB and the score obtained is: ≥75% OR 60-74%	Dsn	
EWA: Emissions to Water			
EN-EWA-1	**Implement stormwater management strategies**		C
	<u>CASE 1: Previously undeveloped site (or the site consists of less than 50% impervious surface in its pre-development state):</u> Stormwater management strategies are implemented in accordance with Stormwater Management Manual for Malaysia (MASMA) that prevent the post-development peak flow rate from the outlet point(s) of the site to the downstream public drainage system or receiving water from exceeding the pre-development rate. <u>CASE 2: Previously developed site (or the site already consists of more than 50% impervious surface in its pre-development state):</u> Stormwater management strategies are implemented in accordance with MASMA that result in a 25% decrease in the volume of stormwater runoff. *<u>Note:</u> Often the techniques used are architectural (e.g. vegetative roofs), landscaping (pervious pavements, bioswales), and civil (detention basins, filtration). Other technique includes collecting the stormwater and storing it for future use on-site.*	Dsn	
EN-EWA-2	**Minimise storm sewer or stream pollution from site workers' accommodation**		C

	N.A.		
EN-EWA-3	**Utilize on-site wastewater treatment systems using greywater**		S
	The design provides all individual occupancies in the project with separate supplies of potable water for required occupancy uses and greywater for toilets and irrigation. OR The design provides all individual occupancies in the project with separate supplies of potable water for required occupancy uses and greywater for irrigation only. *<u>Note:</u> The greywater system collects drainage from sinks (except for kitchens and clinical areas) and showers, washing machines, condensate from air-conditioning systems and water discharged from cooling towers, swimming pools, fountains and other water sources that do not contain food or human waste. The greywater is filtered and disinfected and then stored in a cistern or tank until needed. It is then piped in a special separate piping system for reclaimed water to the points of use. The on-site sewage treatment system approach can include traditional septic systems or more modern biological treatment systems that create a local natural wetland ecosystem that purifies wastewater after a biological digestion process is applied to the sewage.*	Dsn	
ADJ: Impacts on Adjacent Properties			
EN-ADJ-1	**Reduce noise and vibration generated during construction**		C
	Contract documents clearly spell out the requirement for noise and vibration that may be caused by the works to be lower than the maximum permissible limit stipulated in Schedule 6 of the Planning Guidelines for Environmental Noise Limits and Control by Department of Environment.	Dsn	
ENE: Non-renewable Energy Consumption			
EN-ENE-1	**Use energy efficient light fixtures and office appliances**		B
	Design documentation indicates that the lighting load or power density (including ballast loss) for 90% of the NLA meet the following criteria at 720mm AFFL: 5 W/ m^2 OR 7.5 W/ m^2 OR 10 W/ m^2	Dsn	
EN-ENE-2	**Use highly efficient ventilation and air-conditioning systems**		B
	Energy efficient ventilation and air-conditioning systems are selected in accordance with the Energy Efficiency and Conservation Guidelines for Malaysian Industries Part 1: Electrical Energy-use Equipment.	Dsn	
EN-ENE-3	**Use passive cooling strategies**		B
	The Designers have conducted a site investigation on local topographic conditions and building arrangements in the surrounding area for site layout planning. *<u>Note:</u> The topographic conditions shall include nearby hills/mountains, vegetation and water ponds which may affect the natural ventilation and evaporative cooling effectiveness. Also, the building height, dimensions and separation of surrounding buildings shall also be identified to evaluate the effectiveness of daylight access, solar shading, wind permeability and noise source.*	Dsn	
	ADDITIONAL: Building envelop is designed to cut down external heat gain and hence reduce cooling load of the air-conditioning system, and meet the following criteria: - The overall thermal transfer value (OTTV) of building envelope for a building having a total air-conditioned area exceeding 4000m^2 and above,		

	does not exceed 50 W/m² as stipulated in MS1525. AND - The roof thermal transfer value (RTTV) of building roofs with skylight and the entire enclosure below is fully air-conditioned, does not exceed 25 W/m² as stipulated in MS1525; OR - The thermal transmittance (U-value) of the roof of a conditioned space does not exceed 0.4 W/ m²K (for light weight roof under 50kg/ m²) or 0.6 W/ m²K (for heavy weight roof above 50kg/ m²) as stipulated in MS1525.		
EN-ENE-4	**Use integrated lighting concept**		B
	The percentage of the NLA that has a Daylight Factor (DF) of 1.0-3.5% at the working plane level (800mm from floor level), as indicated by design and relevant simulation results, is: 70% OR 50% OR 30% *Note: Review sun path diagram relative to the site and building forms to guide development of the daylight design. Consider sun angles throughout the year for the best orientation and shading strategies. Establish daylight strategy early in schematic design, as it influences decision making related to the site plan, building orientation, building massing and fenestration. However, daylighting needs to take into account the sky conditions more than sun movement. Locate program area that benefit most from daylight at perimeter zones with northern and southern exposures to the greatest extent possible. Eastern and western exposures require more careful sun control strategies to control glare and overheating from low angle sun. The requirement for daylight can be effectively controlled by the depth of the room. In general, higher levels of reflectance and higher window head heights allow deeper rooms.*	Dsn	
EN-ENE-5	**Reduce fossil fuel energy consumption**		B
	Conditional requirement for the whole assessment: The project's predicted Building Energy Intensity (BEI) which measures the total energy used in the building for one year (in kilowatts hours) divided by the air-conditioned floor area of the building (in square meters), must not exceed 150 kWh/m²/year. 0-89 kWh/m²/year; OR 90-120 kWh/m²/year; OR 121-150 kWh/m²/year	Dsn	
EN-ENE-6	**Optimise the size of building systems control zones**		B
	Design documentation indicates that all individual or enclosed spaces are individually switched; the size of individually switched lighting zones does not exceed 100m² for 90% of the NLA; and Switching is clearly labelled and easily accessible by building occupants;	Dsn	
	ADDITIONAL: An individually addressable lighting system (i.e. the lighting fixtures must be able to be readdressed/regrouped without wiring) is provided for 90% of the NLA. *Note: 'Easily accessible switch' = wired for each zone of 100m² and must be located as follows:* • *within the 100m² zone and at every entry (2- or 3-way switches may need to be provided) to the floor or tenancy (if known), whichever is smaller; OR* • *at the entry point to the tenancy or floor (whichever is smaller) if the area controlled by the switching does not exceed 500m².* *'Individually addressable lighting system' = the lighting fixtures must be able to be readdressed/regrouped without wiring.*		
	ADDITIONAL: Provisions are designed to enhance the thermal comfort performance at partial operation based on system part-load operation and control strategies of centralized system.		

	Note: For buildings with centralized building services systems, certain level of operational flexibility is restricted. On some occasions, whole floor building systems have to be activated in order to serve single building occupant outside of normal operating hours, such that building system is operated uneconomically and energy is wasted. Hence, the optimum size of control zones shall be determined according to the space usage and floor area.		
EN-ENE-7	**Use automatic lighting control system**		B
	Design documentation indicates that automatic lighting control system will be provided in all daylight zones to allow coordinated and active operation between natural and artificial light sources in response to the interior requirements and outdoor daylight conditions. *Note: The integrated control shall be able to minimise the operating period of electric lighting and to allow for more use of daylight.*	Dsn	
	ADDITIONAL: Design documentation indicates that occupancy sensors which automatically shut off lighting in unoccupied areas will be provided for at least 25% NLA. *Note: Types of sensors include passive infrared sensors (sense the heat radiated by people), ultrasonic sensors (detect motion), and dual-technology occupancy sensors. Integrate occupancy sensors with daylight dimming controls that dim electric lighting levels in response to daylight.*		
EN-ENE-8	**Install energy sub-metering system for each floor/section/tenancy**		B
	According to design documentation, sub-metering will be provided for substantive energy uses within the building (i.e. all energy uses of 50kW or greater) and the system will be linked to BMS to monitor energy consumption data. If the building is less than 500m², this credit is 'Not applicable'.	Dsn	
	ADDITIONAL: Sub-metering will be provided separately for lighting AND separately for power for each floor or tenancy, whichever is smaller. *Note: Metering of all individual equipment may not be cost-effective, but metering of particular groups of equipment and major equipment could be sufficient in many cases in order to understand the energy use pattern and for future energy use planning. Also, metering provisions allow regular energy audits to be carried out by building operators or energy audit consultants. Energy metering, monitoring and logging provisions for the continuous recording of energy use are recommended.*		
EN-ENE-9	**Facilitate personal control of thermal comfort systems**		B
	Design reports and relevant technical specification and drawings indicate that individual comfort controls (over air temperature, radiant temperature, air speed or humidity) will be provided for ≥50% of the building occupants to enable adjustments to suit individual task needs and preferences, while maintaining the indoor environment within acceptable limits. AND Comfort system controls will be provided for all shared multi-occupant spaces (meeting rooms, amphitheatre etc.) to enable adjustments to suit group needs and preferences. *Note: Occupants in many building experience an uncomfortable environment when working at odd hours (at night or on weekends) because the HVAC systems have not been designed to permit occupants to control their own needs. This criterion is applicable to personal control over thermal comfort system only as lighting system control zone is addressed in other credit. Also, it applies to the extent to which passive strategies in hybrid ventilated (air-conditioned and natural ventilated) buildings are capable of providing a range of control patterns as it does for fully air-conditioned buildings.*	Dsn	
WAT: Potable Water Consumption			
EN-WAT-1	**Harvest rainwater for later re-use**		S
	Design documentation indicates that a rainwater harvesting system will be provided and the calculations provided suggests that the provision will	Dsn	

		lead to 20% reduction in potable water consumption; OR …10% reduction…		
	EN-WAT-2	**Use water efficient plumbing fixtures and appliances**		B
		The percentage of all lavatory faucets with water flow between 0.5-1.0 GPM, as indicated by design reports and specifications, is: 100% OR 75-99% ADDITIONAL: The percentage of all toilets with dual-flush or low-flush system (less than or equal to 6 liters) is: 100% OR 75-99% *Note: Use aerators on lavatory faucets to reduce water flow from 2.5 GPM to 0.5 or 1.0 GPM. Use automated controls for lavatory faucets for water conservation, such as infrared sensor faucets, delayed action shutoff, or automatic mechanical shutoff valves. Use dual-flush or low-flush toilets. Do not use automatic flush toilets and urinals to avoid excessive flushing.*	Dsn	
	EN-WAT-3	**Minimise use of potable water for landscaping irrigation**		S
		Potable water consumption for landscape irrigation is predicted to be reduced by 50% through the following: - Installation of water-efficient irrigation systems e.g. sub-soil or drip irrigation and/or - Use of non-potable water (i.e. captured rainwater or greywater) for landscape irrigation OR According to landscaping plans and specifications, water-conserving or self-sustaining landscape will be installed which is based on plants tolerant of soils, climate and water availability If there is no landscaping, or landscaping represents less than 1% of the site area, this credit is "Not Applicable".	Dsn	
	EN-WAT-4	**Minimise use of potable water for cooling system**		B
		Potable water consumption of water-based heat rejection system is predicted to be reduced by: 90% OR 50% OR According to design documentation, no water-based heat rejection systems will be provided.	Dsn	
	EN-WAT-5	**Install water meters for all major water uses in the project**		B
		Design documentation indicates that a water sub-metering system will be provided for high water-usage operations (e.g. irrigation, cooling tower) or for tenants.	Dsn	
		ADDITIONAL: All water sub-meters will be linked to BMS to monitor water consumption data and to enable detection of water leakage.		
Issue	**Sub-Issues**	**Criteria & Benchmarking**	**Assessmt. Phase**	**Spatial Scale**
EC: ECONOMIC				
	TBL: Triple Bottom Line Accounting – Planet, People, Profit			

EC-TBL-1	**Refer to Environmental Impact Assessment (EIA) report**		C
	Evidence suggests that the preliminary EIA report prepared by environmental experts (if available) has been referred to by the project team during the design process.	Dsn	
EC-TBL-2	**Assess and evaluate the quality of workmanship of construction works**		B
	N.A.	C&C	
EC-TBL-3	**Consider both capital/construction and operational costs**		B
	LCC has been carried out for major sustainable/green building features and systems and the calculation results of savings by adopting the features and systems, as well as their payback period are available. It shows that the number of major green building features and systems included in the analysis is: ≥ 10 OR ≤ 5 OR < 5 *<u>Note:</u> The economic analysis shall be in form of life-cycle costing (LCC) approach, with the considerations of capital cost, construction and installation cost, operation and maintenance cost, decommissioning cost, life of the building/component/system, interest rates, discount rates and other significant factors that may affect the LCC results. The LCC process shall be a co-operation among the Client, Designer and Quantity Surveyor.* *Sustainable/Green building features and systems include, but not limited to:* *High performance building envelope* *Energy efficient lighting* *Stormwater management* *Chiller heat recovery* *Waterside economizer cycle* *Desiccant dehumidification* *Materials selection for the project* *Rainwater harvesting* *Greywater recycling systems* *Evaporative condensers* *Indirect and direct evaporative cooling* *Ventilation air heat recovery* *Radiant cooling* *Renewable energy systems* *Enthalpy heat recovery* *Displacement ventilation* *Variable Speed Drive*	Dsn	
EC-TBL-4	**Conduct Triple Bottom Line before deciding to pursue with the project**		O
	N.A.		
EC-TBL-5	**Manage the performance risks associated with new and untested sustainable building products and technologies**		O
	If new and untested building products and/or technologies are selected, contract documents expressly state such products and/or technologies are new, and that their selection or recommendation does not constitute a warranty of performance. OR Contract documents clearly spell out who is responsible for the selection of products and technologies to be used, so that the parties can adequately address the risks assumed and planned accordingly, including cost estimates. *<u>Note:</u> Performance risks center around the ability of products, systems and buildings to perform in a sustainable/green environment. New products and technologies are being developed to meet the increasing demand for sustainable/green construction. Many 'environmental-friendly' products and technologies are in their infancy in terms of field testing; hence disputes may arise regarding who bears the risk of failure or poor performance. Only time will tell whether the new products and technologies will actually perform as promised.*	Dsn	
EEF: Efficiency, Effectiveness and Flexibility			

EC-EEF-1	**Develop and implement a long-term maintenance management plan**		B
	An explicit plan exists for future preventive and corrective maintenance and efficient operation of the facility, covering all technical systems, and providing performance targets, system maintenance and replacement guidance over a 25-year period; OR … over at least a 10-year period.	Dsn	
EC-EEF-2	**Provide and operate an effective building management control system**		B
	A systematic tool called Central Control and Monitoring Systems (CCMS) or Building Management System (BMS) will be provided and its capability is consistent with the complexity of building systems; AND the system will enable the followings: - The operation status monitoring of various major electrical and mechanical installations, such as lift & escalator, electrical system, chiller plant, boiler plant, pumping system, water circulation systems, fire and smoke alarm system, and security system; the daily automatic monitoring of operation such that system faults and abnormal operations can be identified at an early stage; the recording of operating history hence helping the building operator to establish an effective maintenance plan.	Dsn	
	ADDITIONAL: - The operation control of various major electrical and mechanical installations as described above, to minimise failures due to human errors. *Note: If a fire is detected, then the system could be used to prevent the smoke from spreading by opening exhaust dampers and closing outdoor air intake dampers of the fire floor and send all elevators to the ground floor and park them to prevent people from using them in the event of a fire.*		
	ADDITIONAL: - The automatic control and monitoring of lighting installations according to the scheduled occupancy programme. *Note: Energy management and control system should be considered in any building exceeding 40,000sqft or 3700 sqm of gross area. A Building Management System (BMS) manages the following systems:* - *Building Automation System (BAS) that provides automatic monitoring, interaction and management for electricity, lighting, plumbing, ventilation and air-conditioning, water supply and drainage, and environmental control systems at a simple control centre.* - *Security Automation System (SAS) – addressed by other credit.* - *Fire Automation System (FAS) – addressed by other credit.*		
EC-EEF-3	**Provide comprehensive building records to operating staff and owners**		O
	Tender Specification clearly specifies the requirements comprehensive building records from the Contractor. *Note: The building records shall comprise, but not limited to the following items:* - *Documented design intent – building, structural, drainage, site formation, alterations and additions plans approved by the Local Authority.* - *Building services as-built drawings – fire services, underground drains, drainage, water supply, electrical, lighting, broadcasting, gas supply, HVAC, etc.* - *Layout plan for hidden utilities – electricity cables, gas pipes, telephone lines etc.* - *Operations and maintenance manual for building services, mechanical components and installations;* - *Testing and commissioning report*	Dsn	
EC-EEF-4	**Spatial flexibility for different users/requirements**		B
	Saleable/rental areas can easily be reconfigured to suit different users/requirements by providing open ceiling and removable internal partitions OR No partitions are provided (to be installed by tenants)	Dsn	

	ADDITIONAL: Saleable/rental areas are designed with minimum interior finishing and fittings to minimise waste generation. OR Potential buyers and tenants are allowed to provide their own choices of internal finishing and fittings before completion of construction works to minimise waste generation.		
EC-EEF-5	**Provide building services systems with maximum flexibility for different users/ requirements**		B
	<u>Ease of adapting HVAC systems to changing occupant requirements:</u> With a minimum adjustment, the existing HVAC delivery systems and associated control systems, can accommodate all basic types of layout from open-plan to cellular layout and also accommodate added functions such as copier or meeting rooms, hence changes in layout will result in less disruption to user operations. *<u>Note:</u> For instance, a standardized layout for air and water distributions, and installing of air ducts in open ceilings are possible methods to enhance adaptability. Reasonable spare space in chiller plant, boiler plant, heat rejection plant, and centralized air handling plant, to cope with additional installations for future demand expansion. Reasonable spare capacity of air duct and water pipes would result in these be able to cope with loading increase and reduce friction loss in distribution process, thus lower pumping/fan power.*	Dsn	
	ADDITIONAL: <u>Ease of adapting lighting systems to changing occupant requirements:</u> The lighting layout, luminaire type and control system permit easy and rapid changes required for minor changes in office layout, such as from open-plan to cellular, or to add or delete other functions, such as copier or meeting rooms. *<u>Note:</u> For instance, spare capacity of power and control cabling, normal and essential power sources, cable containment, space in distribution boards and switchboards are all important in enhancing the electrical services flexibility. Sufficient space and convenient access to cable containment are also necessary to minimize cable wiring/re-wiring works, and minimize subsequent disturbance to the building occupants.*		
EC-EEF-6	**Perform comprehensive commissioning, and post-occupancy commissioning for all building services**		B
	Tender Specification clearly specifies the requirement for comprehensive pre-commissioning, commissioning and quality monitoring to be performed for all building services (BMS, mechanical, electrical and hydraulic) and the works shall be done in exact accordance with ASHRAE Commissioning Guideline.	Dsn	
EC-EEF-7	**Structural design with maximum adaptability for new uses**		B
	The location and capacity of the building core and the structural grid have been designed to permit an acceptable level of flexibility in the planning of interior spaces and future uses. *<u>Note:</u> Constructing large-span bays, avoiding disproportionately large columns and infrequent changes of floor levels, optimizes the flexibility of the space and increases its appeal for reuse. Placement of shear walls, utility walls and fire separations acknowledges and provides for changing occupant uses.*	Dsn	
EC-EEF-8	**Adequate floor-to-floor height to offer high level of functionality for almost any occupancy**		B
	Adaptation to another building use would result in a high level of functionality of the new occupancy. Floor-to-floor heights are ≥ 3.6m. OR … would result in an acceptable level of functionality of the new occupancy. Floor-to-floor heights are ≥ 3.4m. *<u>Note:</u> Structural elements such as beams reduce the overall effective floor-to-ceiling height. If these are continuous over the entire floor, the floor-to-floor height refers to the height between the floor and the underside of the structural elements.*	Dsn	
EC-EEF-9	**Maximize workspace/directly functional area to total floor are ratio**		B

	Design documentation indicates that the ratio of the total net lettable area (NLA) over the total gross floor area (GFA) of the building, is: ≥85% OR 80-84% *Note: Nett lettable area (NLA) is the gross internal area less common areas, ancillary spaces (corridors, plant room, toilet blocks etc.) and structural/ internal party walls (but not portioning or other non load-bearing walls).*	Dsn	

Issue	**Criteria & Benchmarking**	**Assessmt. Phase**	**Spatial Scale**
INN: INNOVATION			
INN-1	**Innovative strategies and technologies**		O
	The initiative is a technology or process that is considered a 'first' in the World OR The project substantially contributes to the broader market transformation towards sustainable development in the World. OR The initiative is a technology or process that is considered a 'first' in Malaysia OR The project substantially contributes to the broader market transformation towards sustainable development in Malaysia.	Dsn	
INN-2	**Exceeding MOBSA benchmarks**		O
	The solution results in a substantial (e.g. 5% or greater above the specified percentage for the best performance) social/environmental/economic impact targeted by an existing credit.	Dsn	

Note:
Assessment Phase: P-Dsn = Pre-design phase; Dsn = Design phase; C&C = Construction & Commissioning phase; Ops = Operations phase
Spatial Scale: G = Global level: *Impacts on resources specifically identified to be global;* C = Community and regional level: *Impacts on the neighbourhood, community and region;*
S = Site level: *Site-specific attributes;* B = Building level: *Certain construction techniques, attributes of buildings, or types of building materials;* and O = Other: *Criteria that do not fit the above.*

Although Table 9.3 only includes performance benchmarks applicable to the design phase of assessment, the table shows all criteria (86 in total) in the Validated Comprehensive MOBSA framework with their respective spatial scale. Table 9.4 shows the distribution of criteria by spatial scale in the Validated Comprehensive MOBSA Framework compared to the those in the Tentative MOBSA framework proposed based on literature review in Chapter Four. It indicates that criteria at the building scale remain the majority in both frameworks; however, those with the scales broader than the site level are reduced from 24% in the tentative framework to 16% in the validated framework. Nevertheless, a percentage of 16% criteria at the community/regional and global levels is significantly higher than the percentage in the Singapore's Green Mark (4%), China's Three Star System (8%), and Malaysia's GBI (11%) and comparable with other building performance assessment systems reviewed in Chapter Four (refer to Table 4.6).

Table 9.4: Comparison of distribution of criteria by spatial scales between Tentative and Validated Comprehensive MOBSA Frameworks

Spatial Scale	**Tentative MOBSA framework (Chapter Four)**		**Validated Comprehensive MOBSA Framework**	
	No. of criteria	Percentage	No. of criteria	Percentage
Global level	2	2%	1	1%
Community & regional level	23	22%	13	15%
Site level	12	12%	8	9%
Building level	56	55%	52	61%
Other	9	9%	12	14%
Total	102	100%	86	100%

Clearly, the MOBSA framework had gone through various stages of development and refinements. The process began by developing a tentative framework based on literature, and subsequently added, omitted or refined based on opinions from interviewees, focus groups and the construction industry at large. The refinement process then ended with a validation by relevant stakeholders. To understand which criterion was added, omitted or refined in what stage, a table was composed and this can be referred to in **Appendix G**.

9.5 Conclusion

This chapter has addressed the research question of what could be the relevant form of a MOBSA framework. It was done by proposing tentative local performance benchmarks and the applicable life-cycle phase(s) of assessment to the 88 criteria in the Stage-3 MOBSA framework developed in the previous chapter. The tentative benchmarks were derived theoretically, empirically and by expert opinion.

The suggested tentative Comprehensive MOBSA framework was presented to local building experts to examine the realisability of the benchmarks in current practice. The summary of their comments, the resulted modifications made to the framework in general, and the benchmarks in particular, have been presented in Section 9.4 in a form of Validated Comprehensive MOBSA framework applicable to all phases of assessment. Due to the length of this framework, this chapter has only shown a part of the framework i.e. called Validated MOBSA Framework for the Design Phase[3].

The next chapter will apply the Validated MOBSA Framework for the Design Phase on a real life case study project to further refine the benchmark empirically and to identify any criteria that suffer missing data.

[3] Refer to Appendix F-2 for the complete version of the Validated Comprehensive MOBSA framework.

Chapter 10: Application of the MOBSA Framework for the Design Phase – A Case Study

10.1 Introduction

The aim of this chapter is to show how the framework may be applied in real life, and consequently addressing the final research question: “Will there be any criteria that would suffer missing data when applied to a case study building? If so, to what extent is the sensitivity of those criteria to be an integral component of the assessment framework?” The thesis will focus on applying the Validated MOBSA Framework for the Design Phase only (as presented in the previous chapter), which contains a portion but the majority of criteria in the Validated Comprehensive MOBSA Framework. In other words, only the criteria under the control of designers are applied in the case study.

In doing so, a scoring system to enable the application of the Validated Comprehensive MOBSA framework is first described by recalling the important levels proposed in the Stage-3 MOBSA framework in Chapter Eight. The criteria applicable to the design phase of assessment (including their appropriate benchmarks and the proposed scoring system) are then extracted from the framework and subsequently applied on the case study building by running an assessment using archival data available at the end of the design stage, as well as inputs from key project stakeholders. This application enables the benchmarks to be further refined empirically and any criteria with missing input data to be identified. Additionally, the case study assessment results between Validated MOBSA Framework for the Design Phase and Green Mark Version NRB/3.0 are compared and discussed.

10.2 Scoring System to Enable Application

As the framework developed in this study uses a criteria-based passive system which assigns point values to assessment criteria, it is considered necessary for a scoring system (i.e. a system to facilitate the process of deriving the final building performance score of an assessment) to be developed before the Validated Comprehensive MOBSA framework could be applied in real life. As reviewed in Chapter Four Section 4.5.5.5, the method of deriving the final assessment score depends on the methodology of weightings adopted in the framework. For instance, on one hand, LEED and GBI assign different total points available for each sustainability issue to reflect the relative weighting of the issues, and use a “simple additive scoring methodology” where the total scores are obtained from simply adding up all the points. On the other hand, BREEAM, SBTool, and Green Star for instance, use “additive weighing scoring methodology” where the detailed performance scores of assessment issues are weighted before the final building performance score is derived. In both approaches, a certain number of maximum points are assigned to each criterion. The difference between the two is that the latter approach assigns and applies weightings to the detailed performance scores to obtain a summarized score. It should be noted that weightings, if adopted in the MOBSA framework, could be a means to differentiate the relative importance of sustainability issues between different parts of Malaysia to reflect its local context. Weightings could also be a means to differentiate the relative importance of sustainability issues between different phases of assessment. For example, human health and well-being issue may have higher weightings if assessed during operation phase than design phase. It is therefore deemed appropriate for the study to adopt the latter approach by combining points and weightings in order to establish the priorities among the issues so that the final result of assessment will be more meaningful.

Obviously, the MOBSA framework proposed in this study has been structured hierarchically in three levels, with the higher level logically derived from the lower ones: 1) Performance Issue; 2) Performance Sub-Issues; and 3) Performance Criteria. Accordingly, it is considered reasonable for the framework to provide a three-tiered weighting structure, as follows:

- The number of points allocated to each Criterion is effectively a weighting between Criteria within a Sub-Issue;
- Individual weighting percentage is assigned to each Sub-Issue and Issue.

It is important to note that these points and weightings are assigned on the basis of recalling the important levels indicated in the Stage-3 MOBSA framework in Chapter Eight, as discussed below.

10.2.1 Assigning Number of Points

Stage-3 MOBSA framework proposed in Chapter Eight highlights the important level of each performance criterion as either high (H), medium (M) or low (L). Hence, it is proposed for the maximum number of point(s) allocated to each criterion to reflect its important level, by using the following scale:

- High: 3 points

- Medium: 2 points
- Low: 1 points

However, as highlighted in the previous chapter, stakeholders have provided cogent insights for the study to consider assigning higher points to criteria that are very essential in contributing to sustainability in a long-term, and lower to those that are considered as short-term benefits. Accordingly, the maximum number of points for a few criteria was adjusted as shown in Table 10.1.

Table 10.1: Adjusted maximum points available according to stakeholders' comments during the validation process

Criteria	Important Level	Adjusted Max. Number of Points
S-HUM-13: Adequate monitoring of occupants' satisfaction with indoor environmental quality	M	3
E-LAN-5: Minimize land pollution from site workers' accommodation	M	1
E-EWA-2: Minimize storm sewer or stream pollution from site workers' accommodation	M	1
EN-ENE-3: Use passive cooling strategies	H	4

Another aspect worth noting is the fact that the framework adopts both quantitative and qualitative criteria of which each type has different way of allocating points. For instance, quantitative criteria can be readily evaluated on the basis that "the better the performance, the more points are awarded" (Cole, 1998). In other words, the scores are presented on a scale that give more points for a given increment in performance as the overall performance level increases. The rationale being that it becomes increasingly more difficult to attain performance improvements. For instance, two points may be awarded if the green space allocated is equal to or more than 20% of the site area, and one point if it is less than 20%. On the other hand, the qualitative criteria can be evaluated on a 'feature-specific' basis, where points are awarded for the presence or absence of desirable features (Cole, 1998). For instance, points should be awarded if all new occupants have received a simple and easy-to-use building users' guide and no points if they have not.

10.2.2 Assigning Weightings

Similar to performance criteria mentioned above, Stage-3 MOBSA framework also highlights the important level of all 3 Issues and 17 Sub-Issues as high, medium or low. However, these important levels are not used directly in calculating the weighting values of each sustainability Issue, as they differ slightly from results obtained from in-depth interviews as discussed in Chapter Six. It should be noted that results from both data collections indicate that “Environmental Protection” and “Human Well-being Enhancement” are deemed more important than “Economic Development” (refer discussion in Section 8.3.3.5, Chapter Eight). Hence, their mean values, as indicated in both Chapters Six and Eight, were averaged and consequently used as the basis of deriving their weighting values. Each Issue’s weighting percentage is calculated as the average mean value of that Issue divided by the total average mean values of all Issues multiplied by 100. Results are shown in Table 10.2. It is believed that the proposed weighting percentages are in accordance with the important levels as indicated in the Stage-3 MOBSA framework.

Table 10.2: Proposed weightings for Sustainability Issue of MOBSA Framework

Sustainability Issues	Code	Mean: Interview (refer Table 6.6)	Mean: Questionnaire (refer Table 8.6)	Average Mean	Proposed Weightings*	Important Level**
Social	S	3.7	3.5	3.6	34.3%	H
Environmental	EN	3.6	3.6	3.6	34.3%	H
Economic	EC	3.5	3.1	3.3	31.4%	M
Total				10.5	100%	

Note:
* Proposed weighting value for each Issue is calculated as the average mean value of that Issue divided by the total average mean values of all Issues multiplied by 100. For example, the proposed weighting value for “Social” Issue was calculated as (3.6/10.5) x 100 = 34.3%.

** The important level of each Issue is brought here from the Stage-3 MOBSA framework in Chapter Eight. H = high and M = medium.

With regard to the 17 Sub-Issues, their weightings were assigned using the same scale system used to reflect the important level of each Criterion, as mentioned earlier; for example, Sub-Issue with high important level is assigned with 3 points, medium with 2 points, and low with 1 point. Proposed weighting percentage for each Sub-Issue is calculated as the scale value of that Sub-Issue divided by the total scale values of all Sub-Issues within an Issue multiplied by 100. Given these percentages, the total weighting percentage for all Sub-Issues within each Issue would always be 100%.

10.2.3 Proposed Scoring System

Taking aforementioned measures into consideration, Table 10.3 shows the total number of points available and weightings proposed for the MOBSA Framework for the Design Phase (as presented in the previous chapter) to enable it to be applied on a case study building. Meaning, these available points are only based on criteria applicable for the design phase of assessment. The detailed points system proposed for all phases of assessment (i.e. Validated Comprehensive MOBSA Framework) is provided in Appendix H-2; whereas a table showing the distribution of total points available by phases of assessment is provided in Appendix H-1.

Table 10.3: Proposed number of points available and weightings for the Validated MOBSA Framework for the Design Phase

Sub-Issues	Points Available	Important Level **	Scale	Proposed Weightings ***	Net Weightings ****
S: Social				**34.3%**	
EDU: Education & Awareness	8	H	3	18.2%	6.24%
COH: Support for Social Cohesion	9	M	2	12.1%	4.15%
ACC: Accessibility	11	H	3	18.2%	6.24%
INC: Inclusiveness of Opportunities	7	M	2	12.1%	4.15%
HUM: Human Health & Well-being	27	H	3	18.2%	6.24%
CUL: Cultural & Heritage Aspects	2	M/L	1.5	9.1%	3.12%
LOC: Local People & Employment	6	M	2	12.1%	4.15%
Total EDU+COH+ACC+INC+HUM+CUL+LOC	70	-	16.5	100%	34.3%
Environmental				**34.3%**	
ECO: Land Use & Impacts on Ecology	9	H	3	15%	5.15%
SRM: Supports Resource Management	10	M	2	10%	3.43%
AIR: Emissions to Air	2	H	3	15%	5.15%
LAN: Emissions to Land/ Solid Waste	11	H	3	15%	5.15%
EWA: Emissions to Water	5	H	3	15%	5.15%
ADJ: Impacts on Adjacent Properties	2	M	2	10%	3.43%
ENE: Non-Renewable Energy Consumption	25	M	2	10%	3.43%
WAT: Potable Water Consumption	12	M	2	10%	3.43%
Total ECO+ SRM+AIR+LAN+EWA	76	-	20	100%	34.3%
Economic				**31.4%**	
TBL: Triple Bottom Line Accounting	8	M	2	40%	12.56%
EEF: Efficiency, Effectiveness & Flexibility	22	H	3	60%	18.84%
Total TBL+EEF	30	-	5	100%	31.4%
Innovation	4	N.A.		N.A.	N.A.

Note:
** The important level of each sub-issue is brought here from the Stage-3 MOBSA framework in Chapter Eight. H = high; M = medium; L = low.

*** Proposed weighting value for each Sub-Issue is calculated as the scale value of that Sub-Issue divided by the total scale values of all Sub-Issues within an Issue multiplied by 100. For example, the proposed weighting value for EDU Sub-Issue was calculated as (3/16.5) x 100 = 18.2%
Weightings should be adjusted to ensure that the total weighting of all active/applicable Sub-Issues within each Issue is always 100%.

****Net weighting value for each Sub-Issue is calculated as the proposed weighting of that Sub-Issue multiply by the proposed weighting of the relevant Issue of which the Sub-Issue is fall under. For example, the net weighting value for EDU Sub-Issue was calculated as 18.2% x 34.3% = 6.24%.

It is proposed that the single (overall) score of a project to be determined by taking the following steps:

1. Calculate each sub-issue score;
2. Apply the weighting to each sub-issue;
3. Add all weighted sub-issue scores within each issue together;
4. Apply the weighting to each issue;
5. Add all weighted issue scores together;
6. Add any innovation points that may have been achieved.

A simpler way of deriving the overall score which will result in similar outcome as above is as follows:

1. Calculate each sub-issue score;
2. Apply the net weighting to each sub-issue;

3. Add all weighted sub-issue scores within each issue together;
4. Add any innovation points that may have been achieved.

An example of scoring calculation is provided later in the chapter to demonstrate how the final performance score of the case study building was derived.

It has been previously argued in Chapter Four that the assignment of weightings to the various performance issues is the most contentious part of the framework of any building performance assessment systems. Therefore, it is acknowledged in this research that the proposed weightings percentages are indefinite; hence, should be adjusted by consensus if necessary, while keeping to their relative level of importance and total weightings of all active/applicable sub-issues to always be 100%.

10.3 The Case Study Building

10.3.1 Reason for Selection

The Energy Commission Diamond Building (Energy Commission, 2011) which was completed and occupied in the middle of 2010 is the third showcase energy efficient and sustainable building in Malaysia after the completion of Low Energy Office (LEO) Building for the Ministry of Energy, Water, and Communications in 2002 (Lojuntin & Mahmood, 2006) and the Green Energy Office (GEO, or formerly known as ZEO or Zero Energy Office) Building for the Malaysia Energy Centre in 2007 (Kristensen*, et al.*, 2007). The Diamond Building is located in Putrajaya, the federal administrative centre of Malaysia, and claimed to be the first showcase sustainable and energy efficient building in Putrajaya (Energy Commission, 2007), which is the main reason for the project being selected for the study. At the early design stage, the Energy Commission had set a high goal for the project, inspiring the design team to aim for the highest rating of the Singapore's BCA Green Mark Version NRB/3.0, i.e. the Green Mark Platinum (Energy Commission, 2007). Further, the building is also currently in the process of being assessed and rated by the Malaysia Green Building Index (GBI) system.

As such, the building was designed and built with consideration to the following aspects: reduction in fossil fuels; water conservation; sustainable building materials waste minimisation and avoidance; indoor environmental quality; traffic and transport management; and construction and demolition management plan (Energy Commission, 2011). Because Energy Commission is the building's owner-occupier, it wanted an environmentally conscious building with a conducive working environment that would improve employee comfort and productivity while reducing operating costs (Energy Commission, 2007).

10.3.2 Design Overview

The Diamond Building is an eight-storey office building with a total gross floor area of 14229 square metre, consisting of a one-storey podium of commercial, office, and gallery spaces; and a seven-storey office spaces as well as two storeys of basement parking. The design concept evolved from early design decisions to be slanted downwards and inwards derived from a contemporary interpretation of the distinctive diamond form, which symbolizes Value, Transparency and Durability (see Figure 10.1). These characteristics represent the Energy Commission's role and mission as a regulatory body (Energy Commission, 2011). The building is orientated in the North, East, South and West directions with the front façade facing the West. While all other façades have a free line of sight to the horizon, the West façade of the podium is partly shaded by the adjacent Immigration Building. Among the facilities provided in the building are a library, nursery, theatrette, dining/multipurpose hall, prayer room, gymnasium, and meeting rooms. A typical floor plan, typical section, basic information, and photos of the building's atrium and facade lightshelf are shown in Appendix I.

NOTE:
This figure is included on page 311 of the print copy of the thesis held in the University of Adelaide Library.

Figure 10.1: The Energy Commission Diamond Building: North & East facades. Source: www.st.gov.my

The building design has incorporated essential green features and strategies under the following five categories, namely: 1) sustainable site; 2) energy efficiency; 3) indoor environmental quality; 4) materials and resources; and 5) water efficiency. Incorporated features under each category are summarized in Table 10.4. The table also describes the incorporated technologies that are considered the 'first' in Malaysia. As the project is fairly new, it is acknowledged that this summary was derived from two main sources, namely: 1) the researcher's personal visit to the building on the 28th of January 2010, guided by the key consultants of the project; and 2) archival data i.e. tender/contract documents, Green Mark assessment reports, and drawings of the project provided by the client.

Table 10.4: Summary of green features and strategies incorporated in the Diamond Building

Category	Incorporated features and strategies
Sustainable Site	1. A variety of native and adapted plantings to limit the need for irrigation; 2. Pervious grasscrete pavers over most paved areas (except walkways) to increase the site's water absorption capacity and reduce stormwater runoff; 3. Zoysia grass for the green roof which makes up 17% of the total roof area; 4. Access to shuttle bus services – available less than 500m away by walking; 5. Bicycle racks and shower rooms; 6. Car parking capacity that meets but do not exceed the minimum local zoning requirements.
Energy Efficiency	Passive Design (Building Envelope) 1. Overall diamond shape which is self-shading; 2. Two daylight systems, namely: a. atrium daylighting with the following design features: 1) automatic roller-blind system; 2) reflective Tannenbaum panels on the fourth and fifth floors to direct light to the first and second floors; and 3) differentiated window sizes for each floor; b. facade lightshelf with fixed blinds for glare prevention. 3. Flush curtain wall facades with double glazing. Low-e glazing for east and west facades; *Result: The calculated Envelope Thermal Transfer Value (ETTV)*[1] *for the building is 35.6 W/m^2.*
	Passive Design (Space Planning)
	1. Open office planning in the perimeter zones to increase access to daylight in most workspaces; 2. Enclosed offices are located inboard to provide more equitable distribution of daylight in office areas. Where perimeter enclosed offices are provided, the design of office fronts incorporate as much glass as possible to provide borrowed light to the interior.
	Active Design Strategies 1. Two cooling systems, as follows: a. floor slab radiant cooling[2] (sensible load only) which helps to reduce the air handling unit (AHU) fan energy consumption; and b. one AHU (sensible and latent loads) per floor except the ground floor which are all fan coil units (FCUs). The AHUs are variable-air-volume (VAV) system, controlled by the room temperature sensor, where the air flow rate is reduced at different zones when the temperature varies. *Result: The calculated percentage of improvement in the efficiency of air distribution equipment is 60.8%;* 2. Demand controlled ventilation by providing carbon dioxide sensor at all return ducts; hence, more fresh air is brought into areas whenever the carbon dioxide concentration reaches 1000 parts per million (ppm); 3. A heat pipe in the primary AHU on the rooftop to remove the moisture from fresh air that is passed through the AHU. This keeps the air dry in the building to ensure that there is no possibility of condensation on the surface of the chilled floor slab while

[1] ETTV is a design criterion for building envelope, applicable only to air-conditioned buildings. In an air-conditioned building, the solar heat gain through the building envelope constitutes a substantial share of cooling load. The ETTV aims at achieving the design of building envelope to minimise heat gain thus reducing the overall cooling load requirement. According to Green Mark Scheme (BCA Singapore, 2010), the maximum permissible ETTV is 50W/m^2.

[2] Radiant cooling from the floor slab is achieved by cooling the floor slabs with chilled water to the desired temperature of 18-20 Degree Celsius. The cold water pipes (PERT) are embedded in the concrete slab which is supplied with chilled water to cool the slabs for providing cooling to the building.

	reducing sensible heat cooling by the cooling coil; 4. Energy efficient electric lighting in office areas; 5. Energy efficient lifts; 6. Motion/occupancy sensors in the toilets to switch on the lighting and ventilation; 7. Light sensors to switch light automatically off when the light level is enough; however, the light can only be switched on manually; 8. Shower drain water heat recovery system to help reduce the energy consumption required to heat the water for shower. *Result: Efficiency about 35%.*
	Renewable Energy Photovoltaic (PV) system on the rooftop. The total PV capacity is 71.4 kilowatts-peak (kWp), which is estimated to meet about 8.6% of the energy needs of the building.
	Overall Results: *1. The savings that contribute to total building energy reduction was estimated to be 10%;* *2. The building energy index (BEI) was targeted to be 85 kWh/m2/yr, in contrast with the standard index of 135 kWh/m^2/year, as stipulated in the MS1525.*
Indoor Environmental Quality	1. The relative humidity in the building is set at 65%; 2. The operative temperature[3] is kept at around 24 degree Celsius during occupancy hours; 3. Attenuators as silencers for the ventilation system to control the sound power level of the fan; 4. Low-emitting products and materials that complies with the requirement of the Singapore Green Labelling Scheme (SGLS), as follows: a. low VOC paint; b. Boral Plasterboards for the suspended ceiling and internal partitions; and c. Shaw carpets for more than 90% of the spaces.
Materials & Resources	1. Environmental friendly programmes, including: a. allocating recycling bins on site to allow wastes (i.e. metal, wood, brick, glass, plastic, paper, cardboard) to be sorted on-site which were then collected and sent to recycling facilities; b. sending steel to recycling facilities; c. sending waste concrete back to the sub-contractor to be used as backfill and hardcore; and d. putting up signs to remind site workers to save energy. 2. Recycling facility in the building; 3. Recycling bins near loading and unloading dock on the ground floor.
Water Efficiency	1. Water efficient fittings and fixtures, as follows: a. dual flush cisterns; b. fittings with a 2L/min water saving aerators; c. showerhead with a 4L/min water saving aerators; and d. waterless urinal with EcoTrap[4], but water tap is also provided for Muslim users. *Result: 70% of potable water used for toilet flushing and washing can be saved.* 2. Rainwater collection for toilet flushing and landscape irrigation which covers more than half of water load required for the building. Rainwater is collected from the crown of the dome roof where it is directed to four rainwater tanks located on the roof with the total rainwater storage capacity of 9.2 cubic meters; 3. Grey water recycling for landscape irrigation. 4. Water efficient irrigation system used for 77% of the landscape area i.e. two subsurface drip irrigation pipelines; one for grey water and the other for rainwater.
Local Economy	Built within the local economy, utilizing local materials, including concrete, steel and glass, within the experience of local trades.
First innovative technologies in Malaysia	1. Shower heat recovery system; 2. Grey water recycling system; and 3. Advanced automatic control of blinds in atrium for daylighting.

[3] Operative temperature is the average of air temperature and mean radiant temperature.

[4] EcoTrap is a special drain insert, containing a layer of BlueSeal liquid that floats on top of the urine in the trap and forms a barrier against sewer vapour escape.

10.4 Framework Application Method

For the purpose of applying the proposed framework on the aforementioned case study building, this chapter focuses on the Validated MOBSA Framework for the Design Phase (presented in the previous chapter), which contains a fraction but majority of the criteria in the Validated Comprehensive MOBSA framework. The framework was applied by running an assessment of the project using archival data available at the end of the design stage, including tender/contract documents and drawings, and reports related to the building design.

It is important to note that the purpose of this application process was not solely to obtain the total score of the case study building's assessment result. More importantly, it was to identify any difficulties in obtaining input data to complete the assessment, and to further refine the proposed benchmarks and weightings based on empirical data. Therefore, to a certain extent, inputs from four key projects stakeholders were sought. These include the client's project manager, architect, energy manager, and mechanical and electrical engineer.

Their inputs were sought via verbal and electronic communications for assessing the qualitative criteria such as those related to management, process, and communication were applied, e.g. maintenance management, skills and knowledge, participation and inter-disciplinary work. They were particularly requested to select the appropriate points that should be awarded for the criteria under their investigation, including any supporting documents or a brief explanation for the suggestions made. In doing so, any benchmarks which requires adjustment or suffer with unavailable data could be identified. In addition, they also received a few quantitative criteria assessed and scored by the researcher for verifications and comments. In average, each of these consultants was assigned with ten criteria which fall under their area of expertise or responsibility.

10.5 Framework Application Results and Discussion

10.5.1 Adjusted Benchmarks

All consultants provided a brief comments or explanation to justify their proposed score of the allocated criteria. However, only three comments led to the necessity for previously developed benchmarks to be further adjusted and these adjustments are shown in Table 10.5. It is important for this table to be read in conjunction with the proposed benchmarks in the Validated MOBSA Framework for the Design Phase in Table 9.3 to comprehend the adjustments made.

Table 10.5: Adjustments made to three criteria based on consultants' comments

Criterion	Consultant	Summary of Comments Made
S-INC-3 Facilities for users with children	Architect	*A nursery is provided on level 1 with a pantry and washrooms. The actual nursery space however is to be fitted out by the end user. Mothers' room is therefore yet to be provided.*
		Amended benchmark
		The design provides a crèche area and a mother's room together with a pantry and washrooms to cater for building users (and if necessary, users of neighbouring blocks) to enhance their quality of life.
EC-TBL-3 Capital cost & long-term operational costs	Mechanical & Electrical Engineer	*Capital and operation cost evaluation has been carried out in the beginning of the project. While not exactly presented in LCC format, ROI of the options were weighted and chosen based on the following (not in order):* • *Capital Cost* • *Constructibility* • *Maintainability* • *Efficiency* • *Operation cost* • *Payback period* *Variable speed drive is considered base, and capital cost for the radiant cooling and thermal mass storage system is equivalent to the base variable volume air system.*
		Added benchmark
		OR ROI of major sustainable/green building features and systems have been weighted and chosen based on the following (not in order): - Capital Cost - Constructibility - Maintainability - Efficiency - Operation cost - Payback period It shows that the number of major green building features and systems included in the calculations is: ≥ 10 OR ≤ 5 OR < 5
EC-EEF-1 Long-term maintenance management plan	Mechanical & Electrical Engineer	*Comprehensive facility management plan with 3 year budget will be made available by the facility management contractor. Currently in progress. Although there can be preventative maintenance plan for 25 years, the plan will not cover details. Generally, detail plans should be drafted every 3 years. This will be a guide for facility management contracts.*
		Added benchmark
		ADDITIONAL: The plan is more detailed with budget allocation for the first 3 years as the basis to guide FM contracts.

10.5.2 Unavailable data

All criteria which are relevant to the design phase of assessment are most likely to be assessable or realisable in the current practice with limited risk of data unavailability, except for one criterion, namely "EN-SRM-1: Increase use of materials that have less environmental impact in producing them", which falls under the Environmental Sub-Issue of "Supports Resource Management". The assessment of this criterion requires an estimation of the embodied energy of materials used in the structure and building envelope. The implementation of this criterion was found to be currently unpractical due to the following reasons:

- The collection of the requisite building information to enable an embodied energy analysis requires disproportionate amount of effort; and
- Sufficient comprehensive energy intensity characteristics on the various building materials and components are currently unavailable.

The extent of the sensitivity of this criterion to be an integral part of the MOBSA framework is identified and discussed in the next section.

Another point worth noting is regarding the usage of green products to promote a healthy indoor environment. In particular, such aspect is assessed under "S-HUM-8: Use interior finish materials with low- or zero-pollutant off-gassing". As mentioned earlier in Table 10.4, the case study building uses three Singapore Green Labelling Scheme (SGLS) certified products, namely: 1) Low VOC paints; 2) Boral Plasterboard; and 3) and Shaw carpets. Hence, necessary points were awarded for meeting this requirement under the MOBSA framework regardless of the fact that the green labelling scheme referred to was not locally-based. This was inevitable as equivalent green labelling scheme yet to exist in Malaysia. Thus, it is of paramount importance and timely for such scheme to be initiated in Malaysia to promote the supply and demand of green building products in the local markets.

10.5.3 Building Performance Scores and Criteria Sensitivity

The detailed assessment results of MOBSA Framework for the Design Phase are shown in Table 10.6; whereas the proposed score calculation is shown in Table 10.7. In order to illustrate the different results between Sub-Issues and Issues in a clearer manner, summaries of weighted scores for all Sub-Issues and double-weighted scores for all Issues are provided in Figure 10.2 and Figure 10.3 respectively.

Table 10.6: Points achieved by the case study building

Social Sub-Issue	Code	Criteria	Points Available (Av)	Points Achieved (Ac)
Education & Awareness	S-EDU-1	Awareness of building occupants	3	-
	S-EDU-2	Readiness & competency of design team	3	0
	S-EDU-3	Skills & knowledge of maintenance & operation staff	3	3
	S-EDU-4	Skills among construction workers	2	2
		EDU score	8	5
Support for Social Cohesion	S-COH-1	Inter-disciplinary work	3	3
	S-COH-2	Support active streetscape	2	2
	S-COH-3	Space planning for maximum social interaction	2	2
	S-COH-4	Participation of affected community	2	-
	S-COH-5	Participation of users	2	2
		COH score	9	9
Accessibility	S-ACC-1	Personal safety & security	3	3
	S-ACC-2	Maintenance access for building facades	2	1
	S-ACC-3	Access to communication technology	2	2
	S-ACC-4	Maintenance access for all building services installations	2	2
	S-ACC-5	Access to nearby services	2	0
		ACC score	11	8
Inclusiveness of Opportunities	S-INC-1	Universal access	3	0
	S-INC-2	Facilities to perform religious obligations	2	2
	S-INC-3	Facilities for users with children	2	2
		INC score	7	4
Human Health & Well-being	S-HUM-1	Avoid construction accidents	3	3
	S-HUM-2	Level & quality of fresh air	3	0
	S-HUM-3	Openings & cross ventilation	3	0
	S-HUM-4	Noise level & acoustic performance	3	3
	S-HUM-5	Illumination level & artificial lighting quality	3	2
	S-HUM-6	Prohibit tobacco smoking	2	2
	S-HUM-7	Low/zero pollutants cleaning & maintenance	2	-
	S-HUM-8	Interior finish materials with low/zero off-gassing	2	1
	S-HUM-9	Air movement for thermal comfort	2	2
	S-HUM-10	Glare conditions	2	2
	S-HUM-11	Building flush-out	2	2
	S-HUM-12	Areas/rooms which generate pollutants & odour	2	2
	S-HUM-13	Monitoring of occupants' satisfaction with IEQ	3	-
		HUM score	27	19
Cultural & Heritage Aspects	S-CUL-1	Heritage significance of the building or adjoining/nearby heritage buildings	2	N.A.
		CUL score	N.A.	N.A.
Local People & Employment	S-LOC-1	Training opportunities for unskilled local people	3	-
	S-LOC-2	Locally available materials & products	2	1
	S-LOC-3	Local service providers	2	-
	S-LOC-4	Experienced local design teams	2	2
	S-LOC-5	Experienced local contractors	2	2
		LOC score	6	5
Environmental Sub-Issue	**Code**	**Criterion**	**Points Available (Av)**	**Points Achieved (Ac)**
Land Use & Impacts on Ecology	EN-ECO-1	Damage to soil, water bodies, and flora & fauna	3	3
	EN-ECO-2	Landscape spaces on the site	2	2
	EN-ECO-3	Ecological value of natural landscape	2	1
	EN-ECO-4	Risk of flooding	2	2
		Total ECO	9	8
Supports Resource Management	EN-SRM-1	Materials that have less environmental impact**	2	No data
	EN-SRM-2	Building design for maximum durability	2	2
	EN-SRM-3	Bio-based products & materials	2	0
	EN-SRM-4	Materials that can be recovered or recycled	2	0
	EN-SRM-5	Products & materials with recycled content	2	0
		Total SRM	8	2
Emissions to Air	EN-AIR-1	Access to basic services & connection to public transportation network	2	2
		Total AIR	2	2
Emissions to Land/ Solid Waste	EN-LAN-1	Handling & storage of hazardous wastes on site	3	3
	EN-LAN-2	Construction waste management programme	2	0
	EN-LAN-3	Spaces for collection of recyclables	2	0
	EN-LAN-4	Recycling of office recyclables	2	2
	EN-LAN-5	Pollution from site workers' accommodation	1	-
	EN-LAN-6	Standardized & prefabricated components	2	0

		Total LAN	11	5
Emissions to Water	EN-EWA-1	Stormwater management strategies	3	3
	EN-EWA-2	Pollution from site workers' accommodation	1	-
	EN-EWA-3	On-site wastewater treatment systems	2	1
		Total EWA	5	4
Impacts on Adjacent Properties	EN-ADJ-1	Noise & vibration generated during construction	2	0
		Total ADJ	2	0
Non-Renewable Energy Consumption	EN-ENE-1	Energy efficient light fixtures & office appliances	3	1
	EN-ENE-2	Efficient ventilation & air-conditioning systems	3	3
	EN-ENE-3	Passive cooling strategies	4	4
	EN-ENE-4	Integrated lighting concept	3	1
	EN-ENE-5	Fossil fuel energy consumption for operations	3	3
	EN-ENE-6	Size of building systems control zones	3	3
	EN-ENE-7	Automatic lighting control systems	2	1
	EN-ENE-8	Energy sub-metering system	2	2
	EN-ENE-9	Personal control of the thermal comfort systems	2	2
		Total ENE	25	20
Potable Water Consumption	EN-WAT-1	Harvest rainwater	3	3
	EN-WAT-2	Water efficient plumbing fixtures & appliances	3	3
	EN-WAT-3	Potable water for landscaping irrigation	2	2
	EN-WAT-4	Potable water for cooling system	2	2
	EN-WAT-5	Water meters	2	2
		Total WAT	12	12
Economic Sub-Issue	**Code**	**Criterion**	**Points Available (Av)**	**Points Achieved (Ac)**
Triple Bottom Line Accounting	EC-TBL-1	Referring to EIA report	3	N.A.
	EC-TBL-2	Quality of workmanship	3	-
	EC-TBL-3	Capital cost & long-term operational costs	3	3
	EC-TBL-4	Triple Bottom Line	2	-
	EC-TBL-5	New & untested sustainable products & technologies	2	0
		Total TBL	5	3
Efficiency, Effectiveness & Flexibility	EC-EEF-1	Long-term maintenance management plan	3	3
	EC-EEF-2	Building management control system	3	3
	EC-EEF-3	Comprehensive building records	3	3
	EC-EEF-4	Spatial flexibility	3	3
	EC-EEF-5	Building services systems with maximum flexibility	2	2
	EC-EEF-6	Comprehensive commissioning	2	2
	EC-EEF-7	Structural and core layout with maximum adaptability	2	2
	EC-EEF-8	Floor-to-floor height for high level of functionality	2	1
	EC-EEF-9	Directly functional area to total floor area ratio	2	0
		Total EFF	22	19
	Code	**Criterion**	**Points Available**	**Points Achieved**
Innovation	INN-1	Innovative strategies and technologies	3	0
	INN-2	Exceeding MOBSA benchmarks	1	0
		Total INN	Max 4	0

Note:

- Faded criterion means it is not applicable to the design phase of assessment
- N.A. means the criterion is not applicable to the case study building and the point(s) are removed from the total number of points available for the sub-issue.
- "No data" means the criterion is unable to be assessed due to unavailability of data and the point(s) are removed from the total number of points available for the sub-issue.

Table 10.7: Proposed MOBSA framework score calculation

Sub-Issue	Points Achieved	Points Available	% of Points Achieved	Sub-Issue Weighting	Weighted Sub-Issue Score
EDU	5	8	63%	0.197*	12.4
COH	9	9	100%	0.136*	13.6
ACC	8	11	73%	0.197*	14.3
INC	4	7	57%	0.136*	7.8
HUM	19	27	70%	0.197*	13.8
CUL	N.A.	N.A.	N.A.	N.A.	N.A.
LOC	5	6	83%	0.136*	11.3
Total	50	68	74%		
Total weighted Social (S) score					73.2%
Social weighting					0.343
Double-weighted S score					**25.1%**
ECO	8	9	89%	0.15	13.3
SRM	2	8	25%	0.1	2.5
AIR	2	2	100%	0.15	15
LAN	5	11	45%	0.1	6.8
EWA	4	5	80%	0.15	12
ADJ	0	2	0%	0.1	0
ENE	20	25	80%	0.1	8
WAT	12	12	100%	0.1	10
Total	53	74	71.6%		
Total weighted Environmental (EN) score					67.7%
Environmental weighting					0.343
Double-weighted EN score					**23.2%**
TBL	3	5	60	0.40	24.0
EFF	19	22	86	0.60	51.8
Total	22	27	81.5%		
Total weighted Economic (EC) score					75.8%
Economic weighting					0.314
Double-weighted EC score					**23.8%**
				Total Building Sustainability Score	**72.1%**
				Innovation Points Achieved	**2**
				FINAL BUILDING SUSTAINABILITY SCORE	**74.1**

Note:
*Weightings for Social Sub-Issues are adjusted according to the changes in Sub-Issues which remain active/applicable to the case study building. This is to ensure that the total weighting of all active/applicable Social Sub-Issues is 100%. The proposed weightings if all Sub-Issues are active/applicable are shown in Table 10.3.

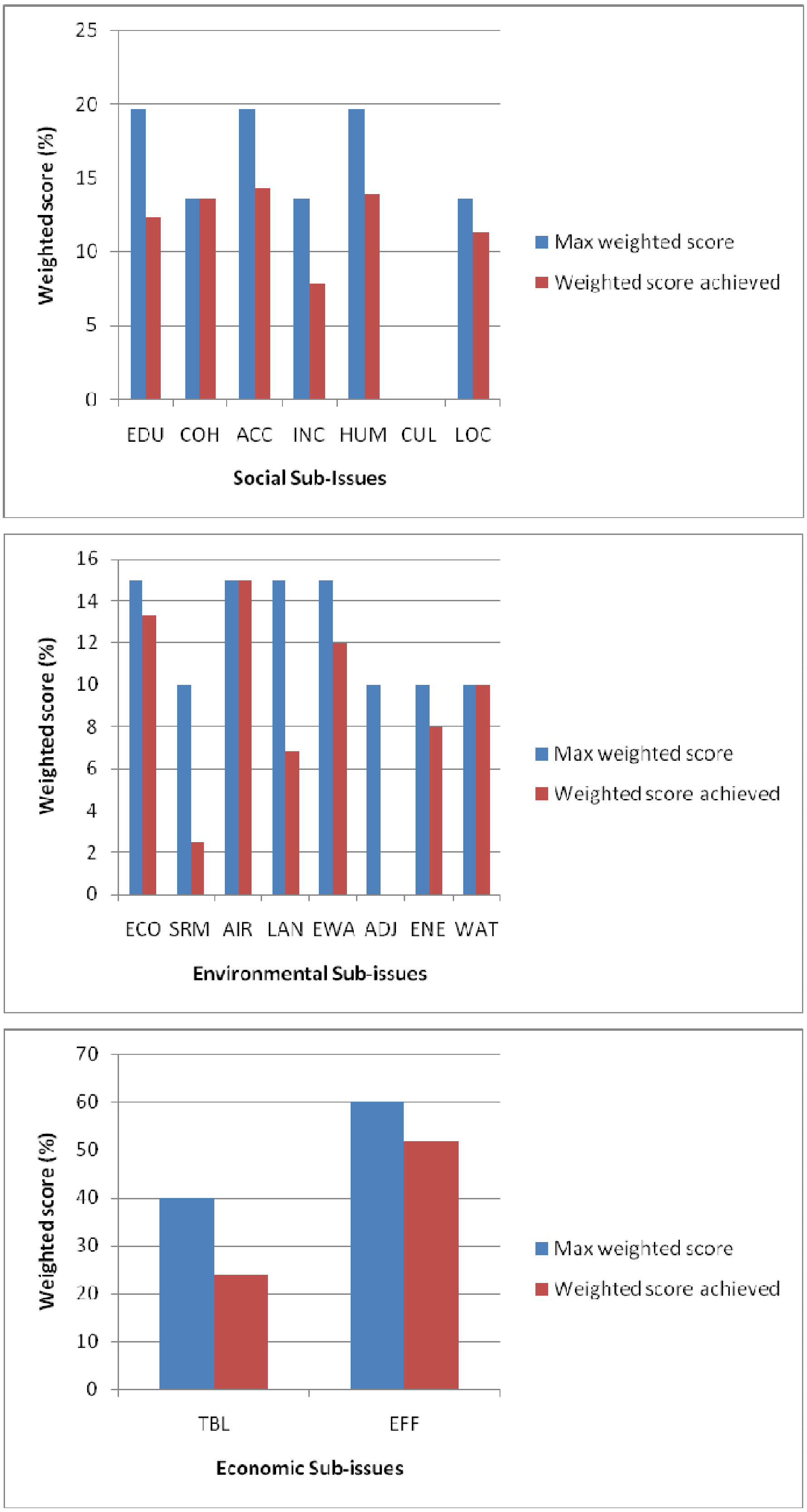

Figure 10.2: Weighted score achieved by the case study building for Social (top), Environmental (middle), and Economic (bottom) Sub-issues

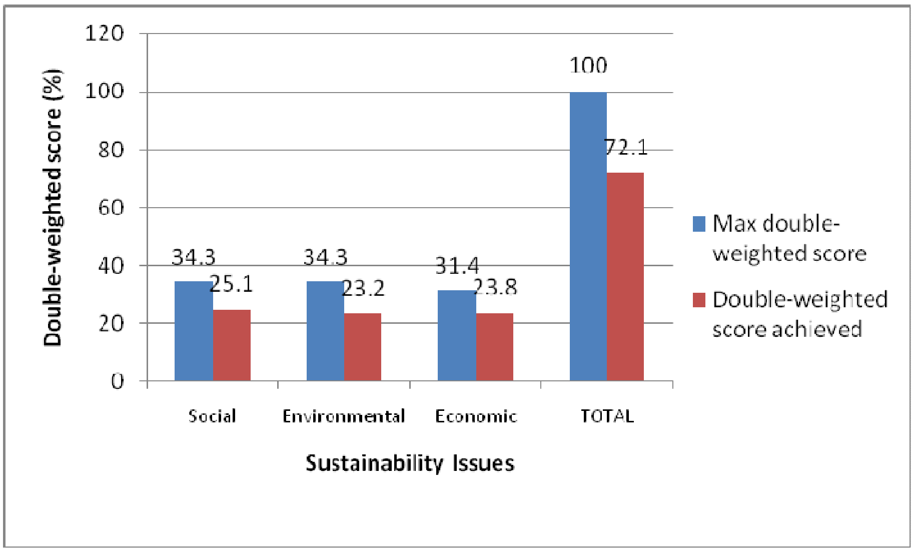

Figure 10.3: Double-weighted and final scores achieved by the case study building for all three sustainability issues

Table 10.7 indicates that the case study building performs poorly on two Environmental Sub-Issues, namely: Supports Resource Management (SRM) and Land Use and Impacts on Ecology (LAN), with less than 50% points achieved. For example, no point could be awarded for the following performance criteria:

- EN-SRM-3: Bio-based products and materials from managed/sustainable sources
- EN-SRM-4: Materials that can be recovered or recycled
- EN-SRM-5: Products and materials with recycled content
- EN-LAN-2: Construction waste management programme
- EN-LAN-3: Spaces for collection of recyclables
- EN-LAN-6: Standardized and prefabricated components

Clearly, these criteria ultimately aim to limit natural resource consumption and to reduce the production of solid wastes. The poor performance on these criteria is unsurprising because the construction and demolition waste treatment and recovery have yet to be commonly practiced in the Malaysian construction industry, and disposing unseparated and reusable wastes in landfills is a common on-going practice (see discussion in Chapter Six Section 6.4.2.2). The reasons for these are: high cost; poor practice of sorting, salvaging and recycling construction and demolition waste, explaining the lack of availability; constant demand for new materials among clients; and inexistence of green labelling system for building materials and components.

Consequently, Environmental Issue obtained the least percentage of points achieved (71.6%), as compared to Social with 74% and Economic Issues 81.5% which represents the highest percentage of points achieved (see Table 10.7). However, this ranking differs after individual Issue is weighted. Table 10.7 and Figure 10.3 show that the doubled-weighted Environmental and Economic scores are comparatively similar (23.2% and 23.8% respectively), but these are smaller than the double-weighted Social score of 25.1%. Despite the fact that Social score is the highest compared to Environmental and Economic scores, all Issue scores seem to be comparatively balanced. Overall, the total building sustainability score of the case study building, without taking into account criterion EN-SRM-1 which suffers missing data, is 74.1%.

Given this overall score, one might wish to question its meaning in terms of the level of rating that the case study building is entitled to. As mentioned in Chapter Four, the minimum score set for the highest rating differs among existing BPASs worldwide. For instance, Green Mark sets as high as 90 out of 100 for its “Platinum” rating; whereas Malaysia GBI and UK BREEAM settle on slightly lower minimum score of 86 for “Platinum” and 85 for “Outstanding” ratings respectively. Interestingly, other BPASs that agree on even lower minimum scores than aforementioned are LEED-US (80 for “Platinum” rating) and Australia Green Star (75 for “6-Stars” rating). It would appear then that the different levels of rating award and the minimum score that should be achieved to earn each rating level is not standardized and it is a construction industry’s prerogative to determine them; hence, beyond the scope of this study.

The previous section has highlighted the criterion with missing data i.e. EN-SRM-1. As discussed in Chapter Four Section 4.6.4, it is crucial for the study to test the sensitivity of this criterion as an integral component of the MOBSA framework, and consequently addressing the final research question set out in the Introduction. The purpose of this sensitivity testing is to determine whether the inclusion of such criterion for assessment would have a significant impact on the overall assessment score; hence, rating. As previously mentioned, 74.1 is the final score of the case study building, as a result of removing the points available for the criterion from the total number of points available for the “Support Resource Management” Sub-Issue. However, if relevant data for assessing such criterion were available and the assigned maximum two points were awarded, the overall score of the case study building would be increased from 74.1 to 74.6. This increment can be considered as not significant in affecting the overall score; hence, a possible shift to a higher level of rating (e.g. from “Gold” to “Platinum”) as a result of addressing this criterion is highly unlikely. It can then be concluded that, at the moment, criterion EN- SRM-1 is unlikely to be crucial in serving as an integral component of the MOBSA framework.

10.5.4 Comparison with the Results of Green Mark Scheme

Given the building performance results mentioned above, it is considered valuable to compare them with those of Green Mark Version NRB/3.0 which was actually used to rate the green performance of the case study building in reality. In terms of specific criteria of which relevant points are achieved by the case study building, Table 10.8 shows the detail comparison between MOBSA framework and Green Mark. It should be noted that equivalent criteria in the Green Mark may or may not have the same benchmarks, or belong to the same sub-issue or issue, as those in the MOBSA framework. From this table, a summary of total number of social-, environmental-, and economic-related criteria addressed in either MOBSA framework or Green Mark or both can be developed, and this is shown in Table 10.9. The specific criteria that are only addressed in the MOBSA framework of which relevant points are achieved, but are not addressed in the Green Mark are shaded in Table 10.8 and their total numbers are highlighted in Table 10.9.

Generally, it can be inferred from these tables that most of the social-related criteria (18 out of 22, or 82%) of which relevant points are achieved by the case study building, are not addressed in the Green Mark Scheme. Contrastingly, there are only three social-related criteria in the Green Mark that are not addressed/applicable/achieved in the MOBSA framework. By the same token, there are a total of 22 social-related criteria addressed in MOBSA as compared to only 7 in Green Mark of which points are achieved by the case study building. In respect of economic-related criteria, all those addressed in the MOBSA framework are not considered in the Green Mark. In fact, there are no economic-related criteria measured, or points offered, in the Green Mark to the case study building. Therefore, it could be argued that the final Green Mark score achieved by the case study building only partly, if at all, based on its social and economic performances.

Table 10.8: Detail comparison of criteria (with points achieved by the case study building) addressed in MOBSA Framework and Green Mark Version NRB/3.0

Issues	Criteria in MOBSA Framework	Addressed & points achieved	Equivalent Criteria in Green Mark NRB/3.0	Addressed & points achieved
SOCIAL	S-EDU-1	N.A.	Building users' guide*	√
	S-EDU-3	√	Nil	
	S-EDU-4	N.A.	ISO14000 certification*	√
	S-COH-1	√	Nil	
	S-COH-2	√	Nil	
	S-COH-3	√	Nil	
	S-COH-5	√	Nil	
	S-ACC-1	√	Nil	
	S-ACC-2	√	Nil	
	S-ACC-3	√	Nil	
	S-ACC-4	√	Nil	

	S-INC-2	√	Nil	
	S-INC-3	√	Nil	
	S-HUM-3		Ventilation in car parks*	√
	S-HUM-4	√	Noise level	√
	S-HUM-5	√	Luminance level	√
	S-HUM-6	√	Nil	
	S-HUM-8	√	Indoor air pollutants & Environmental friendly materials	√
	S-HUM-9	√	Thermal comfort	√
	S-HUM-10	√	Nil	
	S-HUM-11	√	Nil	
	S-HUM-12	√	Nil	
	S-LOC-2	√	Nil	
	S-LOC-4	√	Nil	
	S-LOC-5	√	Nil	
ENVIRON-MENTAL	EN-ECO-1	√	Nil	
	EN-ECO-2	√	Greenery & Innovation – Green roof	√
	EN-ECO-3	√	Nil	
	EN-ECO-4	√	Nil	
	EN-SRM-2	√	Nil	
	EN-AIR-1		Access to public transportation network*	√
	Nil		Bicycle parking lots*	√
	EN-LAN-1	√	Nil	
	EN-LAN-2		Environmental management measures*	√
	EN-LAN-3		Facilities for collection & storage of recyclables*	√
	EN-LAN-4	√	Nil	
	Nil		Efficient concrete usage*	√
	EN-EWA-1	√	Innovation – Integrated stormwater treatment	√
	EN-EWA-3	√	Innovation – Greywater recycling	√
	EN-ENE-1	√	Artificial lighting – lighting power density	√
	EN-ENE-2	√	Air-conditioning system	√
	EN-ENE-3	√	Building envelope – ETTV & RTTV	√
	EN-ENE-4	√	Energy efficient practices and features - daylight	√
	EN-ENE-5	√	Nil	
	EN-ENE-6	√	Nil	
	EN-ENE-7	√	Energy efficient practices and features - sensors	√
	EN-ENE-8	√	Nil	
	EN-ENE-9	√	Electrical sub-metering	√
	Nil		Carbon dioxide sensors*	√
	Nil		Energy efficient lifts*	√
	EN-WAT-1	√	Nil	
	EN-WAT-2	√	Water efficient fittings	√
	EN-WAT-3	√	Irrigation system	√
	EN-WAT-4	√	Water consumption of cooling system (N.A.)	√
	EN-WAT-5	√	Water usage & leak detection	√
ECONO-MIC	EC-TBL-3	√	Nil	
	EC-EEF-1	√	Nil	
	EC-EEF-2	√	Nil	
	EC-EEF-3	√	Nil	
	EC-EEF-4	√	Nil	
	EC-EEF-5	√	Nil	
	EC-EEF-6	√	Nil	
	EC-EEF-7	√	Nil	
	EC-EEF-8	√	Nil	

Note:
Since this table aims to compare criteria (with points achieved) in both or either MOBSA framework or Green Mark, certain criteria within the MOBSA framework are excluded from the list. These criteria must have the following two characteristics: 1) the points allocated are not achieved by the case study building; and 2) they are not addressed in the Green Mark Scheme.
'√' means the criteria are addressed in the framework and the relevant points are achieved by the case study building.

Table 10.9: Summary of the total number of criteria (with points achieved by the case study building) addressed in MOBSA Framework and Green Mark Version NRB/3.0

		No. of criteria			
Characteristics		Social	Environmental	Economic	**TOTAL**
A-	Addressed in **MOBSA** and relevant points are achieved; however, they are not addressed in Green Mark (shaded rows in Table 10.8)	18	10	9	37
B-	Addressed in **Green Mark** and relevant points are achieved; however, they are not addressed/applicable/achieved in MOBSA (marked with asterix in Table 10.8)	3	7	0	10
C-	Addressed in, and relevant points are achieved from, **both MOBSA & Green Mark**	4	13	0	17
TOTAL number of criteria addressed in **MOBSA** and relevant points achieved (A+C)		22	23	9	
TOTAL number of criteria addressed in **Green Mark** and relevant points achieved (B+C)		7	20	0	

The result also shows that there are only 10 environmental-related criteria in the MOBSA that are not addressed in the Green Mark. However, the total number of environmental-related criteria addressed in the MOBSA framework of which relevant points are achieved is comparable to those of Green Mark i.e. 23 and 20 respectively. This means that both MOBSA and Green Mark roughly cover the same scope of environmental-related criteria although their benchmarks are relatively different. By this, the environmental-related points achieved by the case study building in MOBSA could be deemed comparable to those of Green Mark.

What have been said so far suggest that a significant portion of the Green Mark performance criteria addressed; hence, the final score achieved by the case study building, is due to its environmental performance. This result is echoed by the argument developed in Chapter Four that Green Mark is among the BPASs which focuses particularly on rating the greenness of the building itself. In addition, Table 10.9 also indicates that there are only 10 Green Mark criteria of which relevant points are achieved by the case study building but they are not addressed/applicable/achieved in the MOBSA framework. This number is much lower if compared to 37 MOBSA criteria of which points are achieved but are not addressed in Green Mark. Undoubtedly, MOBSA framework is more comprehensive than Green Mark; but more importantly, this suggests that if a building could achieve a large portion of MOBSA points, the building would as well achieve a significant portion of Green Star points, but not necessarily the other way around.

For example, as noted earlier, the design of the case study building aimed for, and subsequently achieved, the Green Mark Platinum rating; hence, the final score achieved was at least 90 out of 100. Further, as highlighted in Chapter Four, Green Mark contains most criteria at the building and site levels and seems not to address any impacts on the community/regional scale. However, the building scores lower i.e. 74.1 when assessed using the MOBSA framework which also contains criteria at the community/regional scale and above, and all parameters i.e. Issues, Sub-Issues and Criteria, are weighted. It is possible for the overall score difference between MOBSA framework and Green Star to be one or two levels of ratings. Overall, it could be argued that a building design could score high when assessed based on the 'greenness' of the building alone but not necessarily so if assessed in a balanced and holistic manner based on the concept of sustainability i.e. inclusion and equitability of the three dimensions of sustainable development within the assessment framework.

10.6 Conclusion

This chapter has brought the Validated MOBSA Framework for the Design Phase into the next level by proposing a scoring system to enable the framework to be applied in real life. The system has been presented in Section 10.2.3 which includes the maximum number of points available to reflect the different important level of each criterion, and weightings for 17 Sub-Issues and 3 Issues. Subsequently, the framework was applied to a real life case study building i.e. a newly built government office rated with the highest rating of Green Mark Platinum for its design.

The framework application results have been presented and discussed in Section 10.5. It was found that benchmarks for three criteria (i.e. S-INC-3, EC-TBL-3, EC-EEF-1) required to be adjusted and the adjustments were proposed. Only one criterion, namely EN-SRM-1, was unable to be assessed due to unavailability of data. However, the sensitivity testing result shows that the exclusion of this criterion from the framework does not significantly affect the overall assessment score and rating; hence, it is unlikely to be crucial in serving as an integral component of the MOBSA framework, at least for the time being.

When MOBSA's assessment results were compared with those of Green Mark Version NRB/3.0, it was found that the building achieved a very high overall score in terms of its environmental design performance (using Green Mark) but scored lower when social- and economic-related criteria at the scale broader than the building itself were also taken into consideration and appropriately weighted (using MOBSA framework). This finding has implications for BPASs development and implementation in emerging/developing countries, particularly Malaysia. It appears that a more comprehensive BPAS, embracing the whole concept or three dimensions of sustainability, is crucial to be introduced and implemented in Malaysia, in priority to, or alongside with, single-dimensional BPASs.

Chapter 11: Conclusions and Recommendations

11.1 Conclusions

The research started from critically examining the key concepts and the current international context of sustainable development, and the key differences between developed and emerging/developing countries in terms of their priorities in pursuing sustainable development. It showed that decision makings to support sustainable development should involve a balanced and holistic approach to the three dimensions of sustainability i.e. social equity, environmental protection, and economic development. In addition, implementing sustainable development in emerging/developing countries is dissimilar to developed countries and requires a different approach due to difference in priorities. In contrast to developed nations which can have more focus on environmental issues to progress towards achieving sustainability, the literature revealed that emerging/developing nations need to firstly focus more on social and economic sustainability. These findings implied that assessment frameworks in emerging/developing countries should be different than those in developed countries.

The research investigated the current status of sustainable development practices in Malaysia – as a case of emerging country in this research – towards understanding its conditions, constraints and priorities. It was revealed that environmental deterioration and negative social impacts contributed by the construction industry has continued to be present in Malaysia as a result of prioritising economic issues (lowest cost, maximum profit) alone. The plethora of sustainable development frameworks, policies and various enabling legislation and regulatory frameworks deployed, was shown to be no longer sufficient to reduce and overcome sustainability issues in Malaysia. Further investigation revealed that the necessary balance between socio-economic and ecological systems to avoid further environmental damage has not successfully been reached due to knowledge- and politically-related constraints. However, the review of commitments by the government of Malaysia in the sustainability agenda discovered that it is a priority of the country in general, and construction industry in particular, to strike the necessary balance.

The thesis has discussed the necessity and the appropriate nature of building performance assessment systems (BPASs) in Malaysia. Introducing voluntary schemes or bottom up approaches, such as building performance assessment systems (BPASs), was shown to be essential in Malaysia as a means to promote self-regulation within the construction industry for the purpose of leading the industry to higher environmental standards. It was concluded that Malaysia urgently needs a context-specific system that serves not only as an assessment system but also an educational medium.

Recognizing the need for developing a Malaysia-specific BPAS and the purpose that it should serve, nine BPASs currently being used in developed and emerging/developing countries (including one in Malaysia) were comparatively reviewed and critiqued. Their characteristics and limitations in assessing building sustainability and supporting sustainable development were discussed at length. It has been revealed that most existing BPASs are single-dimensional in their framework structure; hence, inadequate in addressing the complex concept of sustainability as well as many of the non-environmental priorities of emerging/developing countries, particularly Malaysia. In fact, BPASs from emerging/developing countries were found to have no obvious differences than those from developed countries in terms of their scope of assessment. Very few BPASs address non-environmental issues such as safety and security; social, cultural and heritage; and economic aspects. Missing issues from all BPASs reviewed include job creations for local people, usage of semi-skilled labour, and communication to enhance public awareness and education as well as to support social cohesion beyond the individual building.

Recognizing the aforementioned deficiencies of existing BPASs, the aim of this research has been defined as to *propose an appropriate assessment framework that enables sustainability to be addressed and incorporated in office building development, relevant to emerging/developing countries, particularly the Malaysian context.* It can potentially enhance the quality of building stakeholders' decision-makings in the building and construction processes throughout the life cycle of their projects by taking into account the interrelationship of environmental, social and economic components of sustainable development; and, hence, stimulating needed changes in emerging/developing countries, particularly the Malaysian construction industry.

This research is not aimed to develop an assessment tool; rather, an assessment framework that forms a basis for the development of such tool in the future. The overarching research questions of the thesis are *"How can office buildings in Malaysia (existing or proposed) be meaningfully assessed by stakeholders as sustainable? What would be the nature and form of an assessment framework specifically relevant to the*

Malaysian context, taking into account possible shortcomings in its implementation such as unavailability of data?" Conclusions from the research that answered these research questions or formed the foundation on which the Malaysian Office Building Sustainability Assessment (MOBSA) framework was developed are presented in the following paragraphs.

1) *Identifying the relevant nature of the MOBSA framework – i.e. overall intention, the general scope of assessment, and specific assessment criteria.*

This research has identified the relevant nature of the framework by adopting a mixed-methods approach, particularly using the exploratory sequential design i.e. a qualitative followed by a quantitative phase. The qualitative phase entailed a synthesis of results from research conducted in three stages: 1) wide-ranging literature review; 2) in-depth, semi-structured, open-ended interviews; and 3) focus groups discussion. The literature review in Chapter Two tried to understand how building and construction in emerging/developing countries can meaningfully support sustainable development. Chapter Three then evaluated the Malaysian conditions, priorities, and constraints in promoting and practicing sustainable development; followed by comparative review and critiques of existing BPASs being used in developed and emerging/developing countries in terms of their characteristics and limitations in Chapter Four. This comparative review and critiques are important in order for the study to incorporate features and elements which have proven to be effective and to avoid those which have not. Based on the synthesis of all findings from these three chapters, the requirements for developing the Malaysian assessment framework have been presented. Accordingly, the relevant nature of the assessment framework is as follows:

- **Overall intention:** To suit the context of emerging/developing countries particularly the Malaysian construction industry, not only should the framework evaluate stakeholders' decisions in building and construction processes, but it should also promote participation, and enhances their knowledge and awareness in supporting sustainability throughout the life cycle of their project.
- **General scope of assessment**: Overall, the framework should take into account the interrelationship of environmental, social and economic components of sustainable development and applicable to all phases of assessment i.e. pre-design, design, construction and commissioning, and operation phases; hence, their anticipated audience/stakeholders.

In the first stage, 102 specific assessment criteria have been identified from the literature of which 22% assess aspects at the scale broader than the site level i.e. global and community/regional levels. These are grouped under 17 Sub-issues, which in turn are grouped under 3 Issues, presented in a form of Tentative MOBSA framework in Chapter Four. In the second stage, these 102 criteria have been substantiated and fine-tuned through interviews conducted with 30 experts from various backgrounds of the Malaysian construction industry. Findings with regard to stakeholders' views of sustainability, the extent of sustainable development practices, and primary concerns in pursing sustainable office building development and assessment have been discussed in Chapter Six. The results revealed that 65 criteria identified earlier have been confirmed, 4 refined and the remaining 33 were not cited by the interviewees. However, 13 new criteria have been added, giving a total of 115 criteria (i.e. 65+4+33+13) presented in a form of Stage-1 MOBSA framework. In the third stage, these criteria were further refined through a focus groups discussion participated by 38 building experts, in which criteria have been agreed upon and rated in terms of their relative importance based on consensus. Detailed results have been analysed and presented in Chapter Seven which revealed that 106 criteria have been agreed upon, 7 refined and 2 omitted. The results also discovered an additional 7 new criteria, giving a total of 120 (i.e. 107+6+7) deemed appropriate for the formulation of the Stage-2 MOBSA framework.

Subsequently, a cross-sectional questionnaire survey (the quantitative phase) targeting various groups of local building stakeholders has been conducted, from which 120 criteria identified from, and refined in, the qualitative phase were assigned with their weighting levels, thus providing the basis of reducing the total number. The results were presented and discussed in Chapter Eight which revealed that only 88 out of 120 criteria are eligible to be included in the Stage-3 MOBSA framework because they received a higher mean value (after taking into account their respective standard deviation) than the level set in this study. Subsequently, their weighting levels were assigned accordingly.

The method used has proved effective in impartially determining the inconsistency of views between various groups. The contribution of this survey gives a cogent insight into the priorities and expectations of different decision makers.

2) *Identifying the relevant form of the MOBSA framework – i.e. structure, applicable phase(s) of assessment, performance benchmarks and scoring system*

The research has integrated the qualitative and quantitative results in Chapter Nine in order to determine the relevant form of the MOBSA framework. First, the research determined the applicable phase(s) of assessment for the selected 88 criteria in the Stage-3 MOBSA framework which is the product of the quantitative phase. It then defined the appropriate benchmarks for each criterion by recalling qualitative findings obtained from the focus groups discussion and interviews conducted earlier and reviewing additional literature. The results revealed that out of 88 criteria, 15 were further refined, another 6 were combined (to become 3), 1 was omitted, and the remaining 66 were retained in their original form. An additional 2 criteria under "Innovation" issue were added at this stage, giving the final total of 86 (i.e. 15+3+66+2) criteria altogether. These criteria with their respective proposed benchmarks were then presented to nine local construction industry experts for validation; thus resulting in modifying the framework in general, and benchmarks in particular. Finally, the *Validated Comprehensive MOBSA framework* was proposed in Chapter Nine and it was then embedded with a proposed scoring system in Chapter Ten in order to enable the application of the MOBSA framework in real life. This was done by recalling the weighting levels proposed in the Stage-3 MOBSA framework but further adjusted according to expert opinions obtained during the validation process.

Clearly, at this stage, the research has defined performance benchmarks theoretically and by expert opinion. In Chapter Ten, these benchmarks were then refined empirically by applying them on an environmentally certified local case study project; however, only those applicable to the design phase of assessment (formed as the *Validated MOBSA Framework for the Design Phase*). The results of this application led to further adjustment of three performance benchmarks. Overall, it was found that all criteria within the *Validated MOBSA Framework for the Design Phase* are most likely to be assessable and realisable in the current practice with limited risk of data unavailability or difficulties in obtaining them to complete the assessment, with an exception of one criterion. Based on the sensitivity analysis conducted, it was found that this criterion is unlikely to be crucial in serving as an integral component of the MOBSA framework, at least for the time being. More importantly, a comparison of the building's overall results with those of an existing environmental-focused BPAS indicates that a building that achieves a very high overall score in terms of its environmental design performance can score lower when assessed based on the three dimensions of sustainability in a holistic and balanced way.

In conclusion, the primary aim of this research, to develop a building sustainability assessment framework for emerging/developing countries in general, and Malaysia in particular, has been achieved. The MOBSA framework was presented, discussed, refined, and finally verified and tested in the thesis using a real-life case study office building as shown in Appendix G. All in all, the multiple stages involved in deriving the final MOBSA framework in general, or the appropriate performance criteria and benchmarks in particular, improved the robustness of the MOBSA framework. The key point is that the developed framework and key performance criteria identified in this study will improve the understanding of practitioners, but in a way that allows comparison, discussion, and learning. Also, the developed framework is able to consider different levels of information and structure all relevant issues in an ordered manner, helping decision makers to handle the multiplicity of the issues embodied in the concept of sustainability.

Recalling the research questions mentioned earlier, the relevant form of the *Validated Comprehensive MOBSA framework* is derived as follows:

- **Structure**: Structured hierarchically in three levels, with the higher level logically derived from the lower ones: 3 sustainability Issues (i.e. Environment, Social and Economic), 17 Sub-issues and 86 criteria (a mixture of quantitative and qualitative types). 16% of the criteria assess aspects at the scale broader than the site level i.e. global and community/regional levels;
- **The applicable life-cycle phase(s) of assessment:** Each criterion can be applied to at least one of the life-cycle phase(s) of assessment i.e. pre-design, design, construction and commissioning, or operation phase, which in turn informs the anticipated stakeholders for each of them;
- **Performance benchmarks:** Each criterion has appropriate benchmarks defined to suit its applicable phase(s) of assessment and its type i.e. quantitative or qualitative.
- **Scoring system:** Each criterion is assigned with a maximum number of points available – defined through a questionnaire survey – indicating the relative weighting between criteria. Each Issue and Sub-issue is assigned with a weighting percentage, indicating the relative weighting between them. The total weighting of all Issues or Sub-issues is kept to 100%. The way of calculating the final performance score of a case study building has been proposed.

The weightings developed from this research provide valuable references and can be useful at least in two ways: (1) as a reference when applying weighting system in any BPAS in Malaysia; and (2) as a guide for the Malaysia specific sustainable building researchers and practices to focus on the more important issues.

11.2 Limitations of this Research

Although the research has generally achieved the specific objectives stated in the Introduction, the research was not conducted without limitations. Firstly, the size of the sample was limited to 203; hence, it is acknowledged that the final selected criteria might be different if the sample size was different or larger. Further, the sample size obtained for the qualitative study is only adequate to enable internal generalization i.e. 30; hence, findings may not be employed to make inferences on other construction industry stakeholders not included in the study.

Secondly, the survey is confined to two out of three federal territories (i.e. Kuala Lumpur and Putrajaya), and one out of thirteen states (i.e. Selangor), in Malaysia. Despite the fact that Malaysia has no different climatic zones, certain parts of the countries are drier or wetter than others depending on the months of the year. Other variations include nature, socio-economic background and priorities, and technological achievements. Therefore, the weightings developed in this survey are possibly applicable only to states or cities that are similar to the investigated ones. Otherwise, further research needs to be conducted to generate appropriate weightings for other states or cities. Further, the results of the weighting exercise are inevitably subjective and are time-dependent; hence will require regular updating.

Thirdly, the research is confined to only the office building projects. However, the findings from this study could be considered as a guide to assess and develop sustainable building criteria for other building typologies in the Malaysian context. Finally, the study only tested the applicability of the criteria relevant to the design phase of assessment. This means, performance benchmarks defined for criteria relevant to other phases of assessment may require adjustment due to data unavailability or difficulties in obtaining them to complete the assessment.

11.3 Recommendations for the MOBSA Framework

It is anticipated that in the future, the performance standards of office buildings in Malaysia would rise (more buildings become ‘greener’ or the baseline improves); therefore, over time, regulations would be updated, sustainable technologies, local capabilities and understanding of issues would evolve, and sustainable building performance may be improved. In fact, it should be noted that the proposed benchmarks in this thesis are by no means definitive or conclusive. If this framework were to be adopted, it is recommended for the performance benchmarks defined in the MOBSA framework to be gradually revisited or updated over time. As many of the benchmarks are context dependent, they should also be adjusted if adopted in different areas or regions. Adjustments should also be made to weightings and scoring in response to changing priorities.

Assessment criteria included in the Validated Comprehensive MOBSA framework must be extended at any point in time when the severity of certain issues become more acute or of greater political and public concern. This process will not only facilitate the necessary integration of issues, perspectives and views in building assessment but also facilitate participation and transfer of knowledge among stakeholders.

11.4 Recommendations for Further Research

It is recommended for the following areas to be investigated for further study:

1) Generation of appropriate weightings for other states or cities than those focused in this study i.e. Putrajaya, Kuala Lumpur and Selangor;
2) Testings the appropriateness of MOBSA criteria and benchmarks – applicable to other than the design phase of assessment – on case study buildings in Malaysia;
3) Different levels of rating award and the minimum score that should be achieved for each rating level of MOBSA;
4) The creation of new property databases as well as extending existing property databases/indices for providing more market evidence on the financial performance of local green or sustainable buildings in Malaysia. Empirical studies on the performance of sustainable buildings should not solely focus on operating cost performance or on energy consumption, but also on the overall building performance including rent levels, transaction prices and occupant productivity and well-being;
5) Studies related to life cycle assessments (LCA) to profile the environmental performance of materials and components produced in Malaysia;
6) Development of a Malaysia-specific building sustainability assessment framework for other building types, using the MOBSA framework as the basis as well as adopting the model or approach adopted in this study; and
7) Development of a country-specific building sustainability assessment framework in other emerging/developing countries, using the MOBSA framework as the basis as well as adopting the model or approach adopted in this study.

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