# COST IMPLICATION FOR A RESIDENTIAL HIGH-RISE PROJECT TO ACHIEVE CERTIFIED LEVEL GREEN BUILDING INDEX (GBI) RATING

**LAI WEI CHIAN**

**A project report submitted in partial fulfilment of the requirements for the award of the degree of Bachelor of Science (Hons.) Quantity Surveying**

**Faculty of Engineering and Science**
**Universiti Tunku Abdul Rahman**

**April 2013**

## DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

Signature : _____

Name : _____

ID No. : _____

Date : _____

## APPROVAL FOR SUBMISSION

I certify that this project report entitled **"COST IMPLICATION FOR A RESIDENTIAL HIGH-RISE PROJECT TO ACHIEVE CERTIFIED LEVEL GREEN BUILDING INDEX (GBI) RATING"** was prepared by **LAI WEI CHIAN** has met the required standard for submission in partial fulfilment of the requirements for the award of Bachelor of SCIENCE (Hons.) QUANTITY SURVEYING at Universiti Tunku Abdul Rahman.

Approved by,

Signature : _____

Supervisor : Dr. CHONG HEAP YIH

Date : _____

Specially dedicated to

my beloved family, supportive parents, dedicated supervisor and friends

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## ABSTRACT

The adverse impacts to the environment from the construction industry had led to a growing realisation that there is a need for a more sustainable and responsible approach to the current practices. This growing attention pushes the government and professional bodies in Malaysia to be more proactive in alleviating this problem without restraining the need for development. But, have these borne fruits? Creating sustainable construction depends on the knowledge and involvement of all people involved in the industry. Two particular questions often resonate the loudest in every financial discussion of green buildings. Is there an additional cost? What is the expected return on investment? These questions are often foremost and central in the minds of many green building professionals. There are two types of costing the developers are interested in, the Life Cycle Cost and the Initial Cost (commonly known as capital expenditure or CAPEX). In most cases, the initial costs to construct a building often take precedence because of budget issues. Therefore, this report aims to explore the cost implication for a two blocks conventional high-rise project to achieve the 'Certified' Green Building Index (GBI) rating. This part of the study is often regarded as the most important where surveyors are assigned to evaluate the cost implications for a building to achieve either the Platinum, Gold, Silver or Certified Green Building Index (GBI) rating. This research provides some insights on how the professional consultants approach the 'greening' process by incorporating sustainable features into their development which can then be presented to the developer for a decision whether to proceed. This research also shows a total net additional cost implication of 2.2% of the contract sum to transform a conventional residential high-rise project to one with a 'Certified' Green Building Index (GBI) rating. With the results in this research we may proceed to raise the

awareness of sustainable development and the costs associated with them. This is to educate the organisations and public in order to create avenues for further action towards continual support of constructing sustainable development.

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## LIST OF SYMBOLS / ABBREVIATIONS

| | |
|---|---|
| *%* | Percentage |
| *GBI* | Green Building Index |
| *NRNC* | Non-Residential New Construction |
| *NREB* | Non-Residential Existing Building |
| *RNC* | Residential New Construction |
| INC | Industrial New Construction |
| IEB | Industrial Existing Building |
| EE | Energy Efficiency |
| SM | Site Management |
| CAPEX | Capital Expenditure |
| LEED | Leadership in Energy and Environmental Design |
| MGBC | Malaysia Green Building Confederation |
| AIA | American Institute of Architects |
| GDP | Gross Domestic Product |
| ACEM | Association of Consulting Engineers Malaysia |
| BREEAM | Building Research Establishment Environmental Assessment Method |
| CIBSE | Chartered Institution of Building Services Engineers London |
| MBPJ | Majlis Bandaraya Petaling Jaya |
| CIDB | Construction Industry Development Board |
| PAM | Persatuan Arkitek Malaysia |
| BCA | Building & Construction Authority |
| M&E | Mechanical and Electrical |
| VOC | Volatile Organic Compound |
| WELS | Water Efficiency Labelling and Standards |
| SIRIM QAS | Standards & Industrial Research Institute of Malaysia Quality and Standards |

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# CHAPTER 1

# INTRODUCTION

## 1.1 Overview

In recent years, the Malaysian construction industry has become more complex and advanced in order to satisfy the needs of everyone. The construction industry is one of the most important industry that plays an important role in driving the Malaysian economy. As such, our government has been carrying out various initiatives to improve our construction industry from time to time. "In 2010, the construction industry successfully contributed 5% to the nation's gross domestic product (GDP), albeit small in percentage terms but the total value of RM18.2 billion was actually very significant as it helped to generate huge economic linkages and create a multiplier effect on other economic sectors including the financial, banking, insurance, transportation and manufacturing services" (Lindsay, 2012). The construction industry helps other sectors contribute to the GDP (Zainul Abidin, 2009). To further enhance the construction industry in 2012, the government had allocated a total development expenditure of RM29.8 billion to support the demand for infrastructure, industry, agriculture and rural development. RM13.6 billion has been reserved for social development comprising education, health, welfare, housing and community development.

In general for any development we are always looking for ways to maximize the output of a building with a lower CAPEX and focusing on lowering the Life Cycle Cost of a building. Therefore in the year 2009, driven by the environmental needs to make Malaysia's construction industry more sustainable in the future, the

Green Building Index (GBI) was jointly founded and developed by Pertubuhan Akitek Malaysia (PAM) and the Association of Consulting Engineers Malaysia (ACEM). "The Green Building Index (GBI) is Malaysia's industry recognized green rating tool for buildings to promote sustainability in the built environment and raise awareness among Developer, Architects, Engineers, Planners, Designers, Contractors and the public about environmental issues and our responsibility to the future generations" (Green Building Index, 2011). Throughout the world there are many types of green building certification, some of the well-received certifications comprise Leadership in Energy and Environmental Design (LEED), Building Research Establishment Environmental Assessment Method (BREEAM), Malaysia's Green Building Index (GBI) and Singapore's Green Mark. All the aforementioned certifying bodies are overseen by the World Green Building Council. This is to ensure that all projects will not only be sustainable but are also people-friendly in terms of design and usability (Ahmad Fuad, 2012).

The governments throughout the world play an important role in promoting green buildings and our government has also taken many initiatives towards this direction. Among others, our government has implemented several incentives to aid the small and medium property sized developers. This is because the small and medium sized developers found that incorporating green technology into their design will eat into their profits and in extreme cases may even render their projects to be unfeasible. This is why the Ministry of Energy, Green Technology and Water had came up with several incentives to help property developers and home owners to adopt Green Technology in the Malaysian context (http://www.nst.com.my/opinion/letters-to-the-editor/green-technology-enticements-to-go-green-1.63378).

- Firstly, stamp duty exemptions are given for purchases of properties with Green Building Index (GBI) certifications within the period from October 2009 until 31st December 2014;

- Income tax exemptions on additional capital expenditure incurred to obtain GBI certifications;

- Giving pioneer status or investment tax allowances to companies investing in the generation of energy from renewable sources and energy conservation/energy efficient activities;

- In the year 2010, the government have allocated RM1.5 billion to provide soft loans to companies that supply and utilize Green Technology (Budget 2010-Green Technology, 2009); and

- The Petaling Jaya City Council (MBPJ) is giving rebates of up to RM500 to owners of residential properties who incorporate energy efficient upgrades or adapting Green Technology (Henry, 2012).

## 1.2 Problem Statement

The tremendous growth in economic activity across the globe is placing pressure on natural and environmental resources. It is often said that the real estate industry is a significant contributor to the global warming due to extensive emissions of greenhouse gases (GHGs) from the energy use in buildings. Making things worst, the construction industry has grown tremendously within the last 50 years and will continue to expand. The construction industry is a major source of pollution and is responsible for roughly 4-5 percent of the global particulate emission which make them one of the main culprit in polluting the air and water. As such, building professionals are constantly finding ways to make sure the construction industry play its part and contribute to save Mother Nature. "According to the American Institute of Architects (AIA, 2000), the biggest source of emissions and energy consumption both in the US and around the globe is the construction industry. According to a briefing note prepared for the International Investors Group on Climate Change (Kruse, 2004), the cement sector alone accounts for 5 percent of global man-made Carbon Dioxide emissions" (Florence & Gunawansa, 2011).

As a developing country, Malaysia realized that the construction industry plays an important role in its economic growth. However, the industry is not without

weaknesses. Challenges have been in the areas of productivity, quality, safety, technology and unproductivity. The book ‘Malaysia’s Vision 2020’ published in 1993 defined national ambitions and future opportunities for us. One of the basic visions that emerged is for the country to be ecologically sustainable. This basic vision has become an impetus towards sustainability agenda in the country. The issue of sustainable development has emerged as one of the top issues in the Eight Malaysia Plan (2001-2005). According to the plan, the government gave high priority to research and development as one of their strategy for sustainable development (Eight Malaysia Plan, 2001). Section 19 of the Plan was devoted to integrate environmental consideration into development planning. Concerted efforts were expected to intensify in order to improve energy efficiency, forestry, waste and environmental management (Aini and Nazirah, 2008).

However, we can see in recent years that more property developers are joining the green movement by constructing more sustainable buildings or commonly called green buildings. "In adopting this more sustainable approach to their business, property developers are not only satisfying their own corporate responsibilities but will also attract the increasing number of environmentally-conscious consumers – and likely reap the long-term economic benefits of going green" (Lee, 2010). Nevertheless, it still remains a challenge for developers to promote their green buildings.

Most property developers at this infant stage of green buildings may lack cost experience or comparative costing knowledge on the cost implications for a conventional building to achieve certain certification level in the green building index. This may act as a barrier for the developer to construct a green building as they will need to bring in external specialist consultants if the project consultants have no knowledge of the cost implication. Unfortunately, not enough project feasibility studies consider environmental sustainability, as most of them are still more concerned about economic performance (Shen et al., 2010).

## 1.3 Aim

This research then is to find out the cost implication for a two block conventional residential high-rise project to achieve certified Green Building Index (GBI) rating. This gives us a better understanding on what is the cost implication for a conventional residential high-rise project to achieve certified Green Building Index (GBI).

## 1.4 Research Objectives

This research focuses on finding the cost implication for a two block conventional residential condominium to achieve 'Certified' Green Building Index (GBI). With this knowledge we are be able to come up with rough estimates for cost analysis of future projects. Specifically, the following are the research objectives to achieve the aim of this research:

- To identify the total cost implication for a conventional residential high-rise project to achieve 'Certified' Green Building Index (GBI) rating;
- To identify the percentage of the total cost implication after achieving the targeted 'Certified' GBI rating over the cost of the conventional base building ; and
- To highlight the elements and items incorporated into the building to achieve 'Certified' Green Building Index (GBI) rating.

## 1.5 Scope of Research

Green technology or green building is a very broad research topic and there are still many areas that researchers have yet to venture into. This research focuses on identifying the cost implication for a conventional residential condominium to achieve certified Green Building Index (GBI) rating. The selection of this area is to

provide a better understanding and a rough overview of the cost implication to achieve certified Green Building Index (GBI) rating.

The purpose of selecting a two blocks residential condominium is because in recent years the demand for living spaces is increasing every year. Residential market is growing aggressively. "All this is because the younger crowd and the empty nesters are opting to settle in the city where they can be closer to cultural activity, mass transit, more sustainable lifestyles, and other like-minded people" (Earth Advantage Institute, 2012). The demand of filling in spaces in the city or nearby the city where they could easily get to work remains top priority but there is only that many space to be occupied. Landed properties near the city center remain unaffordable to many. Therefore property developers have been using the concept of utilizing a piece of land by building high rise condominiums where multiple families can live on within that piece of land.

| Quarter | Total | | Residential buildings | | Non-residential buildings | | Civil engineering | | Special trade | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Value of construction work done (RM million) | % | Value of construction work done (RM million) | % | Value of construction work done (RM million) | % | Value of construction work done (RM million) | % | Value of construction work done (RM million) | % |
| Q1/12 | 17,726 | 100.0 | 4,885 | 27.6 | 6,807 | 38.4 | 5,119 | 28.9 | 915 | 5.2 |
| Q4/11 | 17,661 | 100.0 | 4,610 | 26.1 | 5,958 | 33.7 | 6,057 | 34.3 | 1,036 | 5.9 |
| Q3/11 | 16,037 | 100.0 | 4,180 | 26.1 | 6,166 | 38.5 | 4,355 | 27.2 | 1,335 | 8.3 |
| Q2/11 | 15,040 | 100.0 | 3,775 | 25.1 | 6,513 | 43.3 | 3,530 | 23.5 | 1,222 | 8.1 |
| Q1/11 | 15,519 | 100.0 | 3,491 | 22.5 | 6,578 | 42.4 | 4,363 | 28.1 | 1,087 | 7.0 |

(Source: Department of Statistics, Malaysia)

Figure 1.1: Value of Construction Work Done by Types of Construction Activity, Q1 2011 - Q1 2012

Figure 1.1 shows that from the first quarter of 2011 until first quarter of 2012 there is a gradual increment on the total value of construction work done for the residential buildings and it will be expected to continue to rise over time, whereas we can see other sectors like non-residential, civil engineering and special trade construction fluctuating.

## 1.6 Research Methodology

The research methodology is a guideline to a research to be completed in a systematic way to achieve the research objectives.

The research flow is shown in the flowchart below:

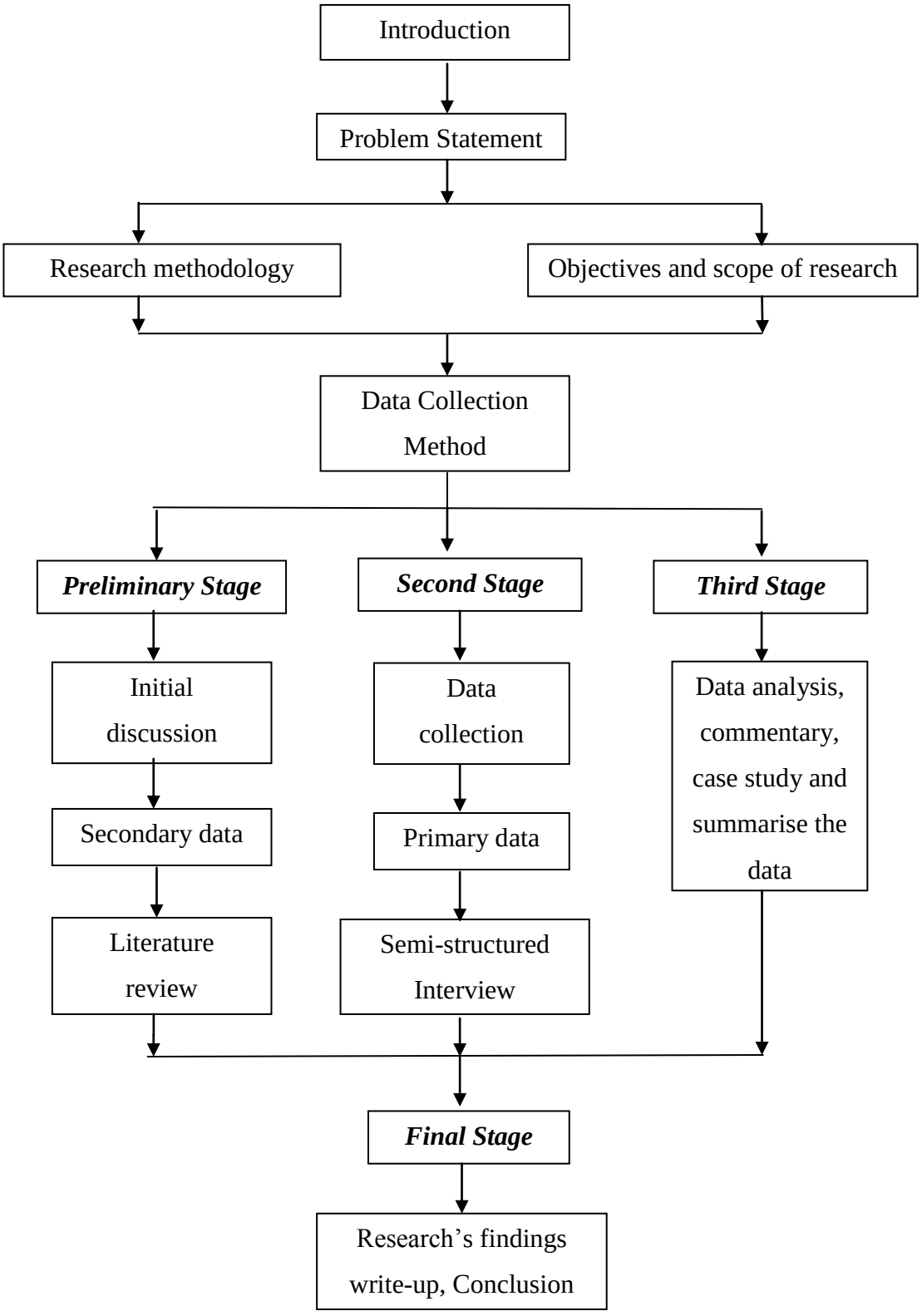



Figure 1.2: Flowchart of Research Methodology

## 1.7 Structure of Thesis

There are five chapters in this thesis. Chapter one discusses the overall intention of the study. It includes the overview of our construction industry as a whole and the government's efforts to drive the green technology and promote sustainable development in Malaysia. It also includes the problem statement, aim of research, research objectives, scope of research, research methodology, structure of the thesis and conclusion.

Chapter two focuses on the literature review which has been examined and discussed. It includes what are sustainable development, sustainability in construction, sustainable construction in Malaysia, green building index (GBI), cost implication and conclusion.

Chapter three describes the research methodology in detail. There are a few stages to complete the report in order to achieve the aim and objective of this report. This includes the methodology for the data collection and data analysis.

Chapter four focuses on analyzing the data obtained from the project consultant. The data in the form of the Bills of Quantities and other information is analyzed in detail whilst identifying appropriate components and their associated cost implication to achieve certified GBI rating for the condominium.

Chapter five concludes the overall study of the report and summarized the cost implications for the two blocks residential condominium to achieve certified Green Building Index (GBI) rating. Lastly, it evaluates whether the aim and objectives of the study are met in this report.

## 1.8 Concluding Remarks

The research aims to highlight the problem statement and to find out the cost implication for a two blocks residential condominium to achieve certified Green Building Index (GBI) rating. This will give us a better understanding on what are the cost implications for a conventional residential high-rise project to achieve certified Green Building Index (GBI). With the study in this research, we will be able to identify the cost difference between a conventional building without GBI rating and a green building with a targeted certified GBI rating and also the percentage difference in cost to achieve the targeted certified GBI rating.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

Green or sustainable construction has experienced rapid growth and has matured over the last 4-6 years. Driven by affirmative actions, clear and established economic benefits of building green commercial and residential buildings have now become more evident. More often than not, people often relate to green buildings as a waste of effort and will only result in high cost to the end users. The commonly held belief that green buildings will result in higher initial costs has proven to be a false assumption, as design and building professionals, together with product manufacturers, have found ways to achieve savings in up-front costs (RSMeans, 2011). This chapter discusses the benefits of sustainable development and elaborates on the Green Building Index (GBI) besides explaining the cost implications to achieve Certified GBI rating for a residential high-rise project. According to the number of buildings assessed by the Green Building Index (GBI) to date, roughly 50-60% of the buildings achieve 'Certified' ratings.

The purpose of selecting a residential high-rise project is because there is a soaring demand of living space in the city. Questions such as "how much a green building would cost?", "is it expensive to construct a green building?" or "what are the cost implication for a conventional building to go green?" are often asked by developers and designers before a building is designed and constructed. It is the objective of this research to provide answers to those questions and give us a broad

idea of the cost implications to construct a residential condominium with a Green Building Index (GBI) certified rating.

## 2.2 Sustainable Development

The term 'Green Building' is part of the larger concept of 'sustainable development' as there are multiple ways that people defines 'sustainable'. Among others, it is "A process that enables all people to realize their potential and improve their quality of life in ways that protect and enhance the Earth's life support system" , as characterized by Sara Parkin of the British environment initiative. Another definition for "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). Yet another encapsulates it as the "Practice of increasing the efficiency of new buildings, and reducing their impact on human health and the environment through better site location, design, construction, operation, maintenance and removal" (Green Building Council, 2009). In short, development should be carried out to meet current human needs without harming the environment and sustain future generations.

Buildings and structures are erected to meet human needs and requirements, both socially and environmentally. They provide shelters to meet human social needs, meet human economic needs for investment and satisfy corporate objectives. However, the satisfaction of human needs usually comes with a high price such as an irreversible damage to the environment. The adverse impact to the environment had led to a growing realization and awareness that there is a need for a more sustainable responsible approach to the current practices without harming the world where human live in (Lim, 2011).

Therefore, developing a strategy for sustainable development is a significant milestone on the road to a more socially and environmentally responsible construction industry. It creates a framework within which the industry can make a strong contribution to a more sustainable future. Construction practitioners

worldwide are beginning to appreciate sustainability and acknowledge the advantages of constructing sustainable buildings.

## 2.3 Sustainability in Construction

Inevitably the construction industry should change its traditional methods of operation with little regard for environmental impacts to a new mode that makes the environmental concern a centerpiece of its effort. For the past 3 years, there is widespread interest in the topics of sustainability and sustainable construction. Presently, a lot of pressure is exerted to build sustainably in the construction world. Previously, concern for the environment play a relatively small part in any construction development.

The direction of the construction industry is moving from developing with environmental concern as a small part of the process into having the development process being integrated within the wider context of the environmental agenda. Therefore, the construction industry must work and meet the demand of the public to protect and sustain the environment. This shift of ideology can be illustrated in Figure 2.1.

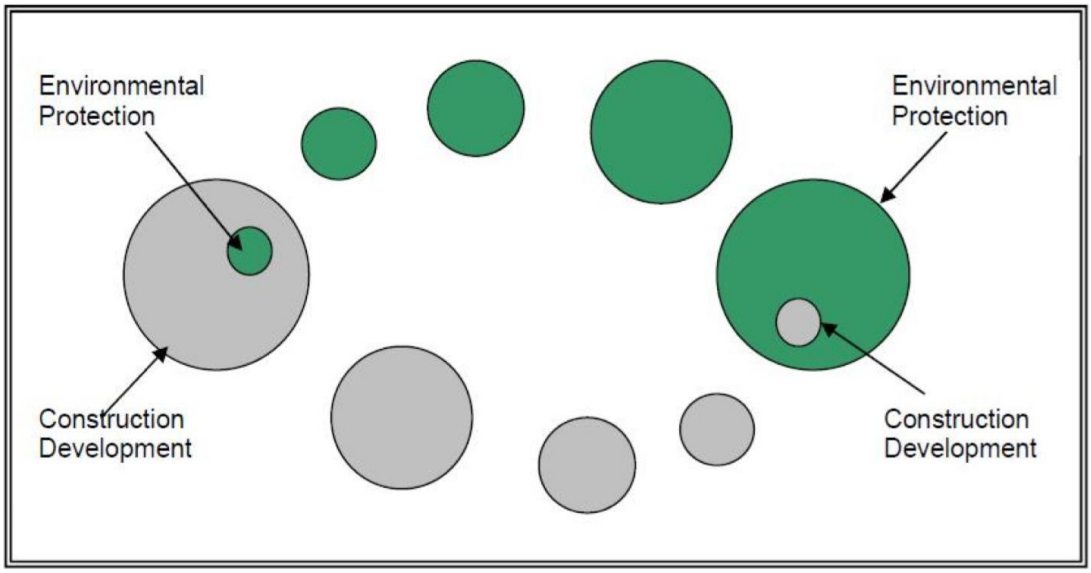



Figure 2.1: The Movement For 'Greener' Construction (adapted from Das Grandhi et. Al., 2006)

Sustainable construction, which means 'green construction', describes the responsibility of the construction industry in attaining sustainability. The term sustainability has been adopted as a panacea for change and development. Sustainable construction is a process whereby, in the long run, sustainability is achieved. It is essential to apply this concept of sustainability into the construction industry to influence the manner in which projects should be executed to create a balance between conserving the environment and maintaining prosperity in development. Attaining sustainability does not mean the eradication of adverse impact, which is an impossible vision at present, but rather the reduction of it to a certain reasonable level (Lim, 2011).

Currently as quoted by Nazirah (2009) in "Sustainable Construction in Malaysia - Developers' Awareness", the concept of sustainable construction is governed by 3 core elements: social well-being, environmental protection and economic prosperity. Figure 2.2 illustrates the tree diagram of these three headings and their areas of concern.

1. Social well-being
   - Social well-being concerns with the benefits of the workers and the future users. Basically, this aspect is concerned with:
     a. Human feelings: security, satisfaction, safety and comfort
     b. Human contributions: skills, health, knowledge and motivation.

2. Environment Protection
   - Environment Protection concerns the built environment and the natural environment. The built environment refers to the activities within the construction project itself, which may, if not handled effectively, cause a serious adverse impact on the environment.

   - Environmental sustainability is also concerned with the extraction of natural resources. Although builders have little influence over the extraction of natural resources, they can help discourage this activity by demanding less non-renewable natural resources, more recycled materials and efficient use of energy and mineral resources.

3. Economic Prosperity
   - Economic sustainability revolves around the benefits of micro and macroeconomics. Micro economics focus on the factors or activities which could lead to monetary gains from the construction per se while macro-economics relate to the advantages gained by the public and government from the project success in the wider perspective.

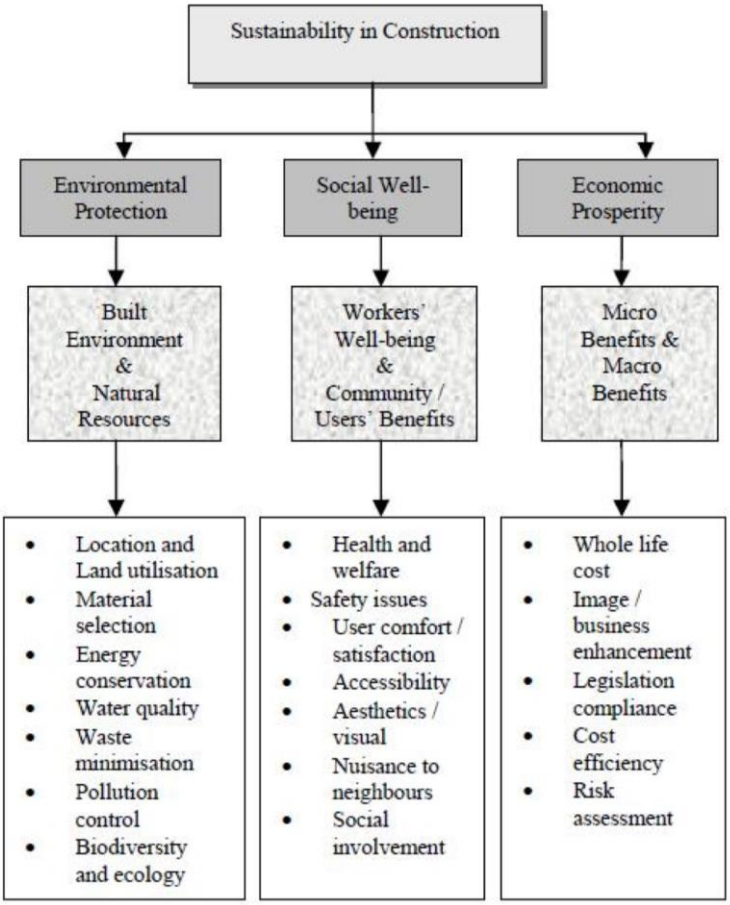



Figure 2.2: The diagram of sustainability in construction (adapted from Nazirah, 2009)

As previously stated, construction practitioners worldwide are beginning to give concern and appreciate sustainability and acknowledge the advantages of building sustainably. For example, research has been conducted which showed that the concept of green buildings saves energy in the long run and added that sustainable buildings will contribute positively to better quality of life, work efficiency and health work environment. Yates explored the business benefits of sustainability and concluded that the benefits are diverse and potentially very significant. The approach of sustainable construction will enable the construction players to be more responsible to the environmental protection needs without neglecting the social and economic needs in striving for better living (Nazirah, 2009).

## 2.4 Sustainable Construction in Malaysia

In Malaysia, there is an increasing public awareness and interest in how buildings affect the environment, worker productivity and public health. The participation of the local government, local authorities, professional bodies and private companies plays an important role for a country to develop sustainably. In 2009 at the United Nation Climate Change Conference in Copenhagen, our prime minister promised to reduce our carbon emissions by 40 per cent by the year 2020 as compared to the level in 2005. Following that in the Budget 2010 (http://www.greenbuildingindex.org/Resources/GBI%20Documents/20091023%20-%20GBI%20Incentives%20Announced%20in%20Budget%202010.pdf), under the Heading 'Developing Green Technology, Item 56 on GBI', our Prime Minister announced that the government will establish a fund amounting to RM1.5 billion to promote green technology. GBI is a green rating index on environmentally friendly buildings. Green buildings save utility costs and preserve the quality of the environment. The government believes that green technology has the potential to become an important sector in economic development and therefore proposed that:

1) Building owners obtaining GBI Certificates from 24 October 2009 until 31 December 2014 be given income tax exemption equivalent to the additional capital expenditure in obtaining such Certificates; and

2) Buyers purchasing buildings with GBI Certificates from developers be given stamp duty exemption on instruments of transfer of ownership. The exemption amount is equivalent to the additional cost incurred in obtaining the GBI Certificates. This exemption is given to buyers who execute sales and purchase agreements from 24 October 2009 until 31 December 2014.

As a developing country, Malaysia realizes that the construction industry is regarded as an essential and highly visible contributor to the process of growth of the country. Over the last two decades, the construction industry had been consistently contributing between 3% - 5 % of the national Gross Domestic Product (Construction Industry Development Board (CIDB, 2000).

The Construction Industry Development Board Malaysia (CIDB) is a corporate body and established with the main functions of developing, improving and expanding the Malaysian construction industry. Besides that, they also placed environmental and other sustainability related issues as top priorities in their agenda to promote in the construction industry.

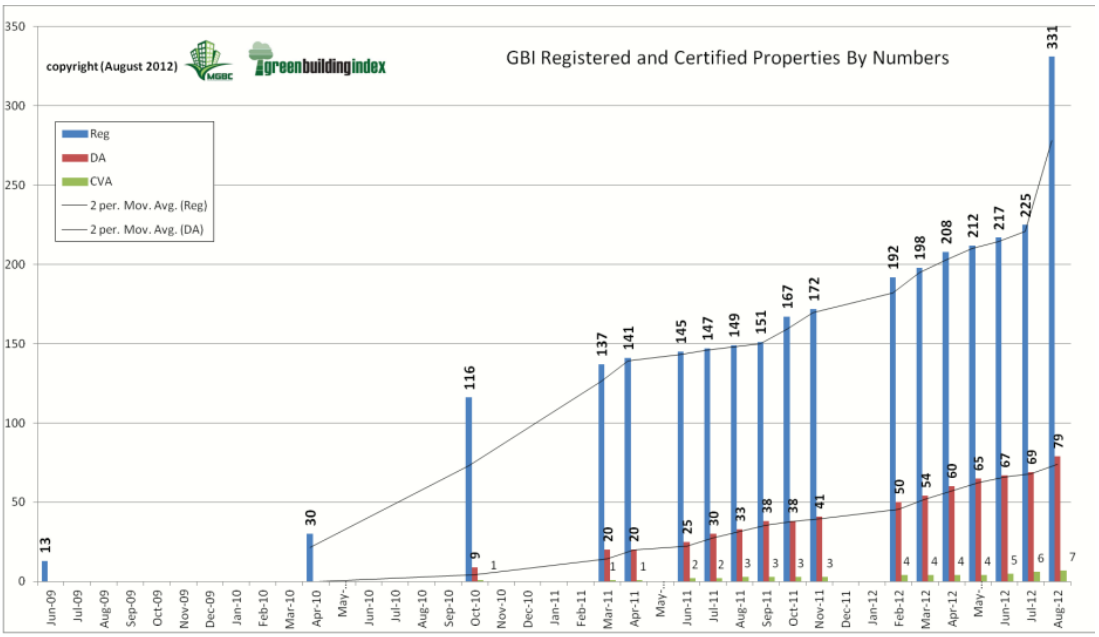
At present, there are several sustainable projects that are being or have been constructed in Malaysia. Several examples include the Bangunan Suruhanjaya Tenaga which achieved Platinum GBI rating, Ken Bangsar with Gold GBI rating, 1 First Avenue with Gold GBI rating and several hundred buildings that are currently being processed by the Green Building Index (GBI). This goes to indicate that the construction of sustainable projects in Malaysia with the concept of sustainable construction is beginning to settle within the industry. However, the development of sustainable buildings in Malaysia at this point in time is still relatively low. Projects on sustainability in Malaysia are mostly at its pioneering stage which indicates that the Malaysian construction industry is still at its infancy level when dealing with sustainable matters.

The growing number of sustainable projects being built in Malaysia is a sign of the moderate assimilation of the sustainability concept among construction practitioners. Much to the detriment of the matter, issues related to sustainability regularly appear in headlines, mainly about the dissatisfaction with the outcome or results of construction and the irresponsible actions by contractors and developers relating to environment protections. These negative remarks about construction show that the contributions and efforts by the government, non-government organisations and educational institutions have not fully penetrated into construction activities. Hence, a lot more effort and work are necessary to enhance and improve the level of environmental awareness and civic consciousness among the people to build sustainably in the future (Nazirah, 2009).

## 2.5 Green Building Index (GBI)

The building professionals of Persatuan Arkitek Malaysia (PAM) and the Association of Consulting Engineers Malaysia (ACEM) came together to form the Green Building Index (GBI) in May 2009. It is formed with the purpose to acknowledge and award local buildings that meet the requirements of a 'Green Building'. Developers and designers are able to construct green buildings without the need of hiring overseas facilitators or certifiers. Over the years, the number of rating system has increased as the market for green buildings is growing rapidly. It is an environment rating system that is viewed upon as a set of good construction guidelines, as marketing tools and also as a way of lowering operating costs (Reeder, 2010). As the main role, it gives the developers and building owners a set of guidelines to design and construct green and sustainable buildings.

The Green Building Index (GBI) Malaysia has already assessed over 26 million square feet of green buildings within 3 years of its launch (GBI, 2012). With the collaboration between GBI and the Malaysian Green Building Confederation (MGBC), the statistic shows that up to August 2012 there are a total of 331 buildings registered for GBI certification. Based on this statistic (http://www.mgbc.org.my/Downloads/Infobyte/20120917%20MGBC%20Info%20byte%2001%20-%20World%20Green%20Building%20Week.pdf), we can say that the Malaysian construction industry is on the right track towards a more sustainable future.




(Source: Malaysian Green Building Confederation (MGBC)

Figure 2.3: GBI Registered and Certified Properties by Numbers

The Green Building Index (GBI) evaluates the design with regards to environment and performance of Malaysian buildings based on the six main criteria of Energy Efficiency, Indoor Environment Quality, Sustainable Site Planning & Management, Materials & Resources, Water Efficiency and Innovation. Points are awarded accordingly for achieving and incorporating environmental-friendly features which are above current industry practice. The accumulated points will determine whether the building is classified under Platinum, Gold, Silver or Certified rating.

**Table 2.1: Green Building Index Classification**

**GBI CLASSIFICATION**

| POINTS | GBI RATING |
|---|---|
| 86+ points | Platinum |
| 76 to 85 points | Gold |
| 66 to 75 points | Silver |
| 50 to 65 points | Certified |

**Table 2.2: GBI points allocation chart (Residential New Construction, RNC)**

| PART | ITEM | MAXIMUM POINTS |
|---|---|---|
| 1 | Energy Efficiency | 23 |
| 2 | Indoor Environmental Quality | 12 |
| 3 | Sustainable Site Planning & Management | 37 |
| 4 | Material & Resources | 10 |
| 5 | Water Efficiency | 12 |
| 6 | Innovation | 6 |
| | TOTAL SCORE | 100 |

The GBI rating tools are separated into two types, Non-Residential and Residential. There are seven types of rating tool in total as of year 2012, Non-Residential New Construction (NRNC), Residential New Construction (RNC), Industrial New Construction (INC), Industrial Existing Building (IEB), Non-Residential Existing Building (NREB) and NRNC: Data Centre and Township. This research is based on the Residential New Construction (RNC) GBI rating tool. Table 2.2 shows the GBI Residential rating tool for evaluation of the sustainable aspects of residential buildings. This category includes linked houses, apartments, condominiums, townhouses, semi-detached and bungalows. The marked differences

between RNC and NRNC are the former places more emphasis on sustainable site planning and management, followed by energy efficiency. That serves to encourage developers and home owners to consider the environmental qualities of homes and their inhabitants through better site selection, provisions of public transport access, increased community services and connectivity and lastly improved infrastructure. Thus they will help to reduce the negative impact to the environment and create a better and safer place for residents and the community as a whole (GBI, 2009). Attached in Appendix A is the GBI assessment criterion for Residential New Construction (RNC).

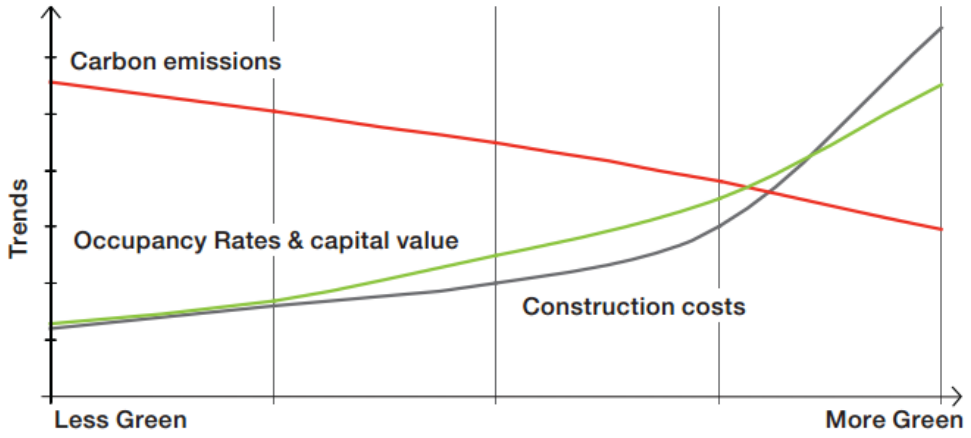
## 2.6 Cost Implication of Going Green

Having set the goals and incorporated them into the design and construction process, there is still the question of what the sustainable features will cost. Underlying this question, however, is another question: “Compared to what?” In many cases, this question is left unasked or is undefined. The most common comparison, at least in anecdotal reporting, is comparing the cost of the green project with the original project budget or the original anticipated cost of the project: “The final project cost me this much; I originally thought it would cost that much; the difference must be what I spent on making it green.” The most common reason cited in studies for not incorporating green elements into building designs is the increase in the initial cost (Morris, 2007).

Developers or owners decide to construct a green building often based on corporate peer pressure, demonstration of stewardship of the environment, operational cost savings through energy reduction, reducing their carbon footprint or just because they want to "do the right thing" (Taylor, 2011). Without proper project management at the inception stage, the developer will suffer higher cost to construct a green building. Owners including homeowners, developers and local government entities often want an environmentally friendly building but do not understand what are the cost implications associated with it. Research had shown that from a conventional building to achieving a building with GBI 'Certified' level rating

currently comes with a cost, but there is sufficient evidence that constructing sustainable buildings make good business (Metthiessen and Morris, 2007).

Builders and developers are moving away from financial modeling that focuses on payback or return of investment towards life-cycle costing (energy efficiency, maintenance cost and employee productivity rate) as it reveals a more realistic picture. Research had shown that green buildings are more valuable. The building will have lower refurbishment works in the future and also act as a safeguard to the end users from future significant energy price increases. Despite the cost implications to build a green building, certain developers are taking the big leap to meet the demand of purchaser of constructing green buildings. This is because the end users are willing to pay an upfront cost and save on the operating and maintenance cost throughout the life cycle of the buildings.




(Source: http://www.davislangdon.com/upload/StaticFiles/AUSNZ%20Publications/Info%20Data/InfoData_Green_Buildings.pdf)

Figure 2.4: Advantage and disadvantage of going green

The possibility that there will be extra cost implication in construction due to new initiatives to mitigate climate change may not be a long term matter. With new and energy efficient technology development, due to their low energy consumption,

the cost of green construction is likely to come down. It is said that, although environmental friendly buildings will cost 5-10 percent more up front, they will bring future savings of about 10-15 percent on energy expenses (BCA, 2007).

**Table 2.3: Cost Implication to Go Green**

| Green Building Index Rating | BEI kWh/m2 (Year) | Energy Saving (%) | Incremental Construction Cost (%) |
|---|---|---|---|
| Average Malaysian Building | 250 | Base | Base |
| Meets MS1525 | 200 – 22 | 10 – 20 | 0 - 3 |
| GBI Certified | 150 – 180 | 30 – 40 | 1 - 5 |
| GBI Silver | 120 – 150 | 40 – 50 | 3 - 8 |
| GBI Gold | 100 - 120 | 50 – 60 | 5 - 10 |
| GBI Platinum | <100 | >60 | 6 - 13 |

(Source: Green Building Index, 2012)

Table 2.3 shows there are cost implication to achieve different Green Building Index certification by comparing to an average Malaysian Building.

In addition, sustainable materials and systems are becoming more affordable, sustainable design elements are becoming widely accepted in the mainstream of project design and building owners and tenants are beginning to appreciate and demand for those features. It is important to note, however, that advanced or innovative sustainable features can add significantly to the cost of a project and that these must be valued independently to ensure that they are cost and/or environmentally effective. Besides, consultants and developers often look at the cost of the added green features individually and effectively comparing the building to itself without the green features. Looking at the added costs of green features create a presumption that the features are, in fact, additional, and that they can be readily priced as separate items and make assumptions regarding what would have been

built. For example, it is easy to look at the cost of a variable-frequency drive on a fan motor. Either you have one or you don't (Morris, 2007).

There are methods and items that could generate more GBI points and at the same time do not add to the initial cost implication for a project. Firstly, the designer should comply with an integrated design process, for example some green initiatives are not add ons but already incorporated from the beginning into the building in the pre-design stage. Decisions made during pre-design not only set the project direction, but can also prove cost-effective over the life of the project. Charting the course of the project at the very beginning by establishing green project goals, defining the process to achieve those goals and developing a clear understanding of the expected results is vitally important. A clearly developed project framework guides the decision-making process throughout the project, incorporating issues related to site selection and design, the building design and its systems, the construction process and building operations and maintenance (Bernheim & Reed, n.d.). This will allow the building owners and designers to achieve higher GBI rating without the need to spend a large sum of money.

Secondly, select a project team (design and construction) that has green design experience. They will have past experience and alternative ways to help the developer achieve the GBI points desired.

Third, optimizing the site selection and orientation of the building. This is because under the GBI index assessment criteria for Residential New Construction (RNC), the sustainable site planning and management carry a total of 39 points, the highest among all the six parts. This shows that site planning and management (SM) plays a big role when it comes to constructing a sustainable residential building.

Beside sustainable site planning and management, Energy Efficiency (EE) of the building is equally as important. Articles and research show that designers prefer to construct buildings which are capable of generating energy by themselves (i.e. self-sustaining) or consume lesser energy. According to Qaemi and Heravi (2012), the energy efficiency is a key performance criteria group for sustainable buildings.

Buildings not only use resources such as energy and raw materials but they also generate waste and potentially harmful atmospheric emissions (Alnaser et al. 2008b).

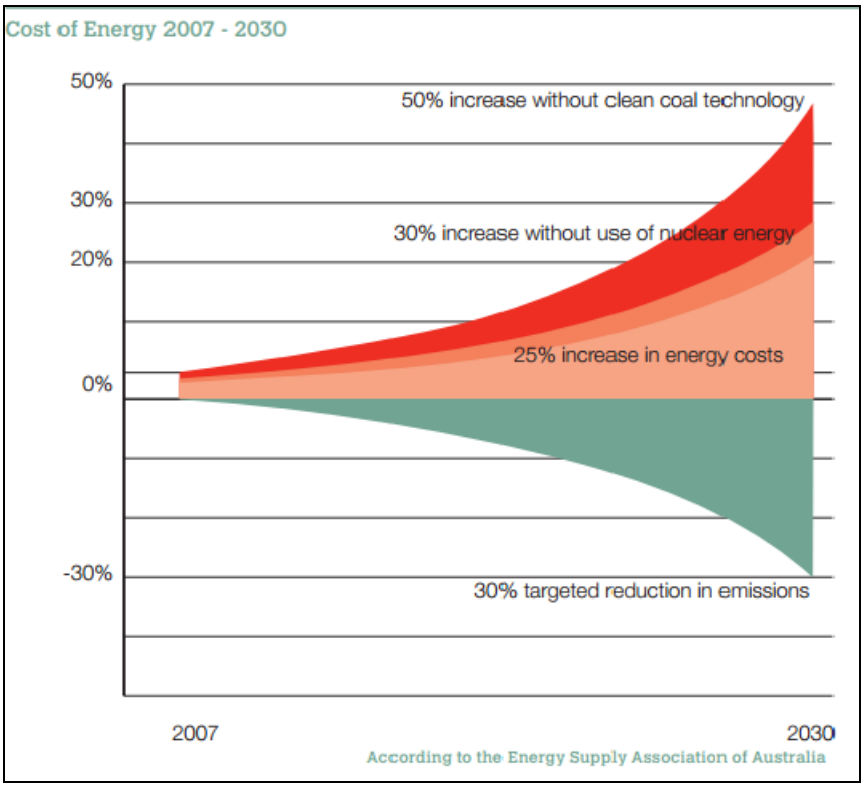
As the economy and population continue to expand, designers and builders face a unique challenge to meet demands for new and renovated facilities that are accessible, secure, healthy, and productive while minimizing their impact on the environment (Alnaser et al. 2008b). In the past decade, emphasis on green building design focused mainly on the development of energy saving technologies such as solar panels and wind farms (Chang et al. 2011). Modern buildings and their Heating, Ventilating, and Air Conditioning systems (HVAC) are nowadays required not only to be more energy efficient while adhering to an ever-increasing demand for better performance in terms of comfort, but equally in respect to financial and environmental issues (Mwasha et al. 2011). Such buildings will offer healthier and more efficient solutions to owners, occupants and businesses (Alnaser et al. 2008a). In order to reduce energy used and its effects on the climate, several strategies are necessary, including energy demand reduction, adoption of passive system and increased energy efficiency (Mwasha et al. 2011). Implementing these strategies in a green building would typically increase the initial capital cost of the building when compared with a conventional home. Yet, the added benefit of energy savings over time is believed to collectively offset part of this increased capital cost (Chang et al. 2011). For these reasons, all building professionals should make energy efficiency a key part of their professional activities. Building professionals should help clients to develop a brief which sets out both user and client requirements and constraints, balancing these against capital costs, running costs, whole life costs and environmental objectives (Energy efficiency in buildings, CIBSE Guide F 2004).

Lastly, the developer must be clear with the level of green certification he desires. For example, if the developer wants to achieve Gold rating, he should ask the designers to design the building according to that rating because if suddenly the developer wants to change from gold to platinum, the team members will have to do add ons. In most cases, these factors have a relatively small but still noticeable impact on the overall cost of sustainability. Cumulatively, however, they can make quite a difference. Thus, cost implications play a big part of sustainability in the construction industry.

### 2.6.1 Benefits of Going Green

Achieving high Green ratings also acts as a safeguard to minimize the effects of future energy price increases – the impact of which should not be underestimated. Therefore, certification with a third-party rating system can demonstrate to potential buyers that a certain level of sustainability has been achieved. According to Davis Langdon Australia (2007), the benefits for building owners who owns a green home include:

1. Potential higher occupancy rates
2. Higher future capital value
3. Reduced risk of obsolescence
4. Less need for refurbishment in the future
5. Ability to command higher lease rates
6. Higher demand from institutional investors
7. Lower operating costs
8. Mandatory for government tenants
9. Lower tenant turnover
10. Costs less to maintain and operate




(Source: Davis Langdon Australia, 2007)

Figure 2.5: Cost of Energy 2007 - 2030

Figure 2.5 shows the cost of energy will increase by 25% towards year 2030 if no effort is done by home owners to divert to sustainable energy. Moreover, if home owners participate in keeping their homes sustainable, they may reduce up to 30% of carbon emissions by year 2030 and also have a better chance of saving on energy price. Therefore, if any new tax in whatever form is imposed, a more energy efficient building will experience a lesser impact – acting as a safeguard to minimize the effects of future energy price increases.

### 2.6.2 Barriers of Going Green

Generally, the barriers or obstacles of going green will depend on the perspective of the person to which the question is directed at and his understanding of green

building design. Some of the major barriers or challenges as quoted by the chairman of Green Building Index Looi Hip Peu (2012), for sustainability drivers can be summarised as follows:

a) Insufficient depth of understanding – Whilst awareness and the take-up rate of green building has seen tremendous increase in the last 3 years, the industry is still plagued by insufficient understanding of the issues involved.

b) Affordable green buildings – The real challenge is to erect a green building at a low cost. Towards this end, it requires the designers to have very good design skill and a good understanding of building design in the context of sustainability and green.

c) Too much green washing – Due to the current uptrend of using 'green' in market branding, cutting through all these marketing claims on building products and its relevance to a particular green building criteria will be a challenge.

d) Managing the diverse social/political milieu - Malaysia is much more politically and socially diverse compared with many other countries. Whilst in one aspect, it may be viewed positively, but in another aspect it can have a negative impact on the consistency of national policies. Therefore a MAJOR challenge for Malaysia will be to manage all the diverse centres of interest-which represent political/policy centres and industry-vested interest. The very success of the GBI rating tool has made it a victim of its own success. This, to a certain extent, has triggered some kind of 'rush' amongst other centres-of-interest to attempt to replicate the 'success' of the GBI rating system. The challenge lies in managing all these diverse initiatives, which will increasingly devolve down to the local authorities. Whilst it may not be necessary or desirable to enforce a rigidly common policy throughout Malaysia (which is what most practicing engineers will love), all these diverse initiatives which are allowed to be enforced, must at least NOT severely conflict with each other or with the national policy in place.

e) Deepening the green-building movement – Green building and sustainable built-environment are just one aspect of the green building movements. Whilst the successful establishment and universal acceptance of the GBI rating tool set the pace, it requires other 'supporting' initiatives (whether led by government or the professionals from the industry) such as the national Ecolabel scheme, the establishment of national framework where life-cycle assessment and ultimately carbon accounting scheme can be implemented and accelerating research into 'next-generation' green buildings. As mentioned in (d) above, due to the diverse nature of Malaysian political/policy segment and industry-vested interest, some of these initiatives which have been initiated as far back as five years ago are proceeding in 'fits and starts'. Other concerns include initiatives which do not have sufficient technical competency (not for want of competent persons) and government inertia which move agendas at quite a slow pace etc. Some of these issues (national ecolabel agenda, simple carbon accounting scheme etc) have enough 'ground swell to warrant major concern.

f) Guarding against over regulation - Whilst the government is increasingly pushing green-technology into the national agenda, sometimes government initiatives tend to go overboard especially with the current rush to enact a plethora of 'energy' and 'sustainability' Acts and Regulations. A major challenge is to be able to convince the government NOT TO OVER-REGULATE and especially where new Acts or Regulations are to be enacted or gazetted, the institutional framework and structure must be carefully thought of before such Acts and Regulations are to be put in place

## 2.7 Sustainable Residential Building

Residential buildings comprises of linked houses, apartments, condominiums, townhouses, semi-detached and bungalows (GBI, 2009). A building shall be regarded as a residential building when more than half the floor area is used for dwelling purposes. One reason builders and developers prefer to build green homes

is to gain a market advantage. According to Rod Leaver from Land Lease, a speaker at the Tropical Subtropical Green Building Alliance Conference 2012, Green Star Rated Buildings have 5% higher rental and 12% higher value whereas for LEED rated buildings the developers enjoys 6% higher rental and 11% to 13% higher value.

One example which stood out in Malaysia is the S P Setia Bhd Group, who has been constantly applying for GBI assessments on their residential buildings for their buyers to enjoy the aforesaid benefits. They have been spearheading the sustainable development in the industry and constantly promoting sustainable homes. Their developments such as KL Eco City, Setia Eco Cascadia, Ecolakes in Vietnam, Setia Eco Park are pioneers of the eco-sanctuary concept in Malaysia and many more are being worked on by GBI facilitators and/or assessed by GBI certifiers. With the growing demand for sustainable residential buildings, S P Setia has made remarkable profit by supplying sustainable development to the public.

Martin et al. (2007) found that the three primary elements critical for growing a green home market are (1) consumers, (2) industry (both for profit and nonprofit organizations) and (3) government. Although there is encouraging progress green homes have yet to make serious inroads in terms of total market share. Several factors could have tempered with green homes penetration. For instance, consumer demand may seem to be or even actually be high but industry capability and/or government support are underdeveloped in relation to this latent demand. Conversely, the industry and government could be actively promoting the residential green building, but a strong consumer preference has simply not yet materialized. Green homes penetration will never be as rapid or as complete as when all three work together in a driven fashion.

Forecast growth in the Malaysian economy and population indicated that strong demands for housing will continue with the number of residential homes increasing tremendously annually. With the majority of these residential buildings to be built in urban areas, it is vital that development is achieved in a way which supports the development of sustainable, integrated neighbourhoods within our cities, towns and villages.


(Source: CIDB, Malaysia)

Figure 2.6: Total Projects According to Site Location

Based on the statistics released by Construction Industry Development Board (CIDB) in 2012, we could see that there are higher percentages of development projects done or on-going in urban areas such as Selangor, Wilayah Persekutuan (Kuala Lumpur) and Johor. In keeping with the concept, sustainable Residential buildings in urban areas must fulfil three categories, the Environmental Benefits, Economic Benefits and Social Benefits.

**1. Environmental Benefits**

- Able to enhance and protect the ecosystem
- Efficient usage of air and water
- Waste reduction
- Reduce greenhouse emissions

**2. Economic Benefits**

- Able to reduce operating cost by meeting energy efficiency
- Improve & optimize life cycle economics
- Improve performance

**3. Social Benefits**

- Enhance residents' comfort and health
- Improve overall quality of life for the residents

## 2.8 Concluding Remarks

Based on literature reviews with regard to the research objectives, this chapter has presented a detailed literature study on the importance of constructing sustainable buildings as well as the cost implications of achieving ‘Certified’ GBI rating for residential buildings in Malaysia. With sustainable development being a growing trend in Malaysia since year 2009, working out the initial costs for construction of green buildings before commencement of the projects are becoming essential routine as part of the works for both project managers and consultants. The results should give the developer an idea of what the cost implications are to achieve different GBI certification levels.

# CHAPTER 3

# RESEARCH METHODOLOGY

## 3.1 Introduction

Research Methodology is a study of the structure, logical organization, methods and means of a systematic approach or activity. Methodology, in this broad definition, is a necessary part of any activity, insofar as the latter becomes the object of consciousness, learning and rationalization in the conduct of an interview. It is essential in any research because it ensure the effectiveness and the smooth flow of the study process. This study uses a case study approach to identify the cost implications of a two blocks conventional condominium to achieve the certified Green Building Index (GBI) rating. Data for this research primarily came from interviews, feedbacks, competitive price quotations, bills of quantities for this project and an analysis of literature sources including books, industry journals, academic journals, newspapers and web sites.

## 3.2 Research Strategy

### 3.2.1 Primary Data

Primary data is often collected from methodologies that use case studies, experiments and questionnaire surveys (Tan, 2007). For example, primary data may be collected from proposed questionnaires or personal interview methods to solicit data or information from different construction consultants. The major advantage of primary data is accuracy of the data as collected by the researcher by time consuming and costly means.

### 3.2.2 Secondary Data

Secondary data is information collected by someone other than the author. Common sources of secondary data for social science include censuses, surveys, organizational records and data collected through qualitative methodologies or research. Secondary data analysis saves time that would otherwise be spent collecting data and, particularly in the case of quantitative data, provides larger and higher quality database which would be unfeasible for any individual researcher to collect on their own.

### 3.2.3 Semi-structured Interview

Interview is a face to face inter-personal situation which one person, the interviewer asks a person being interviewed, the respondent, questions designed to obtain answers pertinent to the subject matter in the research. The semi-structured interview can be thought of as a half-way house between the rigid formality of a structured interview, where the researcher attempts to fix and control the circumstances of the interview so that the data are collected in as consistent a fashion as possible, and the flexibility and responsiveness of a depth interview (Moore, 2000). The classifications

of interviews may be effected on the basis of various criteria. These may be classified according to their functions and number of persons participating. Semi-structured interviews are flexible, new questions can be brought up during the interview as a result of what the interviewee says. This allows the interview to flow more like a conversation.

## 3.3 Research Framework

A clear research framework should be properly designed in order to project a clear methodology for this research. Therefore in order to achieve the research aim and objective of the research, a research framework should be provided to highlight the proper steps to be established. The research flow and output are the main components in the research design as illustrated in Figure 3.1.

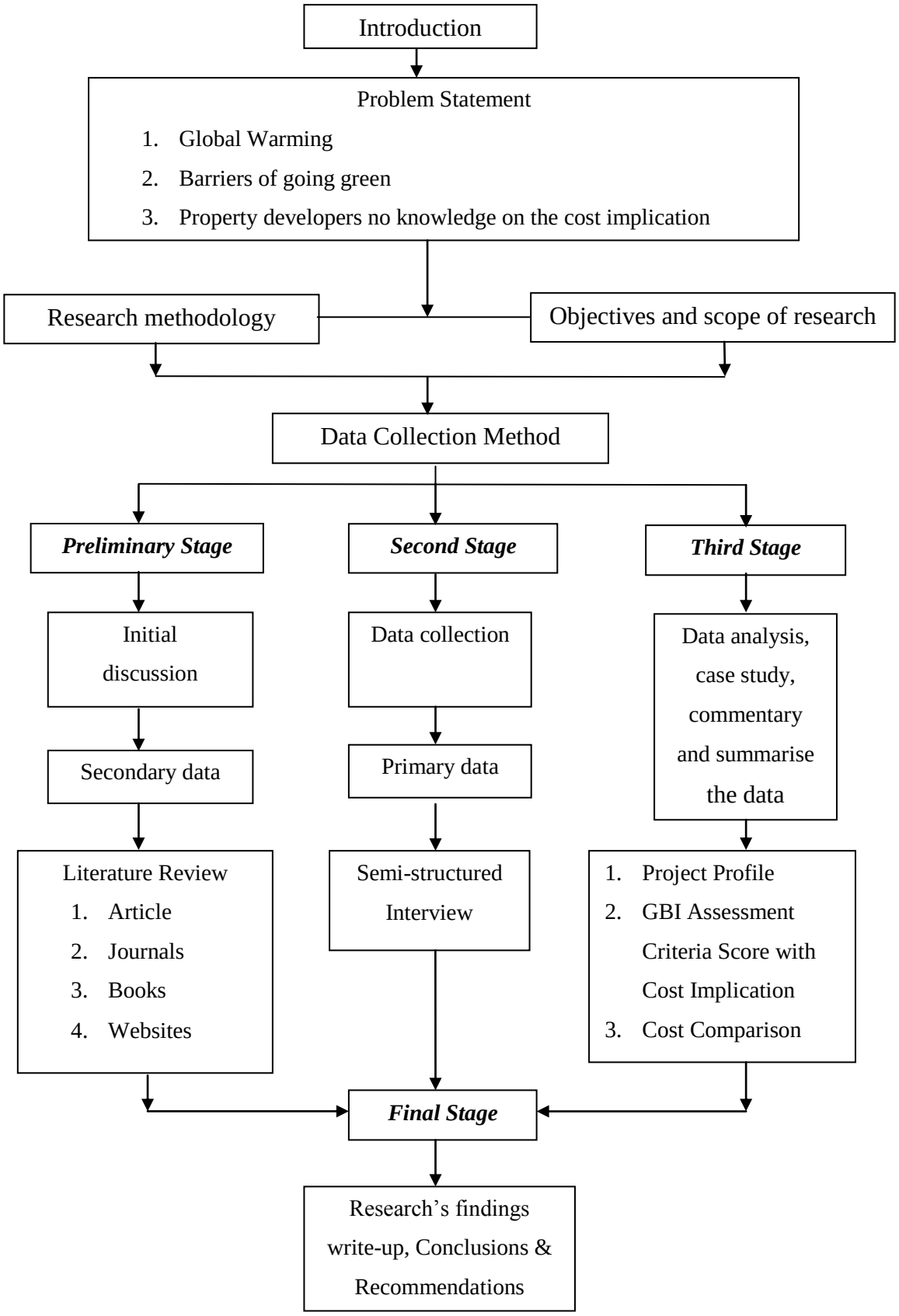



Figure 3.1: Flowchart of Research Methodology

### 3.3.1 Preliminary Stage

a) Initial Discussion

The discussion in this stage relates to the overview of the problem statement and issues related to the research whether it is significant to the industry. It is essential to conduct this discussion with the supervisor as he can provide me a full overview of the limitation and challenges on pursuing this topic and to guide me in completing my research without any impediment.

b) Literature Review

An in-depth literature review is conducted within this chapter, it is to strengthen and verify the area of research. It is to provide evidence that the researcher has read certain amount of relevant literature and he also has some awareness of the current state of knowledge on the subjects (Bell, 1993). With the objectives and scope of research properly defined in chapter one, this part of the research allows me to properly structure the literature review to suit the flow of the research. Reference books, articles, journals and various online sources are widely referred to in this chapter as it helps to strengthen the research reliance. The information in the literature review is then studied, analyzed and summarized to develop the research findings.

### 3.3.2 Second Stage

a) Data Collection – Semi-structured Interview

Interview is a common method used by many researchers to collect information as well as opinions in the research study. The data collected will usually be more reliable and contains more contextual information while providing an opportunity for the interviewee to give a more detailed response. First, the information will be

collected through interviews with the Quantity Surveyors and M&E Engineers in charge of the condominium project regarding the parts of the works covered for assessment and/or upgrading to gain certified GBI rating so as to give a broader understanding to perform this research. At the end of the data collection, I will perform another interview with the Quantity Surveyors to get their feedback on the results. The semi-structured interview was selected mainly because of its flexibility and appropriateness to the study needs.

### 3.3.3 Third Stage

a) Data Analysis, Commentary, Case Study and Summary of the Data

The data or information collected from stage two will be compiled and a summary on the research findings will be done in this stage. The items and figures from the Bills of Quantities are analyzed and abstracted into a summary. The rates for substituted works/products in the quest for certified GBI rating to complete this thesis are competitive rates obtained by me from quotations submitted by contractors, suppliers and nominated sub-contractors and cost advice from specialist consultants for the tender process.

### 3.3.4 Final Stage

a) Research findings write-up and Conclusion

The final stage is the most complicated stage where the findings will be compiled in the final research writing to explain and summarize the collected data for example by working out the percentage of cost difference between a conventional condominium and a condominium with certified GBI rating, which is essential to meet the overall determined objective.

## 3.4 Concluding Remarks

The research methodology described in this chapter enables data to be collected and analysis of the data to be made. All the research methods are interconnected and equally important to achieve the aims and objectives of this research. The detail of literature review (including documentary analysis), interviews and data analysis have been described. The outcomes of the analysis and results of the data collected are presented in Chapter 4.

# CHAPTER 4

# DATA ANALYSIS AND DISCUSSIONS

## 4.1 Data Collection and Research Analysis

### 4.1.1 Introduction

This chapter explains in detail the characteristics and profile of the project to enable a better understanding of the project's background. The GBI assessment criteria score with the applicable cost implications are tabulated in a table to show readers the additional points scored for this residential high-rise project with their corresponding cost implications to achieve the targeted 'Certified' rating. The outcomes obtained from numerous interviews with the specialist consultants of this project are analysed and elaborated further in this chapter. This research is essentially a case study on the Contract Bills of Quantities of the selected Residential High-rise project and calculating the costs of substituted works to achieve certified GBI rating, which include the calling of competitive quotations to make sure the rates are competitive.

The data and information collected from the interviews are compiled and discussed in this chapter. Besides, a summary on the research findings are evaluated and elaborated in detail in this stage. The relevant items and figures from the Bills of Quantities are abstracted and tabulated for cost comparison with the substituted elements and items that have cost implications in the project with a certified GBI rating.

## 4.2 Project Profile and Characteristics

**Table 4.1: Project profile and characteristics**

| No. | Items | Description |
|---|---|---|
| 1. | Project Name | 'Certified' Residential High-rise |
| 2. | Project Profile | 2 Block Service Apartment with 852 units, 6 Floor Car park Podium and Guardhouse |
| 3. | Type of Project | Luxurious high-rise residential development |
| 4. | Built-up | 463 to 1,789 sqft |
| 5. | Procurement Method | Traditional selective tendering method is used for this project because the process incorporates competition among competent contractors from a selected list which has the advantage of producing the highest quality of work. It is competitively tendered and finally awarded to a contractor before work starts on a lump sum basis, usually the lowest. The design is completed before commencement of construction and hence due to its greater degree of certainty in design, this procurement method tends to produce a higher quality of work. Each process of construction is undertaken by different parties having varied expertise in the building team. This method gives a high level of price certainty and control to the developer. |
| 6. | Contract Duration | Three Years |
| 7. | Selling Price | From RM310,000 (starting at RM670/sqft) |
| 8. | Location | Johor Bahru, Malaysia |
| 9. | Summary of Contract Sum | RM243,801,000.00 |

## 4.3 Assessment Criteria Score with Cost Implication

The complete Green Building Index (GBI) assessment scoring criteria are tabulated below with the Cost Implication column indicating whether there will be any cost implication after the designers and GBI facilitator perform add-ons for this project as highlighted by the GBI facilitator, project's consultant Quantity Surveyor and M&E Engineer. The add-ons are elaborated in detail under sub-topic 4.4 Cost Comparison.

**Table 4.2: Summary of Assessment Scoring Criteria and Whether There Will Be Any Cost Implication**

| Criteria | Items | Cost Implication |
|---|---|---|
| **EE** | **ENERGY EFFICIENCY** | |
| EE1 | Minimum EE Performance | Yes |
| EE2 | Renewable Energy | No |
| EE3 | Advanced EE Performance based on OTTV & RTTV | No |
| EE4 | Home Office & Connectivity | No |
| EE5 | Sustainable Maintenance | No |
| **EQ** | **INDOOR ENVIRONMENT QUALITY** | |
| EQ1 | Minimum IAQ Performance | No |
| EQ2 | Daylighting | Yes |
| EQ3 | Sound Insulation | No |
| EQ4 | Good Quality Construction | No |
| EQ5 | Volatile Organic Compounds | Yes |
| EQ6 | Formaldehyde Minimisation | No |
| EQ7 | Post Occupancy Evaluation: Verification | No |
| **SM** | **SUSTAINABLE SITE PLANNING & MANAGEMENT** | |
| SM1 | Site Selection | No |
| SM2 | Public Transportation Access | No |

| | | |
|---|---|---|
| SM3 | Community Services & Connectivity | No |
| SM4 | Open Spaces, Landscaping & Heat Island Effect | No |
| SM5 | Construction System & Site Management | No |
| SM6 | Stormwater Management | No |
| SM7 | Re-development of Existing Sites & Brownfield Re-development | No |
| SM8 | Avoiding Environmentally Sensitive Area | No |
| SM9 | Building User Manual | No |
| **MR** | **MATERIALS & RESOURCES** | |
| MR1 | Storage & Collection of Recyclables | Yes |
| MR2 | Materials Reuse and Selection | No |
| MR3 | Construction Waste Management | No |
| MR4 | Recycled Content Materials | No |
| MR5 | Regional Materials | No |
| MR6 | Sustainable Timber | No |
| **WE** | **WATER EFFICIENCY** | |
| WE1 | Rainwater Harvesting | Yes |
| WE2 | Water Recycling | No |
| WE3 | Water Efficient Landscaping | Yes |
| WE4 | Water Efficient Fittings | Yes |
| **IN** | **INNOVATION** | |
| IN1 | Innovation in Design & Environmental Design Initiatives | Yes |
| IN2 | Green Building Index Facilitator (GBIF) | Yes |

**Table 4.3: Summary of Green Building Index (GBI) points allocation**

| Summary | | | |
|---|---|---|---|
| | | **Allocated Points** | **Total GBI Score** |
| **1** | **Energy Efficiency (EE)** | **23** | **8** |
| **2** | **Indoor Environmental Quality (EQ)** | **12** | **9** |
| **3** | **Sustainable Site Planning & Management (SM)** | **37** | **29** |
| **4** | **Material & Resource (MR)** | **10** | **4** |
| **5** | **Water Efficiency (WE)** | **12** | **4** |
| **6** | **Innovation (IN)** | **6** | **4** |
| | **TOTAL** | **100** | **58** |
| | | **Grand Total** | **58** |
| | | **GBI rating** | **Certified** |

Table 4.3 shows a grand total of 58 GBI points scored for this residential high-rise project. This entitles the project a 'Certified' level GBI rating.

## 4.4 Cost Comparison

For a closer examination of all 6 sections, the tables below show the cost implications in comparing the non-green items with the aforesaid green items. In the tables below, the non-green cost expenditure for the elements of Windows and Vents, Roof and Roof Coverings, Internal Finishes (Painting), Sanitary Fittings, Mechanical & Electrical Works and Others are abstracted from the contract Bills of Quantities and compared against the costs of the alternative green items. The difference between them is then shown in the last column as the Additional Cost Required. Finally a summary of the total cost implications and the percentage of the total additional costs for all the aforesaid elements are presented below under Table 4.10.

### 4.4.1 Windows and Vents

**Table 4.4: Windows and Vents Cost Expenditure**

| | Item Description | Cost (RM) | Additional Cost Required (RM) | GBI Points Scored | |
|---|---|---|---|---|---|
| Non-green Item | Clear Glass | 1,173,083.00 | | | |
| Green Item | Tinted Tempered Heat Soaked Glass | 2,074,673.63 | 901,590.63 | EE1<br>EQ2 | 2<br>1 |
| | Vertical Louvers | 1,533,186.26 | 1,533,186.26 | | |
| **Total :** | | | **2,434,776.89** | | |

Table 4.4 shows a total of RM2,434,776.89 in additional cost is required under the element of Windows and Vents if a tinted tempered heat soaked glass and vertical louvers are used. Instead of using clear glass which allows 100% heat penetration into the building, designers have come up with designs and ideas to block or reduce heat penetration and still allow considerable daylight to enter.

By using a tinted glass over the conventional clear glass, it is able to prevent excessive direct sunrays penetrating into the building. This will have an entitlement of 2 points under Minimum EE Performance. By eliminating certain amount of heat caused by sunrays, the indoor environment will be kept at a satisfactory comfort level. For example, the air conditioning unit can be maintained to work at a temperature at 22-25 degree Celsius throughout the whole day without the need for the air conditioning unit to work harder during mid-day. They are able to establish minimum Energy Efficiency (EE) performance to reduce energy consumption in buildings which could reduce the amount of carbon dioxide emission to the atmosphere.

### 4.4.2 Roof and Roof Coverings

**Table 4.5: Roof and Roof Coverings Cost Expenditure**

| | Item Description | Cost (RM) | Additional Cost Required (RM) | GBI Points Scored | |
|---|---|---|---|---|---|
| Non-green Item | | | | | |
| Green Item | Horizontal Sunshading | 172,740.00 | 172,740.00 | EE1<br>EQ2 | 1<br>1 |
| **Total :** | | | **172,740.00** | | |

Table 4.5 shows the addition of horizontal sunshadings to the design not only for aesthetic purposes but also to prevent excessive direct sunrays penetrating into the building. They are positioned strategically to block direct sunrays entering yet allowing views out from the building and/or allowing indirect lighting into the building. Similar to "Windows and Vents", the GBI facilitator advised that the addition of horizontal sunshading will contribute to the area of assessment under: "Daylighting". This also helps to minimize the energy efficiency performance which will entitled them an additional 1 point under EE1 Minimum EE Performance.

In addition, under EQ2 for daylighting, the project's design has a daylight factor of between 1%-3.5% for more than 50% of Habitable spaces and hence deemed to have demonstrated that the nominated percentage for Habitable Rooms as defined under UBBL of minimum 1% measured at floor level has been met and therefore is entitled to 1 point.

### 4.4.3 Internal Finishes (Painting)

**Table 4.6: Internal Finishes (Painting) Cost Expenditure**

| | Item Description | Cost (RM) | Additional Cost Required (RM) | GBI Points Scored | |
|---|---|---|---|---|---|
| Non-green Item | Basic Emulsion Paint | 2,503,179.20 | | | |
| Green item | Low Volatile Organic Compound (VOC) Paint | 4,205,567.37 | 1,702,388.17 | EQ5 | 1 |
| **Total :** | | | **1,702,388.17** | | |

The type of painting used plays an important role in making the habitable space free from substances that could harm the health of the occupants. As such, instead of using the normal emulsion paint, low VOC paint is used which the GBI recognises and rewards under the area of assessment: “Volatile Organic Compounds”. Attached in Appendix B is the competitive quotation from Nippon paint. For EQ5 on use of low Volatile Organic Compound (VOC), 0.5 point is awarded for using low VOC paints/coating to all internal walls and another 0.5 point for using low VOC carpet/flooring.

### 4.4.4 Sanitary Fittings

**Table 4.7: Sanitary Fittings Cost Expenditure**

| | Item Description | Cost (RM) | Additional Cost Required (RM) | GBI Points Scored | |
|---|---|---|---|---|---|
| Non-green Item | Normal Water Fittings (No WELS Ticks) | 1,702,489.40 | | | |
| Green item | Water Efficient Fittings (With 2 WELS Ticks) | 1,968,705.00 | 266,215.60 | WE4 | 2 |
| **Total :** | | | **266,215.60** | | |

Attached in Appendix C is a supply only quotation obtained competitively from Johnson Suisse. Installation and labour charges are added to the supply only rates of water efficient fittings in the quotation from Johnson Suisse for “apple to apple” comparison with the all-in rates of normal non water efficient fittings in the Bills of Quantities to give us a clear picture of the additional cost implication. As such, water efficient sanitary fittings with 2 WELS (Water Efficiency Labelling and Standards) ticks are suggested to be used which can increase the GBI score by another 2 points.

### 4.4.5 Mechanical & Electrical

**Table 4.8: Mechanical & Electrical Cost Expenditure**

| | Item Description | Cost (RM) | Additional Cost Required (RM) | GBI Points Scored | |
|---|---|---|---|---|---|
| Non-green Item | Normal Fluorescent Light (T8) | 26,800.00 | | | |
| Green Item | Energy Saving Fluorescent Light (T5) | 85,760.00 | 58,960.00 | IN1<br>WE3 | 1<br>1 |
| | Rainwater Harvesting System | 300,000.00 | 300,000.00 | WE1 | 1 |
| **Total :** | | | **358,960.00** | | |

During my consultations with the Mechanical & Electrical engineer, the latter highlighted two items which can contribute to the GBI rating, i.e. using T5 fluorescent lights and incorporating a rainwater harvesting system. The T5 Fluorescent lights save up to 25% more energy than the conventional T8 fluorescent lights. 1 point is given under IN1 Innovation in Design & Environmental Design Initiatives for using energy efficient fluorescent light

For the second item, rainwater harvesting entails the collection and storage of rainwater for reuse before it reaches the aquifer. It is used to provide water for irrigation as well as other similar uses. Although some rooftop materials may contaminate the rainwater collected and could be harmful to human health as drinking water, it can be useful for watering the garden and washing cars; these uses alone may amount to half the water used in a typical home. The engineer had graciously advised me of the materials required and provided me the rates including the quantities of work necessary for me to work out the total cost of RM358,960.00. As such, with the incorporation of a rainwater harvesting system into the design, 1

point can be obtained under WE1 Rainwater Harvesting and another 1 point under WE3 Water Efficient Landscaping.

### 4.4.6 Others

**Table 4.9: Other Cost Expenditure**

| | Item Description | Cost (RM) | Additional Cost Required (RM) | GBI Points Scored | |
|---|---|---|---|---|---|
| Non-green Item | | | | | |
| Green Item | GBI Registration Fees (100,000m2) | 45,000.00 | 45,000.00 | IN2 | 1 |
| | Composting Bins (270litre) | 5,200.00 | 5,200.00 | IN1 | 1 |
| | Vertical Landscape (Green Wall) | 350,000.00 | 350,000.00 | IN1 | 1 |
| | Recycle Bins | 4,200.00 | 4,200.00 | MR1 | 2 |
| **Total :** | | | **404,400.00** | | |

Items which are not included in the Bills of Quantities but nevertheless are cost implications to the project to achieve 'Certified' GBI rating are classified under "Others". GBI registration fees can be found on their web page which works out to RM45,000.00 basing on the building area category for Extra Large Project of 50,001-100,000m2. Other items such as Composting Bins, Vertical Landscape (Green Wall) and Recycle Bins are within the job scope of the landscape consultant. The green wall by Earthia Green (M) Sdn. Bhd. includes panels/pots, plants and an irrigation system. The landscape consultant has kindly provided me the costing of the green wall, also attached in Appendix D is the quotation for the Composting Bins.

Furthermore, any creative sustainable ideas incorporated into the building design shall come under IN1 Innovation in Design & Environmental Design Initiatives. Providing composting bins within the building's perimeter to meet 100%

of landscape fertilizer needs will be entitled to 1 point, putting up green walls another 1 point and employing a GBI facilitator will increase the GBI score by 1 point under IN2. Lastly, the project also properly facilitates the reduction of waste generated by construction, by providing dedicated area(s) for non-hazardous materials for recycling which is good for 1 point whereas providing permanent recycle bins during building occupancy will be entitled to another 1 point thereby giving a total of 2 points under MR1 Storage & Collection of Recyclables.

### 4.4.7 Summary

**Table 4.10: Summary**

| Items | Total Cost (RM) | Total Cost Implication (RM) | Total Percentage (%) |
|---|---|---|---|
| Contract Sum | 243,801,000.00 | | |
| Windows and Vents | | 2,434,776.89 | |
| Roof and Roof Coverings | | 172,740.00 | |
| Internal Finishes (Painting) | | 1,702,388.17 | |
| Sanitary Fittings | | 266,215.60 | |
| Mechanical & Electrical | | 358,960.00 | |
| Others | | 404,400.00 | |
| **TOTAL** | **243,801,000.00** | **5,339,480.66** | **2.2** |

All the Additional Costs Required are tabulated in the Summary Table 4.10 which shows a total cost implication of RM5,339,480.66 for this residential high-rise project to achieve ‘Certified’ GBI rating. In another words, the developer will need to provide the equivalent of 2.20% more aside from the contract sum of RM243,801,000.00 to convert the conventional residential high-rise project to a ‘Certified’ rated green building.

## 4.5 Interview and Feedback

### 4.5.1 Introduction

There were two (2) persons invited to participate in the semi-structured interview. Firstly, Sr Steven Haw Chin Dee, a registered Quantity Surveyor who is the Project Quantity Surveyor for this project from Yong dan Mohammad Faiz Sdn Bhd, and Sr Siow Yin Zoon, a registered Quantity Surveyor who is a Director from RL Bersepadu Sdn Bhd. The interviews were conducted to obtain their feedback on the cost implications for a conventional high-rise building to achieve 'Certified' level Green Building Index (GBI) rating.

Both of them is knowledgeable and has experience on sustainable construction with personal involvement in the construction of green buildings. Besides, they are both quantity surveyors and as such very well verse with costing and estimating. They are very kind to accept interviews with me and provide answers to all my questions relating to the cost implications for upgrading a conventional residential high-rise building to achieve 'Certified' Green Building Index (GBI) rating. The interview questionnaires were prepared to obtain their feedback and views on the costings which are processed and given in the cost tabulation above.

The interview process has been conducted within the district of Kuala Lumpur. Based on their professional knowledge and invaluable experience, the results obtained are supportive and applicable to my research. The backgrounds of the interviewees are briefly described in short notes as listed below. Their background information consists of data on the interviewees' names, professions, company names and current positions in their companies.

**Table 4.11: Background of Interviewees**

| Interviewees Name | Profession | Company Name | Current Position |
|---|---|---|---|
| Sr Steven Haw Chin Dee | Quantity Surveyor | Yong dan Mohamad Faiz Sdn. Bhd. | Project Quantity Surveyor |
| Sr Siow Yin Zoon | Quantity Surveyor | RL Bersepadu Sdn. Bhd. | Director |

### 4.5.2 Summary of Interviews

#### 4.5.2.1 Project Quantity Surveyor – Sr Steven Haw Chin Dee

Based on the interview with Sr Haw, he commented that Malaysia's residential green building market is growing rapidly and maturing over the years but there still remains much to be understood about the dynamics of key market elements. The construction industry still encounter problems such as the lack of people willing to spend on extras for green building materials and the lack of knowledge to fully improvise innovations in sustainable projects. Sr Steven had given his opinion that some people still hesitate to use green building materials because of the misconception of very high costs. Cost is undeniably the most important criteria which dictates the developer's decision whether to construct a sustainable green building. Most of the time the developers are focused on maximizing profits, so they must first be convinced that constructing sustainable buildings can be profitable and such initiatives will indirectly levitate the profile of their companies.

I had approached Sr Steven who is the project quantity surveyor of the green building project to review my cost calculations which he described as accurate and reflected the actual additional cost to achieve 'Certified' Green Building Index (GBI) rating. He confirmed that the results of my research reaffirm the general view in the industry that 'Certified' GBI rating has a cost implication of roughly 2-3%. Sr Steven added that in his opinion, buildings with "Platinum" Green Building Index (GBI)

rating will incur an estimated additional cost implication of 7-10%. Sr Steven foresees that in the near future after wider acceptance of green buildings and competition among green building materials, the price of 'greening' buildings will eventually go down and no longer becomes an issue.

In conclusion, Sr Steven gave his view that the cost implication will reduce through time as incorporation of green features are gradually increased until the practice becomes entrenched in the design process. Finally in future, architects will automatically incorporate green or sustainable design into their buildings. The country will need political commitment to bring sustainable development into the next level including changes in legislations. At present there has been no comprehensive reform of environmental and natural resource legislation in the context of sustainable development.

#### 4.5.2.2 Director Quantity Surveyor – Sr Siow Yin Zoon

At the interview with Sr Siow, he said that sustainability in construction is the current "trend" in the construction industry because the earth's ecosystems are now at a critical stage where they are not only being severely damaged but current human activity leads to irreversible losses of critical (i.e. life-supporting) ecosystem functions. Buildings and construction works produces the highest carbon dioxide and other pollution emissions. Therefore in order to save our environment, Sr Siow felt that the best way is to adopt sustainable development and use environmental friendly building materials in construction.

For the past 2 years, Malaysia's sustainable development has grown rapidly and the number of green buildings is increasing. This is because developers felt that there is growing interest and demand for green buildings. It has also resulted in a slight rush among prominent developers to raise their profile by becoming pioneers in the construction of sustainable buildings. According to Sr Siow, the prices of green building materials had been steadily dropping since two years ago due to higher competition among the manufacturers and suppliers.

Regarding the cost implication of upgrading a conventional building to achieve ‘Certified’ Green Building Index (GBI) rating, Sr Siow commented that there is always a premium we have to pay to save Mother Nature. He said that normally the cost implication will vary between 2-10% depending on the level of certification. To go green, we will have to pay a slightly higher price than the conventional items. Sr Siow also shared the opinion that some developers still hesitate to construct sustainable buildings because of the wrong perception of very prohibitive high costs. It is hoped that the Malaysian Green Building Confederation (MGBC) which was setup to help educate the public on sustainability will meet with success.

To support in the construction of sustainable buildings, the local authorities are playing their part by implementing laws and/or imposing conditions requiring buildings within their jurisdiction to have at least ‘Certified’ Green Building Index (GBI) rating otherwise the building plans will not be approved. Lastly, Sr Siow concurred with the results of my cost calculations and added that the cost may currently be at this level but it will definitely be lower in the future due to wider usage and competition.

## 4.6 Conclusion

There seems to be no published work or research which documented a proper cost breakdown of the cost implications of going green. Therefore, this chapter endeavours to show a complete and detail cost calculations of the cost implications for Windows and Vents, Internal Finishes (Painting), Roof and Roof Coverings, Sanitary Fittings, Mechanical and Engineering and Others to achieve 'Certified' GBI rating. The relevant items are properly broken down under sub-topics for Cost Comparison together with additional information which are attached in the appendices. The Cost Comparison shows the cost difference for a residential high-rise project to achieve 'Certified' Green Building Index (GBI) rating. The total cost implication is also presented in the form of a percentage to give the reader a better perspective of the proportion of additional cost over the contract sum which the developer will have to spend to achieve 'Certified' Green Building rating (GBI).

Moreover, after going through the interviews, both interviewees concurred with the results of my research particularly with regards to the quantum and percentage representation of the cost implication to incorporate sustainable materials/item and design to transform a conventional residential high-rise building into one with a 'Certified' Green Building Index (GBI) rating.

# CHAPTER 5

# CONCLUSION AND RECOMMENDATIONS

## 5.1 Introduction

In conclusion, I felt that the demand has not caught up with the supply because the market for green buildings is still in its infant stage and only those environmentally-conscious consumers will appreciate their worth. The developers will then have to face the risks of a slow take up rate in sales for the development because as with most other buildings, green buildings are also demand-driven. The environmentally-conscious consumers are those who are willing to pay the extra 'premium' to save the environment. Compared to the conventional types of building and depending on how "green" the building is, there is an extra cost implication to achieve different certification levels. Hopefully after conducting this research, it will give a clearer picture to the readers on the cost implication for a residential high-rise project to achieve 'Certified' GBI rating.

This chapter summarizes the findings which were obtained from the executed research. The conclusion of the overall analysis and result are summarized based on the research objectives. The problems and limitations which arose while doing this research are also stated in this chapter. The recommendations for continuation of this research are also proposed in this chapter.

## 5.2 Research Contribution to the Construction Industry

With the results obtained from this research, the cost implication of constructing a building with 'Certified' GBI rating is now known with some degree of certainty. Knowing the cost will give the developers more confidence to embark on green building projects as they can now build in the additional cost into their feasibility studies and evaluate the financial risk of their development. Being able to forecast the expected additional cost will take away the fear of budget over-run affecting the profitability or feasibility of the project and hence promote the building of more green buildings. In other words, this research will result in the construction of more green buildings as a contribution to the 'greening' of the construction industry.

## 5.3 Research Limitations

This research has been reasonably well executed and all the objectives have been achieved. However, there are some constraints that I encountered while completing this research.

1. Among the main problems faced in this research process is to ensure that the quotations obtained were competitive and the prices were at their most reasonable best. Extra time is needed to complete this research for more aggressive checking to ensure the prices obtained in quotations are reasonable. It is a concern of mine that some of the rates given by the supplier or contractor may possibly be high if they felt that their quotations are for academic purpose and not to secure any work. However this concern had been overcome to a certain degree with the help of the project quantity surveyor, senior quantity surveyors and engineers involved in this project to review and even provide me with competitive rates for this research.

2. Another constraint is time and the availability of more sample projects of green buildings so that the results are more representative of the industry as a whole. More industry players must be willing to open up their projects for

research as many would like to maintain confidentiality due to competition in business. However, this research may take more time if more projects are included in the case study.

## 5.4 Recommendations for Continuation Research

The cost implications to achieve different Green Building Index (GBI) certifications will be continuously under study. For a better understanding on the cost implications of constructing a sustainable building, the following recommendations have been proposed and the possible areas for future research that may also be beneficial to the industry:

a) Designers adopting an integrated green approach to design (integrated green design approach)
    - Designers control the design, planning and materials to meet time and budgetary constraints. Hence, it will be beneficial for the developer to know whether there will be a difference in cost and if so, what is the cost difference if green features are incorporated at the initial project conception stage as compared to the ‘greening’ process being implemented during the construction stage. Therefore, it is proposed that a research be continued in that area to find out the cost difference, whether the cost implication will be higher or lower if the design and materials are decided in the early or later stage.

b) Education and training programs on benefits of incorporating sustainable development concept.
    - Professional bodies should take up the responsibility in educating the construction players through conducting conferences, training sessions, seminars and workshops. A study is proposed whether those education and training programs do help in increasing the usage of sustainable materials and reducing the cost implication in ‘greening’ buildings.

c) Cost Implications

- Currently, it is the expectation among industry players that the additional cost implications for a conventional building to achieve different levels of GBI certification (i.e. 'Certified', 'Silver', 'Gold' and 'Platinum') varies between 2% to 10%. With the conclusion of my research, it is now evident that the additional cost implication to achieve 'certified' GBI rating is about 2.2%. It is hoped that further of similar researches be conducted to also identify the additional cost implications of a conventional building to achieve Silver, Gold and/or Platinum GBI ratings for the benefit of industry players to forecast and fix budgetary costs.

## 5.5 Conclusion for Overall Research Results

This research study has successfully achieved all three objectives as stated in the first chapter, namely:

1) To identify the total additional cost implication for a conventional residential high-rise project to achieve 'Certified' Green Building Index (GBI) rating. With the proper guidance of Sr Steven, this objective is successfully reached and the total additional cost implication to achieve 'Certified' GBI rating as worked out in Chapter 4 came up to RM5,339,480.66.

2) To identify the percentage of the total additional cost implication after achieving the targeted 'Certified' GBI rating over the cost of the conventional base building. Industry players are accustomed to making comparisons and referring additional cost in percentages because a sum or an amount on its own cannot be applied to another project unlike a percentage which can be applied to any other similar projects and the amount proportionally represented. Percentage also provides an impact for better representation. Thus, the total additional cost implication of RM5,339,480.66 works out to 2.2% of the contract sum. The percentage represents the proportion of the

contract sum required to transform a conventional residential high-rise project to one with a ‘Certified’ Green Building Index (GBI) rating and is envisioned to give a better realisation of the cost impact.

3) To highlight the elements and items incorporated into the building to achieve ‘Certified’ Green Building Index (GBI) rating. In order that this research met this objective, cross-checks were made in interviews with the project Quantity Surveyor, GBI facilitator and the Mechanical and Electrical Engineer. The items that contribute points to the Green Building Index (GBI) and proposed items to add additional points to achieve ‘Certified’ Green Building Index (GBI) rating were extensively discussed. The items and elements that are taken into consideration or affected in this project to achieve ‘Certified’ GBI rating are Windows and Vents, Roof and Roof Coverings, Internal Finishes (Painting), Sanitary Fittings, Mechanical and Electrical and Other independent cost items.

In conclusion, the Author wishes that the information in this report can assist future researchers to embark on further researches pertaining to the field of sustainable buildings and use the any suggestion contained hereinbefore as rough guidelines for the direction of the next research.

# REFERENCES

Adshed, J. (Eds.). (2011). *Green Buildings and the Law*. Canada: SPON Press.

Aini Jaapar and Nazirah Zainul Abidin. (2008). *Sustainable Concept Awareness in Malaysia Construction Practices*. Retrieved January 15, 2013, from http://www.ljmu.ac.uk/BLT/BUE_Docs/Nazirah_Aini.pdf

Alnaser, N. W., Flanagan, R., Alnaser, W. E. (2008a). *Potential of making—Over to sustainable buildings in the Kingdom of Bahrain.* J. Energy and Buildings. 40. 1304–1323.

Alnaser, N. W., Flanagan, R., Alnaser, W. E. (2008b). *Model for Calculating The Sustainable Building Index (SBI) In the Kingdom of Bahrain*. J. Energy and Buildings. 40. 2037–2043.

Bell, J. (1993). *How to Complete Your Research Project Successfully: A Guide for First-Time Researchers.* New Delhi: UBS Publisher's Distributors Ltd.

Bernheim, A. and Reed, W. (n.d.). *Pre-Design Issues*. Retrieved October 5, 2012, from http://www.gbci.org/Libraries/Credential_Exam_References/Sustainable-Building-Technical-Manual-Part-II.sflb.ashx.

Chang, N. B., Rivera, B.J. and Wanielista, M. P. (2011). *Optimal Design For Water Conservation and Energy Savings Using Green Roofs In a Green Building Under Mixed Uncertainties*. J.Cleaner Production. 19. 1180-1188.

Das Gandhi, N.M., Selladurai, V. and Santhi, P. (2006). *Unsustainable Development to Sustainable Development: A Conceptual Model*. International Journal of Management of Environment Quality, 17(6).

Davis Langdon Australia. (2007). *The Cost & Benefit of achieving Green Buildings*. Second Quarter. Retrieved August 2, 2012, from http://www.davislangdon.com/upload/StaticFiles/AUSNZ%20Publications/Info%20Data/InfoData_Green_Buildings.pdf

Earth Advantage Institute. (2012). *10 Green Building Predictions for 2012.* Retrieved July 23, 2012, from http://www.prnewswire.com/news-releases/10-green-building-predictions-for-2012-from-earth-advantage-institute-137470028.html.

Edward R. Henry. (2011, July 21). *Rewarding lifestyle : Proposal to give rebates to residents who adopt the green way*. StarMetro, p.3.

Eight Malaysia Plan (2001) *Eight Malaysia Plan 2001-2005.*, Percetakan Nasional Malaysia, Kuala Lumpur.

Florence Yean Y. L. and Gunawansa,A. (2011). *Strategies for Potential Owners in Singapore to own environmentally sustainable homes*. Journal of Engineering, Construction and Architectural Management, 18(6), 579-594.

Green Building Index. (2009). *The GBI Rating System*. Retrieved July 20, 2012, from http://www.greenbuildingindex.org/how-GBI-works2.html#RatingTools

Green Building Council. (2009). *US Green Building Council, Green Building Council*. Retrieved July 23, 2012, from http://www.usgbc.org/displaypage.aspx?CMSPageID=1449

Lindsay, E. (2012, May 30). *Construction industry a significant contributor to the nation's GDP*. Borneo Post online. Retrieved July 20, 2012, from http://www.theborneopost.com/2012/05/30/construction-industry-a-significant-contributor-to-the-nations-gdp/

Looi, H.P. (2012). *MGBC Infobyte : World Green Building Week 2012.* Malaysia Green Building Confederation. Retrieved October 3, 2012, from http://www.mgbc.org.my/Downloads/Infobyte/20120917%20MGBC%20Info%20byte%2001%20-%20World%20Green%20Building%20Week.pdf

Looi, H.P. (2012). *The Growth of Green Building : Interview with the President of MGBC*. iProperty.com Malaysia, 92, 20-22.

Mahsa Qaemi & Gholamreza Heravi. (2012). *Sustainable Energy Performance Indicators of Green Building in Developing Countries*. Dissertation Abstracts International. 1961-1970.

Matthiessen, L. F. and Morris, P. (2007). *Cost of Green Revisited : Re-examining the Feasibility and Cost Impact of Sustainable Design in the Light of Increased Market Adoption* (Research Report). Retrieved July 23, 2012, from http://www.davislangdon.com/upload/images/publications/USA/The%20Cost%20of%20Green%20Revisited.pdf

Moore, N. (2000). *How to Do Research: The Complete Guide to Designing and Managing Research Projects.* London: Library Associating Publishing.

Morris, P. (2007). *What Does Green Really Cost?.* PREA Quarterly, Summer. Retrieved August 2, 2012, from http://www.davislangdon.com/upload/images/publications/USA/Morris%20Article.pdf.

*M'sia's GDP grows 5.2% in Q4 2011*. (2012, Febuary 15). The Star Online. Retrieved July 19, 2012, from http://biz.thestar.com.my/news/story.asp?file=/2012/2/15/business/20120215180241&sec=business

Martin, J., Swett, B. and Wein, D. (2007). *Residential Green Building Report : A Market Engagement Framework For Developers and Builders*. Retrieved September 26, 2011, from http://www.erb.umich.edu/Research/Student-Research/ResidentialGreenBuildReport.pdf

Mwasha, A., Williams, R. G. and Iwaro, J. (2011). *Modelling the performance of residential building envelope: The role of sustainable energy performance indicators.* J. Energy and Buildings. Article in press.

Nazirah Zainul Abidin, (2009). *Sustainable Construction in Malaysia – Developers' Awareness*. Retrieved July 20, 2012, from http://www.waset.org/journals/waset/v53/v53-131.pdf.

New Straits Times. (2012). *Green Technology: Enticements to go green*. Retrieved January 15, 2013, from http://www.nst.com.my/opinion/letters-to-the-editor/green-technology-enticements-to-go-green-1.63378

RSMeans. (2011). *Green Building, Project Planning & Cost Estimating Third Edition*. Canada: John Wiley & Sons, Inc., Hoboken, New Jersey.

Reeder, L. (2010). *Guide to Green Building Rating System*. Canada: John Wiley & Sons, Inc., Hoboken, New Jersey.

Thomas A. Taylor. (2009). *Guide to LEED 2009: Estimating and Preconstruction Strategies*. Canada: John Wiley & Sons, Inc., Hoboken, New Jersey.

# APPENDICES

APPENDIX A: GBI assessment criterion for Residential New Construction (RNC)

APPENDIX B: Competitive quotation by Nippon Paint

APPENDIX C: Competitive quotation for water efficient fittings with 2 WELS tick

# APPENDIX D: Quotation for Composting Bins

# APPENDIX E: Windows and Vents Cost Tabulation

# APPENDIX F: Roof and Roof Coverings Cost Tabulation

# APPENDIX G: Internal Finishes (Painting) Cost Tabulation

# APPENDIX H: Sanitary Fittings Cost Tabulation

# APPENDIX I: Mechanical & Electrical Works Cost Tabulation

# APPENDIX J: Other Cost Tabulation

# APPENDIX K: Record of Supervision/Meeting