

**THE USE OF GREEN BUILDING MATERIALS IN THE CONSTRUCTION
INDUSTRY IN MALAYSIA**

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**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
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August 2011

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.

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Specially dedicated to
my beloved family, my love, my supervisor and my friends.

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ABSTRACT

The adverse impacts to the environment from the construction industry had lead 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. So, what is the level of understanding of this concept and application? This report aims to explore the issues of green building materials in the construction industry in Malaysia. Through intensive literature study, it has brought better understanding on the definition and purpose of using green building materials. In addition, this research includes the construction process work for green building materials, risk management for green building materials, design and construction relationships and environmental assessment of materials. This research also recommends some green building materials to be used in the construction industry in Malaysia. Data of this research were collected through questionnaire survey and interview with appropriate professionals. Recommendation will be proposed in order for the construction industry to move towards sustainability. In conclusion, it is necessary to raise the awareness of sustainable development and educate the organisations and public in order to create avenues for further action towards continual performance improvement.

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LIST OF SYMBOLS / ABBREVIATIONS

<i>%</i>	percentage
<i>IEQ</i>	Indoor Environment Quality
<i>IAQ</i>	Indoor Air Quality
<i>VOCs</i>	Volatile Organic Compounds
<i>CFCs</i>	Chlorofluorocarbons
<i>MSDs</i>	Material Safety Data Sheets
<i>AAC</i>	Autoclaved Aerated Concrete
<i>NRNC</i>	Non-Residential New Construction
<i>NREB</i>	Non-Residential Existing Building
<i>RNC</i>	Residential New Construction
<i>CO₂</i>	Carbon dioxide
<i>CO</i>	Carbon monoxide
<i>ROHs</i>	Restriction of Hazardous Substances
<i>UV</i>	Ultra violet
<i>BMT</i>	Base Metal Thickness
<i>GBI</i>	Green Building Index
<i>UBBL</i>	Uniform Building by Laws
<i>ASHRAE</i>	American Society of Heating, Refrigerating and Air-Conditioning Engineers
<i>QLASSIC</i>	Quality Assessment System in Construction
<i>IBS</i>	Industrialize Building System
<i>CVA</i>	Completion & Verification Assessment
<i>APEO</i>	Association of Professional Engineers of Ontario
<i>LEED</i>	Leadership in energy and Environmental Design
<i>CVA</i>	Completion & Verification Assessment
<i>DA</i>	Design Assessment

<i>GBI</i>	Green Building Index
<i>GBIAP</i>	GBI Accreditation Panel
<i>MGBC</i>	Malaysia Green Building Confederation
<i>IBS</i>	Industrialised Building System
<i>GPM</i>	Green Pages Malaysia
<i>FiT</i>	Feed-in Tariff
<i>NABERS</i>	National Australian Built Environment Rating System

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Sustainability is a way as to meet the needs of the present without compromising the ability of future generations to meet the needs of the future. Another term that has come into common usage is high performance building. A high performance building is one whose energy, economic, and environmental performance is substantially better than one designed by standard practice. It is a building that is healthy to live and work in and it has a relatively low impact on the environment.

Beside the term sustainability, green and integrated design is now in common usage. Integrated design describes a process used to design and construct a building in such a manner so as to promote sustainability. The integrated design process required and encourages all the building team members to work together from the earliest stages of project development to achieve high performance and sustainability in design. Green does not mean the shade of the paint but signifies the impact of the building on the environment.

To choose for the building materials, it closely relate to what type of building materials and how well using it. The first question on what type of building materials will have implications for the impact of the choice on natural resources and on the relative healthfulness of the environment. The second question on how well building materials are using will have implications for the performance of the materials.

Life Cycle Assessment (LCA) is the formal methodology for addressing the two questions. LCA is a process to investigate the impact a product at every stage in its life, from preliminary development through obsolescence. At each stage, there are materials and energy consumed and the pollution and waste produced. Life stages include extraction of raw materials, processing and fabrication, transportation, installation, use and maintenance, and reuse/recycling/disposal. There is a general consensus regarding the concept of LCA and its usefulness in quantifying sustainability.

Selection of materials is only one part of making a green building. The LCA methodology helps to visualize the link between the big picture and the details, while bringing the human that much closer to the goal of living sustainably (Spigel and Meadows, 2010). Building materials make up the environment in which human live, work and play. Hence, the selections of green building materials are important to bring forward the human to a sustainable life.

1.2 Sustainability in Construction

Construction industry must inevitably change its historic methods of operating with little regard for environmental impacts to a new mode that makes environment concerns a centrepiece of its effort. Previously, the concern on environment is relatively a small part of most of construction development. However, with the increasing awareness on environmental protection due to the depletion of non-renewable resources, global warming and extremity of destruction to ecology and biodiversity impact, this issue have gain wider attention by the construction practitioners worldwide. Many efforts are being directed to build sustainably in construction world.

The direction of the industry is now 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 environmental agenda. Hence,

the activities of construction industry must work and meet the needs in to protect and sustain the environment. This shift of ideology is illustrated in Figure 1.1.

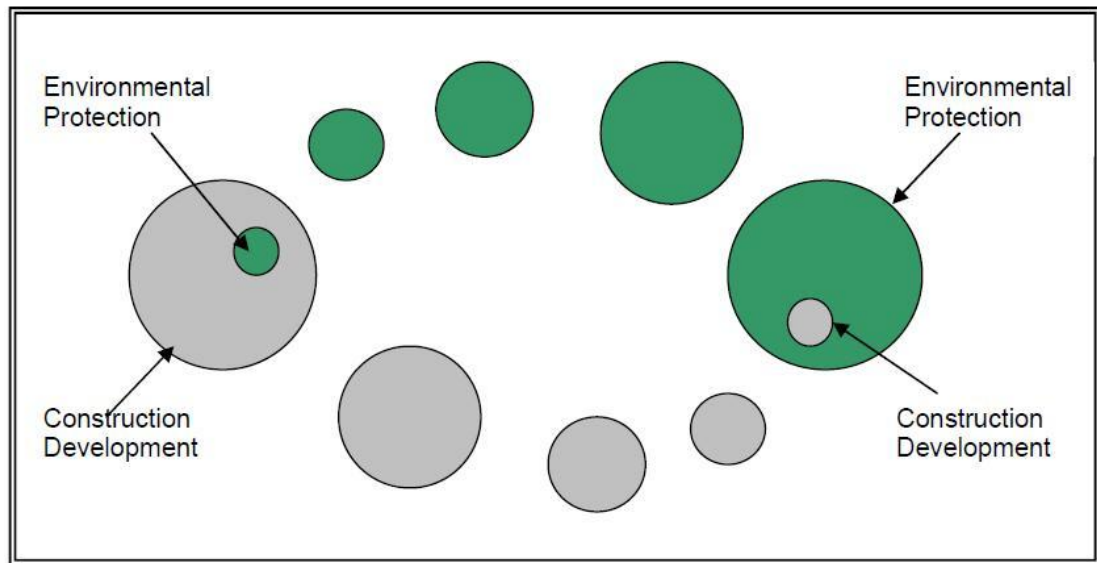


Figure 1.1: Fibreglass impact resistance compared to other window materials (adapted from Das Gandhi et. al., 2006)

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, over time, sustainability is achieved. It is important that the concept of sustainability must be applied into construction industry to influence the manner in which project shall be conducted to strike 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.

The concept of sustainability in building and construction has initially focused on issues of limited resources especially energy, and on how to reduce impacts on the natural environment with emphasis on technical issues such as materials, building components, construction technologies and energy related design concepts. The appreciation of the significance of non-technical issues (soft issues)

has grown, giving recognition to economic and social sustainability concerns as well as cultural heritage of the built environment as equally important.

Presently, the concept of sustainable construction governs three main pillars: environmental protection, social well-being and economic prosperity. Figure 1.2 illustrates the tree diagram of these three headings and their areas of concern.

Environmental Protection

- Environmental Protection concerns on 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, have 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.

Social well-being

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

Economic Prosperity

- Economic sustainability is concerned with the micro and macroeconomic benefit. Micro economic focuses on the factors or activities which could lead to monetary gains from the construction while macroeconomic relates to the advantages gained by the public and government from the project success.

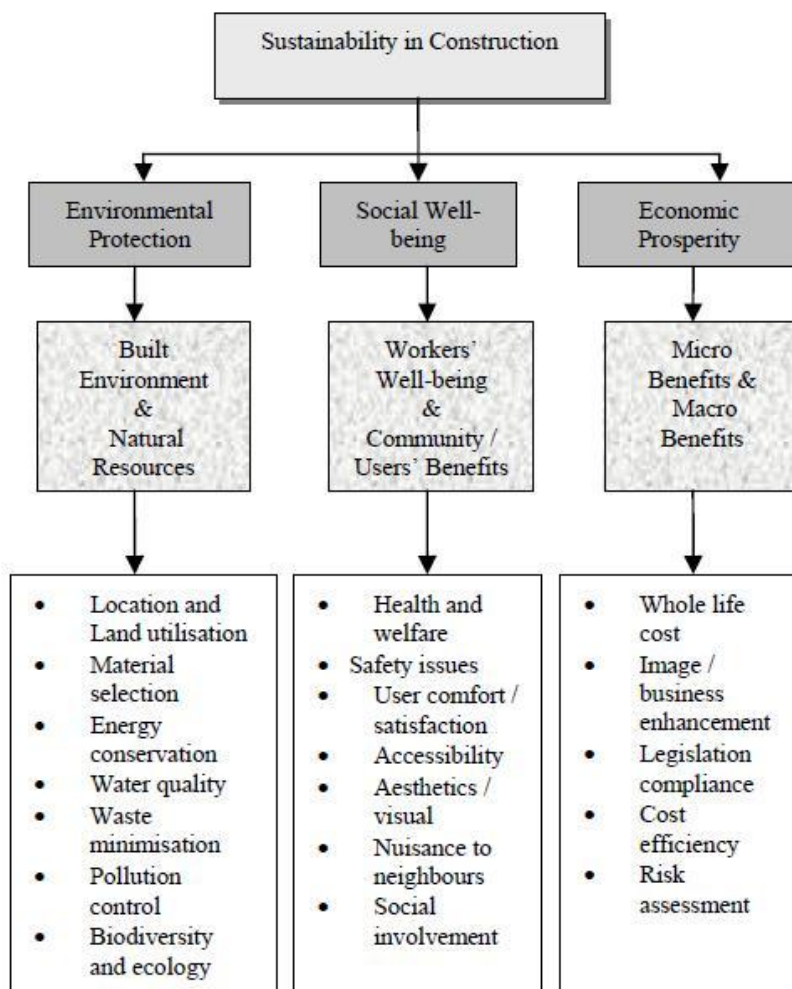


Figure 1.2: The diagram of sustainability in construction

Construction practitioners worldwide are beginning to concern and appreciate sustainability and acknowledge the advantages of building sustainable. For example, the concept of green building costs lower than conventional method and saves energy as demonstrated by Hydes and Greech. This was further supported by Heerwagen, Arlett and Howard and Pettifier, who added that sustainable buildings will contribute positively to better quality of life, work efficiency and healthy 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)

1.3 Sustainable Construction in Malaysia

Buildings and structures enable to meet the human needs and requirements in form of social and environment. It provides a shelter 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 leads 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.

A strategy for sustainable construction is a significant milestone on the road to a more socially and environmentally responsible. It creates a framework within which the industry can make a strong contribution to the better future. Construction practitioners worldwide are beginning to appreciate sustainability and acknowledge the advantages of construct building sustainably.

In Malaysia, there is increasing public awareness and interest in how buildings affect the environment, worker productivity and public health. Hence, the government, professional bodies and private companies are beginning to be aware to reduce this environment problem without restraining the need for development. Although those parties aware of the issues on sustainability or they may have good knowledge on this concept, but little efforts are generated from them to work on it. Knowing but not practicing is another major problem in sustainable concept implementation.

As a developing country, Malaysia realized that construction industry is regarded as an essential and highly visible contributor to the process of growth of country. In a brief, construction industry plays significant role in its economic growth. Over last 20 years, the construction industry has been consistently contributing between 3 % - 5 % of the national Gross Development Product (Construction Industry Development Board (CIDB, 2000)).

The published of book 'Malaysia's Vision 2020' in 1993 defined national ambitions and future opportunities for Malaysian and to consider long term strategies to assist the achievement of national goals. One of the basic visions that set is for the country to be ecologically sustainable and this issue of sustainable development has emerged as one of the top issues in the Eight Malaysia Plan (2001 – 2005). During the period, concerted efforts were expected to intensity in order to improve energy efficiency, forestry, waste and environment management.

The Construction Industry Development Board Malaysia (CIDB) which is a corporate body and established with the main function of developing, improving and expanding the Malaysian construction industry. It also identified the environment and other sustainability related issues as one of the top issues of the construction industry.

At present, there are several sustainable projects that are being or have been constructed in Malaysia. One of the examples is Zero Energy Office building (ZEO) at Bandar Baru Bangi, Selangor which embarked on energy efficiency. Another example is project Tanarimba in Janda Baik, Pahang. Tanarimba is a sustainable housing project that blends manmade and natural elements in an exciting concept of ecologically sensitive community development. It also introduces the world to eco-tourism opportunities in Malaysia Highlands.

The construction of sustainable projects in Malaysia with the concept of sustainable construction has begun settle within the industry. However, the development in sustainable building in Malaysia is relatively low. Projects on sustainability in Malaysia are mostly at pioneering stage, indicating that Malaysia construction industry is still at infancy when dealing with sustainable matters.

The modest number of sustainable projects being built in Malaysia is a sign of the slow intake of the sustainability concept among construction practitioners. To make the matter worst, the title 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 environmental protection. These negative remarks about construction show that the contribute

efforts by the government, non-government and education institutions have not fully penetrated into construction activities. Hence, a lot more efforts and works 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)

1.4 Problems Statement

The aims to promote sustainability normally involve people. First of all, people must understand the theory and practical application of sustainability. It is important because the success of sustainability is depends on people whether willing to adopt its principles. However, people general lack of understanding as to what it means. The concept is vague and there will have a perception that is something complicated and beyond the scope of a local community. It is essential that a correct understanding of sustainability is promoted from the outset of any project. It must include as an integrated package of economic, environment and social best practice.

Besides that, due to the man's irresponsible and lack of concern to the environment, it becomes a problem to have better environment in the future. A lot of environmental problems are arising as time goes on and this threatens the life and well being of the things living in this earth. Another problem is there are general concerns as to the materials used in the construction industry. The components of conventional construction materials may create durable homes but have harmful effects to the environment. Aside from that, buildings may become inefficient as to use of energy and water. To make the matter worst is that people occupying the property may be exposed to various health hazards that is unseen by naked eyes.

However, the important problem is human lack of knowledge on what construction materials can be green. This become the reason why they reliable and still using the conventional construction materials. They are limit knowledge or misperceptions on sustainable materials.

Hence, state and federal governments play important roles in promoting sustainable behaviour through guidance, outreach and support to enhance the capability of local communities, as well as policy and funding decisions.

1.5 Rationale of Research

The rationale of the research is focusing on the issue of Green Building Materials in the construction industry in Malaysia. This research is to improve the knowledge and level of the various parties in the construction industry and provide better understanding and awareness of the Green Building materials.

Besides that, stakeholders in the construction industry will be explained the proper and correct the construction process by adopting the use of Green Building materials in projects. The construction processes will be explained from the bidding phase until the construction phase as successful end to the project. Most green building materials are relatively new to the marketplace and do not have much empirical data supporting their claims. Thus, there will have an explanation of risk management to the Green Building materials

In addition, this study research is also provide better understanding for all the parties who are involved in the construction industry that their relationship between their responsibility or roles with the construction and design. Better understanding with their relationship will enhance the use or adopt Green Building materials in their design.

There are various types of Green Building materials in the market. Hence, some of the potential or suitability of Green Building materials in Malaysia will be recommended in this research. Those Green Building materials are certified by Green Building Index (GBI).

This study research is also included the environmental materials assessment. It educated all the parties in the construction industry have better understanding of 26

the advantages of Green Building materials. For example, the Green Building materials have very minimal impact to the environment especially in terms of the waste, emission, energy consumption and its capacity to replenish itself in order not to deplete the resources taken from nature due to its production.

1.6 Aim and Objectives

1.6.1 Aim of Research

The aim of the research is to investigate the issues related to the use of Green Building Materials in the Construction Industry in Malaysia.

1.6.2 Objectives of Research

The objectives of the research are listed as below:

1. To identify the issues of Green Building Materials in the Construction Industry in Malaysia
2. To explain the construction process by adopting the use of Green Building Materials in projects
3. To make suggestion on the green building materials which can be used in the Construction Industry in Malaysia

1.7 Scope and Limitation of Research

This research is carried out the use of Green Building Materials in the Construction Industry in Malaysia. In this research, it includes the Construction Process Work for the use of Green Building Materials, risk management for green building materials, design and construction relationships, Environmental Materials Assessment and

some of the potential of Green Building Materials to be use in the Construction Industry in Malaysia.

There is limitation in this study. First of all, the research is only focus on certain Green Building Materials in Construction Industry. Hence, only some of the potential Green Building materials have been suggested to be used in the Construction Industry in Malaysia.

1.8 Chapter Outline

There are five chapters include in the report. Chapter 1 discusses the overall intention of the study. It includes the definition of sustainability, sustainability in construction, sustainable construction in Malaysia, problem statement and rationale of research. In addition, it also includes the aim and objectives of the research, the scope and limitation of the research and structure for the report.

Chapter 2 focused on the literature review which are being examined and discussed. It includes what are green building materials, why use green building materials, the construction process work, risk management for green building materials, design and construction relationships, Environmental Materials Assessment and identified some of the potential Green Building Materials to be use in the Construction Industry in Malaysia. There are several of green building materials will be recommend in this chapter which are certified by Malaysia Green Building Confederation (MGBC).

Chapter 3 describes the research methodology in details. There are few stages to complete the report in order to achieve the aim and objectives of the report. This includes methodology for the data collection and data analysis.

Chapter 4 analysed the results from the questionnaire survey. The questionnaire will analyse in details by using Microsoft Office Excel 2007. There

will be a summary for the interviews part. Further information will be finding if necessary.

Chapter 5 is concluding the overall study of the report and evaluate whether the aim and objectives of the study meet with the report. The problems occur and the recommendation will be given.

CHAPTER 2

LITERATURE REVIEW

2.1 What Are Green Building Materials

Green building materials are those that use the Earth's resources in an environmentally responsible way. Green building materials respect the limitations of non-renewable resources such as coal and metal ores. They work within the pattern of nature's cycles and the interrelationships of ecosystems. Green building materials are nontoxic. They are made from recycle materials and are themselves recyclable. They are energy-efficient and water efficient. They are green in the way they are manufactured, the way they are used and the way they are reclaimed after use. Green building materials are those that earn high marks for resource management, impact on indoor environment quality (IEQ) and performance.

While people may recognize that the term green means "environmentally friendly," most have several misperceptions about how environmentally friendly products perform relative to the standard, more familiar products. It is politically correct to express concern for the environment. Paradoxically, it is equally acceptable to express apprehension at implementing green approaches rather than standard approaches.

The correlating education and support network that would enable people to respond actively and positively to the environmental warnings is still forming. Partial information, outdated information and misinformation plague the successful development of green building. The majority of building owners, designers,

engineers, contractors, manufacturers and building officials are receptive to protecting the environment but are not receptive to using green materials to accomplish the task. The unfortunate perception is that green building materials look bad, cost a lot and do not perform well. Understanding this perceptiveness is essential for effectively resolving such concerns. Therefore, in order to better understand what green building materials are, it is necessary to clarify what they are not. It is important to get rid of the pervasive misperceptions about green building materials. (Spigel and Meadows, 2010)

2.2 Why Use Green Building Materials

Using green building materials can help divert indoor air quality (IAQ) liability claims, respond to consumer demand and provide for compliance with certain regulatory requirements. Liability concerns regarding healthy buildings and healthy sites are rising in proportion to our growing understanding of the potential hazards associated with certain materials. Asbestos and lead are classic examples. Green building products, especially those fabricated from non-toxic, natural and organic materials can reduce IAQ contaminants and the accompanying complaints and claims.

Consumer demand for healthy buildings and for energy efficient structures also drives manufacturers and designers to explore options for green products. Meeting consumer demand is good business. Failure to meet consumer expectations is likely to remind about the liability concerns.

Altruism, however, is the most frequently cited reason to use green building materials. As custodians of the built environment, daily decisions that make with respect to product selection have a ripple effect on the natural environment that merits a significant level of professional care. Selection of materials used in buildings impacts the Earth directly and indirectly. The building industry is a major consumer of raw materials. Obviously, the type and quantity of raw materials that are

extracted and how they are processed constitute the direct impact. Which materials are selected also affects how the building occupants use the building.

By obligating occupants, neighbours and the community to use buildings in certain way, the selection of building materials constitutes to indirect impact. For example, a building uses a membrane roofing system, the installation is likely to involve the release of solvents in the air. If the membrane is black, it is likely to have a negative impact on the energy demands of the building of the building and of the adjacent structures because of the albedo (the reflected heat that raises temperatures in the microclimate). If it is a single-ply membrane system, it is likely to be fabricated entirely from synthetic chemicals and virgin materials rather than recycled materials. Single-ply systems, especially adhered systems, make future disassembly and recycling unfeasible.

Altruism is certainly the most laudable reason to use green building products. Self interest, however, is generally the most compelling. Using green building materials can satisfy some very self-interested motives: deflection of liability, economic gain and simple regulatory compliance. Self interested motives beautifully illustrate the relative worth of an ounce of prevention and a pound of cure. (Spigel and Meadows, 2010)

2.3 The Construction Processes

According to Spigel and Meadows (2010), they stated that every building construction project, green or not, goes through several phases, beginning with the planning phase and concluding with the post construction phase. The bidding and construction phases are where the rubber meets the road for the building's design professionals. By examining the process of bidding and construction, the actions required to ensure the successful incorporation of green building materials into a project.

2.3.1 The Bidding Phase

Using the construction documents prepared by the design professional during the preceding phase, the owner solicits construction bids either by advertisement, in the case of public projects or by invitation in the case of private projects.

During the bidding phase, each bidder solicits bids from subcontractors for the portions of the work they are not going to perform with their own forces. The purpose of the competitive bidding process is to determine the lowest responsive and responsible bidder who will be able to construct the project with the funds the owner has available. In public projects, the owner generally accepts the lowest bid. In private projects, the owner usually selects the bidders in advance and is free to choose any of them.

Whether bids are solicited by competitive bid or negotiation, it is during the bidding phase that bidders review project specifications and drawings to determine which products and systems are included. When green building materials and systems are specified, the design professional has two important responsibilities during bidding: (1) educating bidding general contractors, subcontractors, suppliers, manufacturers' representatives and others about green building materials and systems that may be relatively unknown to them and (2) processing substitution requests for green building materials and systems.

The reason because there are many green building materials are manufactured by small or new companies, many bidders may not be familiar with them or do not know how to contact them. In addition to the contact information the design professional provides either in the specifications or on the drawings, the subject should be covered at the pre-bid conference. Another issue that must be dealt with at that time is the tendency on the part of contractors to use materials with which they are familiar. The fear of the new or untried is a powerful issue when the contractor is responsible for guaranteeing or warranting the entire building for a year.

The pre- bid conference, at which the design professionals, owner and bidders are present, can be used to dispel some of these concerns. A full discussion should be

conducted by the design professionals of the importance and reasons for using green building materials and systems on the project, along with a review of the materials and systems and how to contact the manufacturers. A discussion of alternates and substitution request procedures is also helpful. Bidders should be encouraged to raise questions or concerns they have about these products and systems at this time. Minutes of the pre-bid conference should be kept and distributed to all holders of bidding documents. Documentation information discussed during the conference is extremely important to prevent misunderstanding later in the project. Of course, clarifications of, revisions of, addition to, and deletions from the bidding documents should be incorporated in an addendum.

Another useful practice is to notify the manufacturers of the green building materials and systems when a building project that incorporates their products and system is released for bidding, so they can contact the bidders directly. To further encourage the dialogue between bidders and green building material and system manufacturers, the design professional can provide a list of bidders to the manufacturers. (Spigel and Meadows, 2010)

2.3.2 The Construction Phase

The construction phase of the project usually begins when the bid award is made by the appropriate authority on a publicly financed project or when the contract is signed on other projects. If the contract documents require it, the contractor must submit a list of proposed products and a schedule of submittals to the design professionals usually within 30 days after the contract is signed. In some cases, the owner may require that the list be submitted at the same time the bids are submitted.

The list of proposed products, prepared by the contractor, is reviewed by the design professional and then forwarded to the owner for approval. The submittal of the list by the contractor to the design professional is a means of confirming that only specified products or approved substitutions are used. The preparation of the list also allows contractors to confirm that their suppliers and subcontractors are following

the contract document requirements. The design professional must specify which products the contractor must include on the list, as the typical project includes a substantial number of products.

When green building materials are specified on a project, the submittal and review of the list takes on added significance. The design professional must clearly express in the contract documents that substitution requests cannot be proposed through the list of proposed products. If the list contains unapproved substitutions for specified green building materials, the design professional must quickly and clearly notify the contractor that the list is not in conformance with the contract documents. The contractor must revise and resubmit the list until it is acceptable to the design professional and the owner.

Once the list is found acceptable, the design professional distributes the approved list to the contractor, owner and consultants. The contractor is responsible for distribution of the approved list to subcontractors and suppliers. The approved list serves as a checklist throughout the construction of the project to ensure that only specified green building materials and approved substitutions are incorporated into the completed building.

A schedule of submittals is another useful tool for the design professional to use to monitor the flow of information and tasks during the early stages of construction. The schedule of submittals is usually submitted in conjunction with the construction progress schedule. The design professional should review the schedule to confirm that the contractors have included all of the submittals required by the technical specification sections.

It is because the contractor must take into consideration many factors when preparing the schedule, the design professional should verify that the submittals are not scheduled simultaneously, that submittals for materials in an assembly are submitted together, and that the contractor has allowed adequate time prior to the need for materials on the project for preparation of submittals, review by the design professionals, and re-submittal in the event that the submittal is not acceptable the first time. The design professional should encourage the contractor to allow more

time for submittals for green building materials because of the possibility that submittal information may be more difficult to obtain.

As mentioned earlier, many manufacturers of green building materials are either new or small or both and may require more time to assemble a submittal. With this understanding, the contractor and design professional can easily accommodate the green building material manufacturer's submittal time schedule. (Spigel and Meadows, 2010)

2.3.3 The Construction Phase as the Successful End to the Project

Many design professionals, after investing a great deal of their energy and talent in the design and specification of a building project using green building materials, are disappointed when the materials are changed during the bidding and construction phases without agreement. By putting an equal amount of effort and care into the bidding and construction phases of the project, the design professional can ensure that the green building materials they selected and worked so hard to include in their project will actually be incorporated in it. By working to make the contractor's job of using relatively unknown materials easier, the design professional can serve both the owner's needs and those of the environment. (Spigel and Meadows, 2010)

2.4 Risk Management for Green Building Materials

Building materials make up the environment in which humans live, work and play. That is a lot of exposure. As the percentage of green building materials utilized in building increases, so does their share of that exposure.

Still, most green building materials are relatively new to the marketplace and do not have much empirical data supporting their claims. Add to this, the risk of using building materials that may have been "green washed" by material

manufacturers trying to cash in on the surge in green buildings. The combination of newness, lack of field testing, and “green washing” present a risk potential for all members of the project team – product manufacturers who pledge their company’s support of a new formulation or novel widget, the design professional who selects and specifies the untried product, the owner of the building in which the green building materials have been incorporated and will effectively be beta tested and the insurer of all of the above.

The risk potential for each member of the design and construction team is different and requires a different response. Clearly, it is in every participant’s best interest to avoid or minimise risk wherever possible. Sometimes, that is interpreted to mean that it is better to avoid the risk. Hence, let’s review the big picture risk. There is a real and very substantive risk and if fail to develop, market, purchase, use and reuse green materials. There is nobody who insures against that. Any consideration of risk must include consideration for the larger, shared risk. (Spigel and Meadows, 2010)

2.5 Design and Construction Relationships

2.5.1 The Building Owner

The building owner is the person or company, either public or private, whose idea the building was in the first place. The owner is also responsible for funding the construction of the project and for operating it once it is complete. The owner is the one party who enters into separate contracts with both the design professional and the contractor. This creates a third-party relationship between the design professional and the contractor. For example, during construction, certain responsibilities of the design professional, acting on the owner’s behalf, are included in the owner-design professional contract. They are also included in the owner-contractor contract.

The building owner rarely cites environment concerns as a reason for building. The reason for building is to meet a specific need of the owner. The owner

also rarely cites spending money as a reason for building. Spending money is viewed as an unfortunate consequence of meeting the identified need. Another necessary evil is the time required to transform the owner's need into a building.

The building owner may be a single person, several persons, or an organization. The organization, public or private, is probably represented by several key contacts (e.g., director of construction), who may or may not have a clear understanding of the hierarchy relationships among themselves. However, to successfully incorporate green building materials into a project, it is as important to understand the relationships of the owner to other parties on the project. (Spigel and Meadows, 2010)

2.5.2 The Building Official

The building official is the leader for the location at which the project is being constructed. The reason because the building official's primary responsibility is to ensure the health, safety and welfare of the building's occupants after its completion, he or she takes a conservative approach to permitting new and unfamiliar building materials into projects.

Most building codes contain provisions governing the use of non-traditional and new materials in buildings. In order to avoid the delay in time in the approval of these materials, providing the building official with extensive testing reports and where available, engineering documentation, speeds the process of getting them approved for use on a project. Providing a list of projects where the material has already been used is also beneficial. (Spigel and Meadows, 2010)

2.5.3 The Design Professional

The design professional, who may be either an architect or engineer, is generally the primary consultant on a building project. Based on licensing laws and training, the primary design professional on a project is usually the architect. The architect typically subcontractors portions of the work to other design professionals, such as structural engineers, landscape architects, electrical engineers, civil engineers, mechanical engineers and others as necessary. As the primary consultant, the architect usually has the most direct contact influence on the building owner. The architect is probably also involved in construction contract administration.

Many architects are interested in environmental issues. Some are concerned. Some do not place any priority on green at all. Others are actively attempting to improve the world to the extent they can. In short, architects are like everyone else. When the actively committed design professional and the inspired green product manufacturer meet, the synergy can be tremendous. On average, though, the architect typically experiences more frustration than usual when searching for green building materials. Similarly, the manufacturer often feels frustrated trying to market a green product. This is true primarily for two reasons: Architects have extremely limited time in which to research new materials and green building material manufacturers often lack a working knowledge of the building industry.

Many architects do not know where to go to get information on green building materials or know how to evaluate it once they have it. For a small firm, the time involved in researching these materials is prohibitive. Further, green building materials represent a rapidly changing segment of the industry that must be constantly monitored. Although a few small firms specialize in green architecture, many do not have the time or the expertise to follow the market changes regarding green. Larger firms can support more overhead activities. The green building material manufacturer would do well to identify those firms, large or small, that have indicated a commitment to green architecture and market their products to them. (Spigel and Meadows, 2010)

2.5.4 The Construction Manager

The Construction Manager is either an individual or an entity hired by the owner to supplement the owner's role in a project. The construction manager may have a background as an architect, engineer, or contractor, however, most states do not require construction managers to be licensed. Construction managers can have different degrees of authority granted by the owner depending on how the project is organized. Construction managers are most likely to be found on projects with complex schedules or budgets, those that require extensive coordination between disciplines and those where the owner has limited experience with the design and construction projects.

The construction manager provides professional management services. These may run for the duration of the project, from design through post construction, or for any portion thereof. Typically, one of the duties is to oversee the process of submittals. On a green project, this becomes an even more important role since the accumulation of the proper documentation is one of the main factors enabling submittal of the project for certification.

Another common duty is the coordination of the work of the various contractors. This is extremely important on green projects. For example, where commissioning is required for certification, the construction manager must ensure that the commissioning agent's requirements are met by all project members, that scheduled testing and demonstration is performed in a timely manner, and that closeout documentation (required for certification) is properly prepared and assembled for delivery to the architect and commissioning agent. (Spigel and Meadows, 2010)

2.5.5 The Contractor

The contractor is the entity that enters into a contract with the building owner to build the project. The contractor, however, retains responsibility for completing

the project in accordance with the contract documents. For this reason, it is important that contractors incorporate provisions of their contract into the contracts with their subcontractors and suppliers.

Provisions of the contract documents that should be incorporated include submittal procedures and substitution request procedures. The subcontract or purchase order should reference the relevant drawings and specifications that pertain to the portion of the work being performed or building material being supplied.

When green building materials are included in a project, the contractor must deal with the additional demands of purchasing and installing unfamiliar materials. The contractor must ensure that the subcontractors and suppliers are aware of and follow the environmental requirements associated with these products. The contractor must also be familiar with substitution request procedures.

To avoid conflicts with both the owner and the design professional, the contractor should be aware of the owner's reasons for requiring the use of green building materials on a project and understand how flexible or not the contract documents are with respect to substituting non green materials for green ones. (Spigel and Meadows, 2010)

2.5.6 The Subcontractor

The subcontractor is a company or individual that enters into an agreement with the contractor to perform a specific portion of the construction contract or to supply materials for a project.

As the use of the subcontractors has grown, the need to ensure that provisions of the construction contract are included in subcontracts has increased correspondingly. Subcontractors are usually selected in much the same manner as contractors, through competitive bidding. In some instances, contractors may select subcontractors based on past experience rather than purely on price.

With subcontractors performing more and more of the work on a project, it is not only contractors who must be sensitized to special requirements of projects that include green building materials. Because subcontractors compete for work through variances in labour costs and by the use of competing materials and products, they, too, must clearly understand the limitations placed on them when green building materials are specified, because acceptable alternates for green materials may not always exist. (Spigel and Meadows, 2010)

2.5.7 The Design Team

Ideally, a green building material is designed into a building such that it can function optimally. Good communication and a focused understanding of the environmental goals for the project help the design team identify, specify, and utilize green building materials affectively.

The relationship between the architect and the manufacturer is the most important in terms of successfully implementing green building materials. They must work together. Neither can fully implement green building materials without the other.

The architect relies on the manufacturer for applicable performance data, installation expertise and product service. The manufacturer relies on the architect for product considerations at the critical first moments of design when the green product can be implemented most efficiently, economically and successfully. Together, they can support a growing market and have the satisfaction of knowing they have done the right thing. (Spigel and Meadows, 2010)

2.6 Environmental Materials Assessment

With the reference to Lynn (1999), she defined the assessment of environmental materials begins with establishing criteria for evaluating building materials. The criteria should compliment the overall environmental project goals. Often extensive research is necessary to evaluate prospective products. Based on the environmental material criteria established for a green building project, selection of appropriate building products and systems can be accomplished.

The environmental material criteria may vary per project. Criteria may also vary depending on whether a project is new construction, a renovation of an existing building, or whether site work is associated with the project. The following are recommended environmental material criteria for use in green building product or system assessment and evaluation:

- ***Low toxicity*** : Materials the manufacturers demonstrates to have reduced toxicity or are nontoxic and avoid carcinogenic compounds and ingredients.
- ***Minimal emissions*** : Products that have minimal chemical emissions emit low or volatile organic compounds (VOCs) and avoid the use of chlorofluorocarbons (CFCs).
- ***Low-VOC assembly*** : Materials installed with minimal VOC-producing compounds or no-VOC mechanical attachment methods and minimal hazards.
- ***Recycled content*** : Products with identifiable recycled content in the material including post-industrial content with a preference for post-consumer content.
- ***Resource efficient*** : Products manufactured with resource-efficient processes including reducing energy consumption, minimizing waste and reducing greenhouse gases.

- ***Recyclable*** : Materials those are recyclable at the end of their useful life.
- ***Reusable*** : Building components that can be reused or salvaged.
- ***Sustainable*** : Renewable natural materials harvested from sustainably managed sources and preferably that have an independent certification.
- ***Durable*** : Materials that are longer lasting or are comparable to conventional products with long life expectancies.
- ***Moisture*** : products and systems that resist moisture or inhibit the growth of biological contaminants in buildings.
- ***Energy efficient*** : Materials, components and systems that help reduce energy consumption in buildings and facilities.
- ***Water conserving*** : Products and systems that help reduce water consumption in buildings and conserve water in landscaped areas.
- ***Improves IAQ*** : Systems or equipment that promotes healthy IAQ by identifying indoor air pollutants or enhancing the air quality.
- ***Healthfully maintained:*** Materials, components or systems that required only simple, nontoxic or low-VOC methods or cleaning.
- ***Local product*** : Building materials, components and systems found locally or regionally saving energy and resources in transportation to the project site.
- ***Affordable*** : Building product life cycle costs comparable to conventional materials or as a whole, are within a project defined percentage of the overall budget.

The environmental assessment of green building materials can be broken into three phases: research, evaluation and selection. Research is the aspect that takes most time consuming amongst the three aspects. Evaluation can be equally difficult and dependent on product information provided by manufacturers that is often incomplete as it related to environmental issues. Since there is currently no standard format for providing environmental product information, interpreting and comparing product information can also be difficult. Environmental criteria and proper application of the materials should be considered when selecting green building materials. The following are the three phases of the environmental assessment process:

i. Research

This aspect includes gathering information which directly from manufacturers such obtaining material safety data sheets (MSDs), IAQ test data (if available), environmental statements, recycled content data, durability information and product warranties. Additional information sources include the various resource guides currently available. Due to the variability and in some cases, inaccuracies in resources, most guides should be considered only as a starting point for which additional research is required. If a guide is not update, the information can become obsolete due to evolving nature of environmental building materials or modifications in green product lines.

ii. Evaluation

Evaluation can begin once research and information gathering is complete. Evaluation often includes confirmation of the information provided by manufacturers and requests for missing or incomplete data. Evaluation can be a frustrating process since some manufacturers may exaggerate product environmental qualities, whereas others may not recognize the environmental attributes that apply to their products.

Additional information to review includes MSDS and IAQ test data from independent laboratories. However, the MSDS may not indicate all the ingredients of a product nor include proprietary compounds material composition can often change, even within the course of the building project.

This can be alleviated by requesting letters of clarification from the manufacturer. It is important to review product warranty and durability test information. Based on the environmental criteria, the comparison of similar types of building materials can be accomplished by evaluation and assessment.

iii. Selection

Green building material selection is based on the product that best meets established environmental criteria and the most appropriate application for the project. When comparing similar types of products, a rating system can be established by giving higher points to products that meet the environmental criteria and lower points to materials that do not meet the criteria. By totaling the points, an “environmental” score or rating can be ascertained. Sometimes a product may have strengths in some areas but may have a characteristic causing enough concern to not be selected if it does not meet the project’s environmental goals. Selected green building materials are then incorporated into the project specifications. The matrix in Figure 2.1 can be used as a tool to compare and assess similar green building materials in like categories.

Environmental Criteria	Prod. "A"	Prod. "B"	Prod. "C"
Low Toxicity			
Minimal Emissions			
Low-VOC Assembly			
Recycled Content			
Resource Efficient			
Recyclable Materials			
Reusable Components			
Sustainable Sources			
Durable Materials			
Moisture Resistant			
Energy Efficient			
Improved IAQ			
Water Conserving			
Healthful Maintenance			
Local Product			
Affordable Material			
Environmental Score:			

Figure 2.1: Environmental Material Assessment Matrix (compare similar product categories)

2.7 Green Building Materials

According to Spigel and Meadows (2010), they stated the range of green building materials that are currently available has grown exponentially in response to the growth in green building rating systems on the local, state, national and international level. Green Building Materials offer a range of aesthetic options. They perform well and cost-competitive. Many mainstream manufacturers have jumped on the bandwagon in response to the growth in demand and the realization that green building materials are not a fad that is soon going to fade away. It is not only possible to incorporate green building materials into the design and construction practices, it is imperative. The following sources are collect from GreenPagesMalaysia.

a) Cellulose Fibre Cement Boards (Prima)

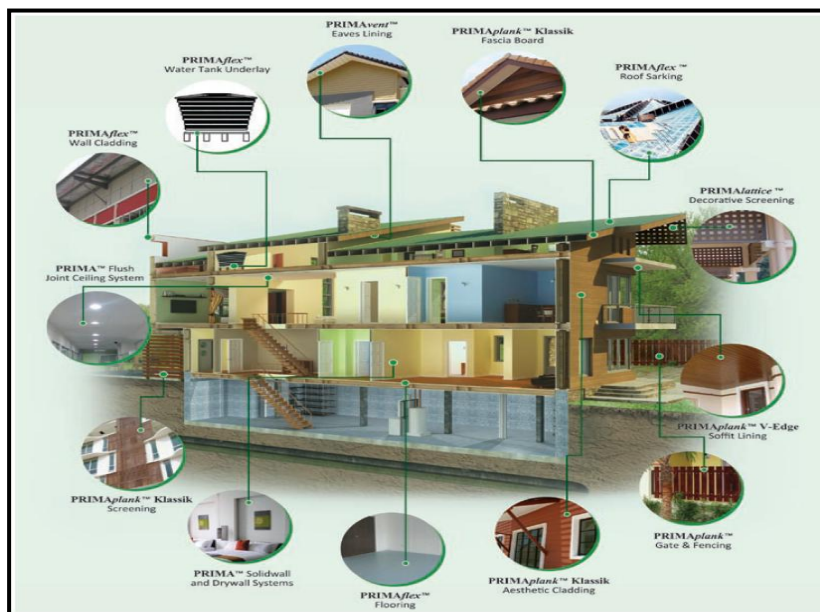


Figure 2.2: Prima Cellulose Fibre Cement Boards

➤ Why is it green?

- Made from renewable resources such as pulp fibre from managed plantations & the minerals are from local resources with up to 20% recycled content.
- It goes through a green manufacturing process that meets the ISO 14001 Standard and is also aligned with the concept of Reduce, Reuse & Recycle of raw materials.
- It is non-hazardous, low VOC, has no formaldehyde and durable.
- It has been certified as Green Building Material by Global Eco-Label Certification Bodies such as Singapore Environmental Council, Good Environmental Choice Australia, Korea Environmental Industry & Technology Institution, etc.

➤ **Product Features**

- Strong (MoR 16MPa)
- Water Resistance
- Weather Resistance
- Fungus Resistance
- Termite Resistance
- Good Thermal Insulation
- Good Sound Insulation
- Fibre Cement Waste is non-toxic and easy to dispose
- Recyclable and Reusable
- 50 years durability

➤ **Applicable GBI credits**

NRNC	EE1, EE5, EQ13, MR2, MR3
NREB	EE1, EE5, EQ13, MR2
RNC	EE1, EQ3, MR4, MR5

➤ **Green Labels / Accreditation**



Cert No: 041-026



Australia Eco Label



Taiwan Green Building Material



Korea Eco Label

b) Autoclaved Aerated Concrete (AAC) Blocks

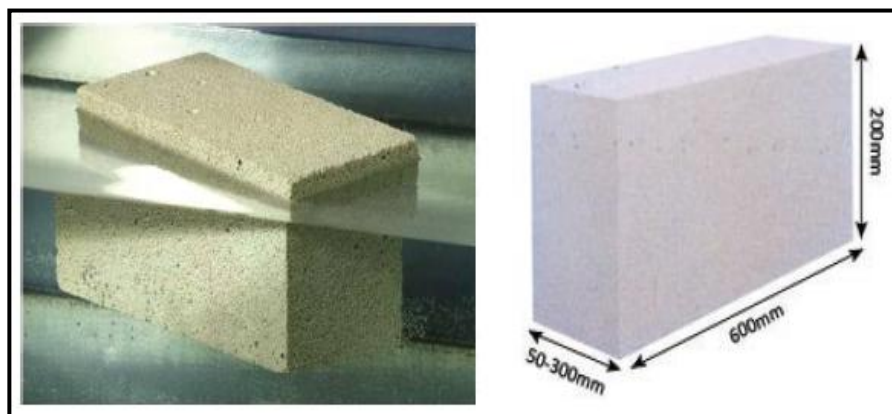


Figure 2.3: Autoclaved Aerated Concrete (AAC) Blocks

➤ Why is it green?

- It contains a pore content of approximately 45%, the consumption of raw materials and the total energy consumed during the production is 2-3 times lower than other building materials such as burnt bricks.
- Emissions of gasses such as CO₂, CO and NO_x are also relatively low. By-products of AAC Production such as condensate from the autoclaving, hardened AAC waste and unhardened AAC mixture can be recycled back into the production of AAC. Besides that, other industrial waste like fly ash and slag can be utilised as main raw materials too.
- It has excellent thermal insulation properties, less energy is required to cool an AAC building. It is breathable and effective in moderating the moisture levels and maintaining the correct relative humidity.

➤ **Product Features**

- Lightweight
- Durable
- Thermal resistant
- Fire Resistant
- Acoustic
- Breathable
- Non-toxic
- Workability

➤ **Product Compliance**

Applying for:

- Green Label Singapore
- IBS Status
- SIRIM
- ISO 9001 & ISO 14001

➤ **Applicable GBI credits**

NRNC	EE1, EE5, MR2
NREB	EE1, EE5, MR2
RNC	EE1, EE3, MR4

c) Ceiling Board (Queen Energy)

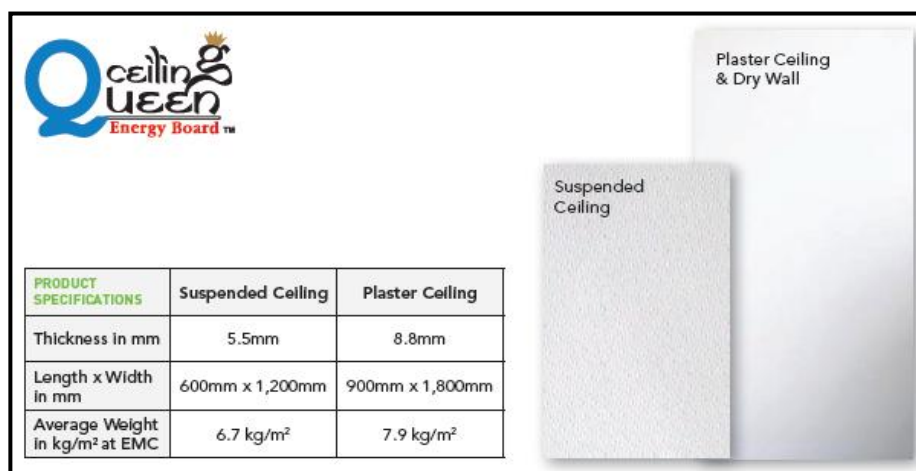


Figure 2.4: Ceiling Queen Energy Board

➤ Why is it green?

- Ceiling Queen Energy Board uses bio technology from Japan and Korea that can generate and emit negative ions and far infrared rays using natural radiation materials, i.e. Tourmaline, Radium, Thorium and Potassium.
- Its low thermal conductivity and excellent insulation properties can help to reduce heat generation and energy consumption of the air conditioning system.
- The micro fibre or fibreglass can also be installed in contact with the ceiling to further enhance its thermal qualities and provide additional heat penetration control.

➤ Product Features

- i. Safe
 - Does not produce toxic fumes of hazardous substances that are harmful to health.
 - Passed Emission Test and Formaldehyde Test from PSB Singapore.

- Passed ROHs (Restriction of Hazardous Substances) of Europe Standard.
 - Passed heavy metal tests from SGS Malaysia and PSB Singapore.
- ii. Energy Efficient
- Energy saving
 - Heat/thermal insulation
 - Alternative to ionizer and air purifier
- iii. Improves Indoor Air Quality
- Purifies the air and provides a fresh environment
 - Reduction on sensitiveness such as asthma and sinus
 - Prevents the spread and protects from haze, secondary smoke, pollen, bacteria, viruses and fungi
 - Neutralises odour, smoke, dust and CO₂
 - Neutralises volatile organic compounds (VOCs)
- iv. Eco-friendly
- Made from reusable and recycled content materials
- v. Economical
- Fire-resistant
 - Multiple functions and longer usage

➤ **Applicable GBI credits**

NRNC	EE1, EE5, EQ4, MR2
NREB	EE1, EE5, EQ4, MR2
RNC	EE1, EE3, EQ5, EQ6, MR4

➤ **Green Labels / Accreditation**



Cert No: 041-037

Made from reused
Waste Materials



d) Biobrick (Exxomas)



Figure 2.5: Exxomas Biobrick

➤ **Why is it green?**

- Made by the save resources which is recycling and compressing industrial waste-dust to become green, environment friendly, energy saving product.
- It contains no virgin sand, clay or mud, so it makes ecological & environmental sense. Unlike clay bricks, bricks

are produce without depleting resources. Exxnomas Biobricks eliminated the dust and air pollution problem.

- Price as cheap as claybrick.

➤ **Product Features**

- Size: 215mm x 99mm x 64mm (solid w • ith groove) in red colour
- Complies with BS476:PT.22:1987 & BS6073:PART1:1981
- Integrity & Insulation: 130 Minutes
- Uniform water absorption, resulting in less defects
- 40% cost saving on plastering as compared to clay bricks
- Maximum wastage of 4% results in cleaner construction site and less waste
- No burning, firing, autoclaving or other heating processes are required during manufacturing therefore there are no carbon dioxide emissions
- Fire Resistant
- As cool as clay bricks
- Reduced energy consumption
- Reduced resources use
- Reduced air pollution
- Recyclable and refillable
- Recycled content
- Waste reduction
- Non-toxic

➤ **Applicable GBI credits**

NRNC	MR2, MR3
NREB	MR2
RNC	MR4, MR5

e) **Window Film (3M™)**



Figure 2.6: 3M™ Window Film

➤ **Why is it green?**

- It is a simple, cost effective window solution for commercial and residential buildings – film designed to be applied to an existing window to improve occupant comfort and cut energy costs by reducing the sun’s heat passing through the glass.
- Its advantages such as blocking harmful UV light, improving exterior building appearance, delivering daytime privacy and even holding broken glass together.
- It includes metal free sun control films that allow in more natural daylight and colour stable films that resist colour shift.
- Due to customers’ increasing requirement for day lighting which letting natural light complement or replace artificial light and its impact on lower energy costs for lighting has also led to the significant advancement of the development

of spectrally selective window films that can block certain wavelengths of radiation while allowing other wavelengths through.

➤ **Product Features**

- High Visible Light Transmission
- Superior heat rejection performance
- Block up to 99% of UV rays
- Reduce glare and improve comfort
- Reduce temperature imbalance within the building
- Reduce peak load demand
- Up to 10 years warranty

➤ **Association & Alliance**



➤ **Applicable GBI credits**

NRNC	EE1, EE5, EQ8, EQ9
NREB	EE1, EE5, EQ8, EQ9
RNC	EE1, EE3, EQ2

f) Jotashield Extreme (JOTUN)



Figure 2.7: JOTUN Jotashield Extreme

➤ **Why is it green?**

- With twice UV Protected Colours and up to 8 years Performance, Jotashield Extreme allows less repainting cycles and this reduces impact on the environment.
- Jotashield Extreme with its unique 2x heat Reflective technology reflects heat absorbed by walls, therefore improving indoor temperature.
- This increase the comfort level and decrease the energy loaded to cool homes in the heat, ultimately reducing energy consumption.
- The entire Jota shield range is also 100% free from harmful chemicals such as APEO, Formaldehyde and Heavy Metals.

➤ **Product Features**

It is the most durable paint for the harsh tropical climate. It utilises a 100 % Extreme Acrylic formula, which comes with both twice Heat Reflective features and twice UV Protected colours.

- 8 Years Performance Warranty
- Twice heat reflective feature
- Twice UV protected colours
- 100% APEO free (base paints & colourant)
- 100% Formaldehyde free
- 100% Lead and Mercury free
- Low VOC
- Low Dirt Pick Up
- Anti Algae/Anti Fungal

➤ **Green Labels / Accreditation**



Cert No: 032-081



Licence No: ECO 012

➤ **Applicable GBI credits**

NRNC	EE1, EE5
NREB	EE1, EE5
RNC	EE1, EE3

g) Steel (Clean Colorbond)



Figure 2.8: Clean Colorbond Steel

➤ **Why is it green?**

- Lightweight – Reduce need for heavy lifting equipment, construction time and transport cost. For example, 1 kg of steel would likely clad almost 9 times the area of 1 kg of roof tiles.
- High strength to weight ratio – Material efficiency and dematerialisation is possible without any sacrifice in functionality. For example, uses Base Metal Thickness (BMT) of 0.42 mm steel roofing instead 0.55 mm (24 % Less)
- Low thermal mass – Lower the demand for cooling in the building
- High solar reflectance index (SRI) – Reduce UHI intensity
- Emit less VOCs and formaldehyde – Better IAQ

- Strong & Durable – Low maintenance and replacement
- Reusable & Recyclable – Reduce raw material consumption and GHG emissions

➤ **Product Features**

- Proprietary paint system to give optimum colour performance – Maximum 15 years warranty against paint peeling & flaking and maximum 10 years warranty against colour fading.
- Specially developed self-cleaning technology especially for roofing sheet application where natural rain water is able to wash away dirt particles
- Incorporated with IR pigments into paint system to reflect heat, thus cooler surface temperature.

➤ **Applicable GBI credits**

NRNC	EE1, EE5, SM12, MR2
NREB	EE1, EE5, SM6, MR2
RNC	EE1, EE3, MR4

h) PVC Membranes (Sika Sarnafil)



Figure 2.9: Sika Sarnafil PVC Membranes

➤ Why is it green?

- a) Sustainability That Pays Membranes for cool roofs in hot climates
 - It allows owners of buildings to create high performance structures that are acknowledged under the LEED Certification Program (USA).
 - It includes a highly reflective, lacquer-coated surface that decreases heat flow through the building envelope and has been proven to reduce the amount of energy required to maintain comfort in an air-conditioned building.
- b) Membranes for green roofs for better urban climates
 - Green roofing is one of the most exciting developments in sustainable building design.
 - The environmental benefits for which green roofs have obtained the most attention are improvements in air

quality, storm water runoff management, reduction of urban heat island effect, and energy efficiency.

- During warm weather, green roofs are cooler than conventional roof surfaces. Sika's membranes meet the most stringent test standards for root resistance and have a proven history of durability.

➤ **Product Features**

- Proven performance history of over 40 years
- Inherently fire resistant
- Highly puncture and impact resistant
- Easy to repair
- Proven durability against rooftop soiling and contamination
- Installation friendly
- Aesthetically appealing

➤ **Green Labels / Accreditation**



➤ **Applicable GBI credits**

NRNC	EE1, EE5, SM12
NREB	EE1, EE5, SM6
RNC	EE1, EE3

i) Coolroof & System (Legacy)

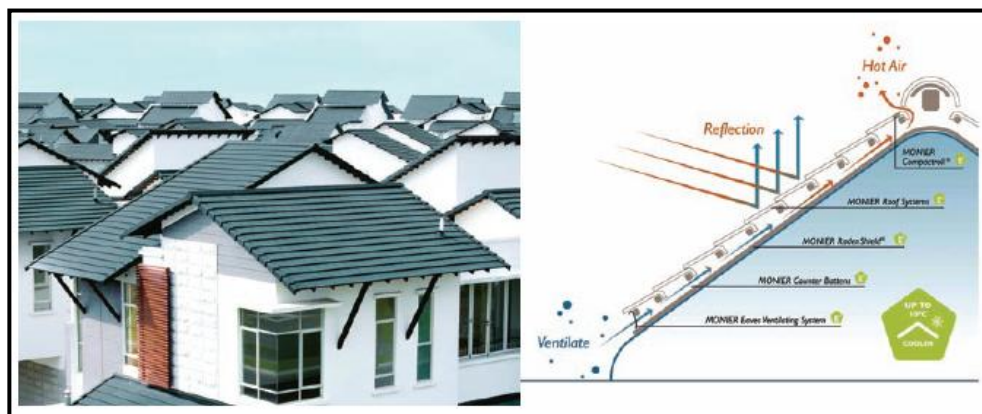


Figure 2.10: Legacy Coolroof & System

➤ Why is it green?

- Is a passive cooling energy efficient roof system, able to reduce the temperature
- Up to 10 degrees cooler
- Consists of a high dense two layer thick water based coating, to ensure a water
- Repellent effect from the tile
- Consists recyclable content material; such as fly-ash
- In the manufacturing process we aimed for low scrape rate
- During the production process all unused material can be reused
- Low VOC content in the material

➤ **Product Features**

- The top surface coating has passed all laboratory tests simulating normal Malaysian weather conditions with the results of a 10-years colour ageing of the surface with no algae growth within first 5-years (excluded for straight cut area), and the secondary pigmented quartz based coating displayed another 10-years colour ageing.
- Is highly resistant to the typical weather and ensures a mattle finish of the tiles

➤ **Applicable GBI credits**

NRNC	EE1, EE5, EQ4, MR2
NREB	EE1, EE5, EQ4, MR2
RNC	EE1, EE3, EQ1, EQ2, EQ5, MR4, IN1

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Research Methodology is the study of the structure, logical organization, methods, and means of 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 interview. It is essential to ensure the effectiveness and smoothness of the study process.

3.2 Research Strategy

3.2.1 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 research problems. 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 in the process. Another basis of classifying interviews is the type of approach employed which is structured or unstructured interviews.

Structured interviews involve the use of a set of pre-determined questions and of highly standardized techniques of recording. The reason for standardization is to ensure that all respondents reply to the same questions. Structured interviews mostly involve the use of fixed, alternative questions. Unstructured interviews characterized by a far too greater flexibility of approach to questioning the respondents. Unstructured interviews involve relatively much lesser standardization of relevant techniques and operations if compared to structured interviews.

3.2.2 Questionnaire

Questionnaire is a list of questions sent to a number of persons for them to answer. It secures standardized results that can be tabulated and treated statistically. Questionnaire is a set of questions. Generally, it is mail or distributes to be respondents for collecting information. It is a method of social research, which is employed when the area widely dispersed. In this method, the investigator or the research does not collect information by him. He relies on the information provided by the respondents.

There is also a vast variety of questionnaires, which can be classified as open or closed questionnaires. Closed-ended questionnaires are those which pose definite, concrete and preordained questions which is prepared in advance and not constructed on the spot during the questioning period. Closed-ended questions are more easily analyzed. Every answer can be given a number or value so that a statistical interpretation can be assessed. Closed-ended questions can be more specific, thus more likely to communicate similar meanings. In large-scale surveys, closed-ended questions take less time from the interviewer, the participant and the researcher, and so is a less expensive survey method.

Open-ended questions allow respondents to include more information, including feelings, attitudes and understanding of the subject. This allows researchers to better access the respondents' true feelings on an issue. Because they allow for obtaining extra information from the respondent, such as demographic information

(current employment, age, gender, etc.), surveys that use open-ended questions can be used more readily for secondary analysis by other researchers than can surveys that do not provide contextual information about the survey population.

3.2.3 Primary Data

Primary data are often collected for methodologies that use the case study, experiments and questionnaire surveys (Tan, 2007). For example, propose questionnaire or personal interview method to get the data or information from different construction personnel. The major advantage of primary data is accuracy of data because it is collected by the researcher but it is costly and time consuming.

3.2.4 Secondary Data

Secondary data is data collected by someone other than the user. Common sources of secondary data for social science include censuses, surveys, organizational records and data collected through qualitative methodologies or qualitative 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 databases than would be unfeasible for any individual researcher to collect on their own.

3.3 Research Design

The research procedure is shown in the flowchart below:

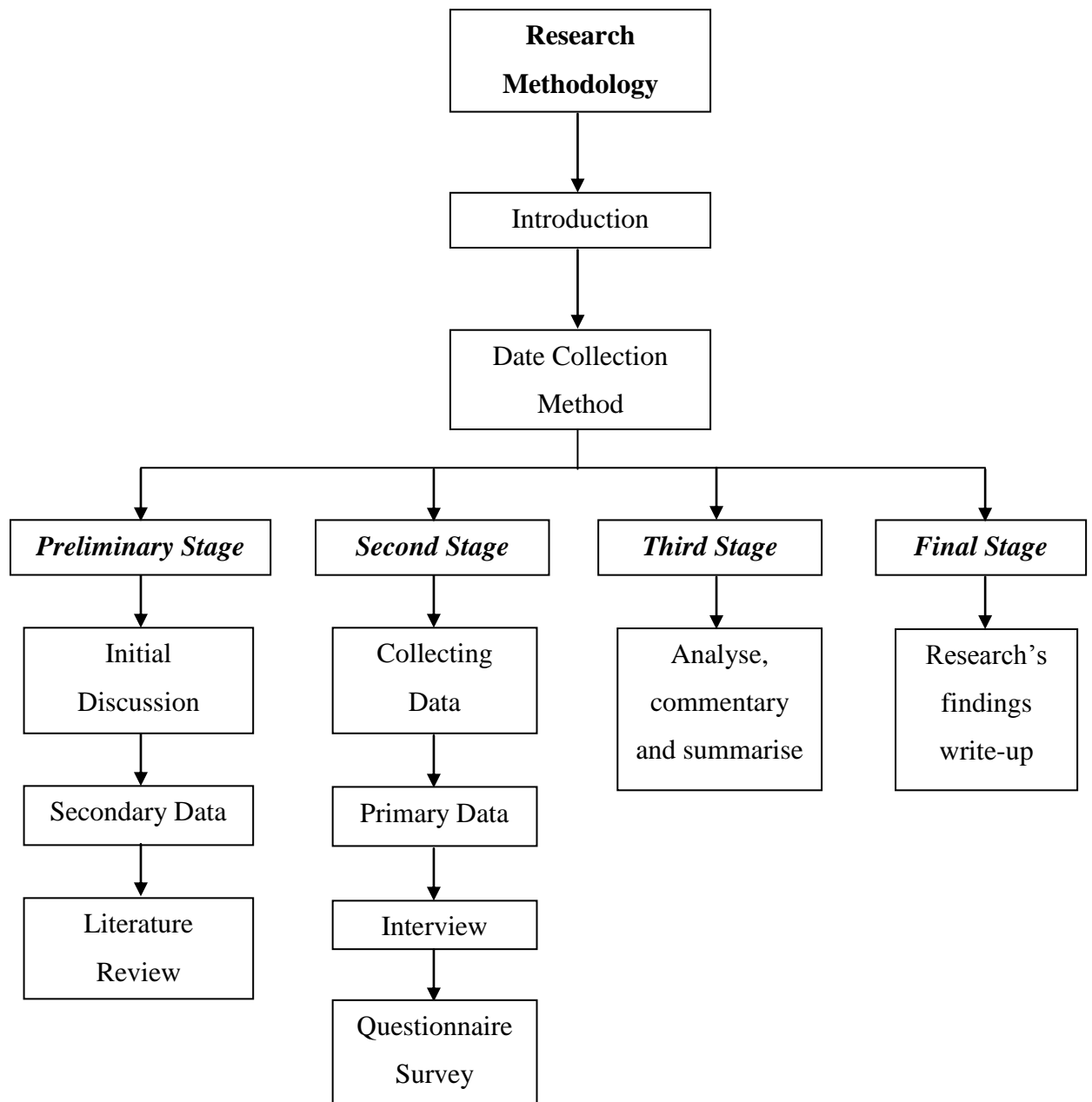


Figure 3.1: Flowchart of Research Methodology

3.3.1 Introduction

Research design is a planned sequence of the entire process involved in conducting a research study. It also the plan, structure and strategy of investigation conceived so as to obtain answers to research questions and to control variance. Generally a study methodology is planned by stages according to their priorities and functions. The research work will be divided into few steps in logical and coherent order and provide answers under the scope of research. This methodology consists of four stages:

3.3.2 Preliminary Stage

a) Initial discussion

The discussion in this stage is related to the overview on issues related to the research. It is important to have this discussion with supervisors where he can lead or guide to do the research and exchanging ideas with him.

b) Literature Review

In this stage, a depth literature review was conducted to strengthen and verify the research area. The objective and scope of the research were decided. In this literature review, it discussed about the use of Green Building Materials in Construction Industry. The discussion includes the articles of sustainable materials in construction industry. The information of the literature review obtained from the reference books, articles and various online sources. Study and analyse the information and summarised to develop the research findings.

3.3.3 Second Stage – Collecting Data

a) Interview

Interview is a commonly used method of collecting information as well as opinion in the research study. The data collected will usually be richer and more contextual information and it provides an opportunity for the interviewee to give a more detailed response. In this stage, the information will be collected through interviews with Architect and Engineer. After that, will collect, analyse and do comparison with their feedback. By having interview can broaden the research and have a clear picture on the issue of Green Building Materials.

b) Questionnaire Survey

The questionnaire was designed in such a manner to elicit responses that could be easily analysed by the use of closed-ended questions with suggested answers on ordinal scales. The questionnaire will focus on awareness, understanding and knowledge of the sustainable construction and Green Building materials in Malaysia. Besides, there would be about 30 survey questionnaire will be sent out to the respondents and the respondents of the survey will be those who working in the construction industry.

The questionnaires consist of two sections with a total of seventeen questions. Section A consists of two questions which were about the respondent's background. There are fifteen questions in Section B which was about the issues on sustainable construction and Green Building materials. The questions will be set as closed-ended questions.

3.3.4 Third Stage – Analyse, commentary and summarise the data

In this stage, the data or information collected from stage two will be compiled and do a summary based on the research findings. The survey questionnaires will analyse in details by using Microsoft Office Excel 2007. The data and information from the survey forms and interviews were all recorded and analyzed qualitatively and quantitatively by using average index calculation and other suitable statistical methods.

3.3.5 Final Stage – Research’s findings write-up

This is the toughest step of the whole research process. The findings will be compiled in the final research writing to explain and summarise the collected data which is needed to achieve an overall determined objective.

3.4 Questionnaire Design and Structures

There are total two methods to be used for analysing the results from the respondents as shown as below:

3.4.1 The descriptive statistic method

This method is the simplest method of analysis which provides a general overview of the results. It gives an idea of what is happening. The descriptive method with either analyse the responses in percentage or will contain actual numbers. In this study, some of the questions will be analyse using percentage and presented into pie chart.
(Dr. S.G Naoum)

3.4.2 By using formula

A questionnaire will be developed in order to evaluate the importance and the ranking of Green Building materials issues. There are a variety of designs for scaled response and hence the design options need to be considered by the Author. One of the most common scaled-response formats is the Likert scale. It is developed by Rensis Likert in an attempt to improve the levels of measurement in social research through the use of standardized response categories in survey questionnaire. Respondents were asked to indicate their opinions on five point scale (from ‘least important’ to ‘most important’). A sample of survey questionnaire was included in Appendix D.

i. Five point scale (from ‘least important’ to ‘most important’)

$$\begin{aligned}
 \text{Conversion Formula} &= \frac{5N_1 + 4N_2 + 3N_3 + 2N_4 + N_5}{5(N_1 + N_2 + N_3 + N_4 + N_5)} \\
 \text{(Importance Index)} &= \frac{5(\) + 4(\) + 3(\) + 2(\) + (\)}{5(\)}
 \end{aligned}$$

The value of is also called as “Ranking Index” or “Importance Index”.

N1 = Number of respondents with “most important” (N1)

N2 = Number of respondents with “very important” (N2)

N3 = Number of respondents with “moderately important” (N3)

N4 = Number of respondents with “less important” (N4)

N5 = Number of respondents with “least important” (N5)

CHAPTER 4

DATA ANALYSIS AND DISCUSSION

4.1 Survey Questionnaire

4.1.1 Introduction

This chapter presents the result obtained from survey questionnaires. The collected data is analysed through the statistical technique. Finally, analysis and discussion on the results will be made.

A total of 30 sets of survey questionnaire were sent out to various company in the construction industry, it is mainly comprises of the architect firm, consultant firm, contractor firm and developer firm in Malaysia. The questionnaire was aimed obtain their view of opinion about the issue of sustainable construction and Green Building materials.

A full amount of questionnaires responded were returned, it represent a response rate of 100 %.

4.1.2 Result of Research Analysis

This subtopic is based on the description in Chapter 3 (Research Methodology). It is explained the method to analyses the questionnaires by using quantitative measurement with percentage and Likert Scale in the research result analysis.

Microsoft Office Excel 2007 used in accommodates the analysis works. The data analysis is presented in charts.

The analysis discussion is based on the 2 section of questionnaires as followings:

1. Section A: Respondent's Background
2. Section B: Issue related sustainable construction and green building materials

4.1.2.1 Section A: Respondent's Background

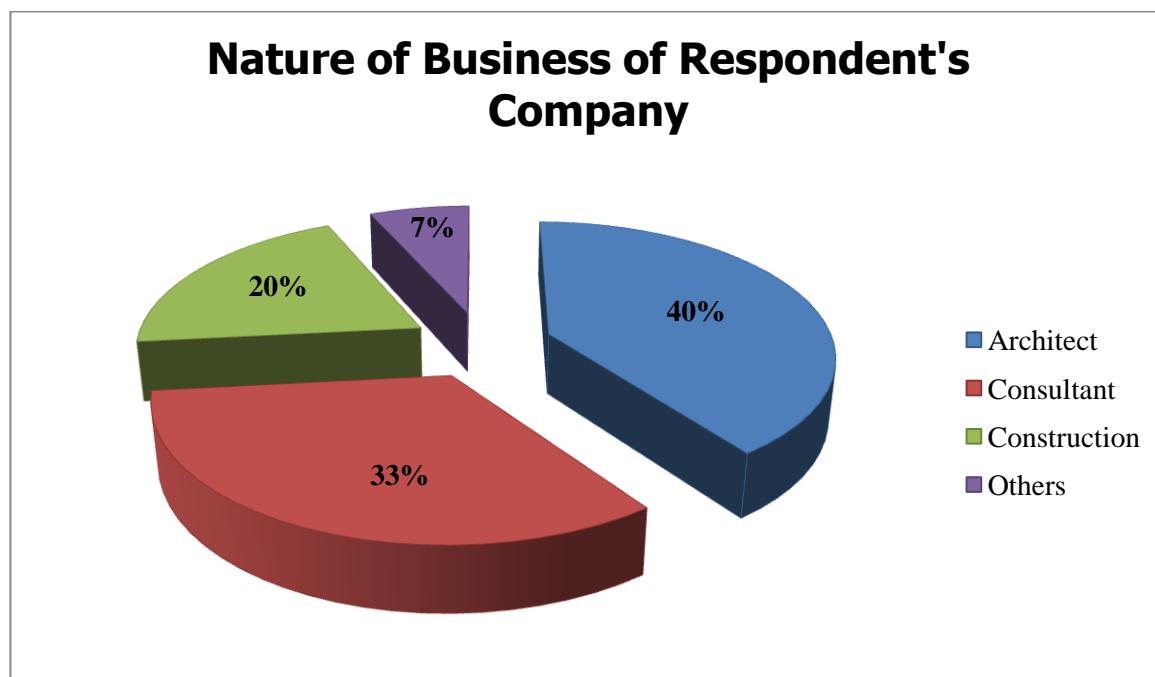


Figure 4.1: Nature of Business of Respondent's Company

The data analysis examines the respondent's company nature of business. This is to ensure that the involvement of respondents in construction industry and to ensure their qualification to answer the survey questionnaire which relate in construction industry. Figure 4.1 shows four different nature of business which included in the survey questionnaires. The result shows that the majority of the business nature of respondent's company is Architect firms, which consists of percentage of 40 %. The second higher percentage is Consultant firms which are 33 %. Then, it followed by

Construction firms which add up to 20 % and the others firm which are developer firms which only obtained 7 %.

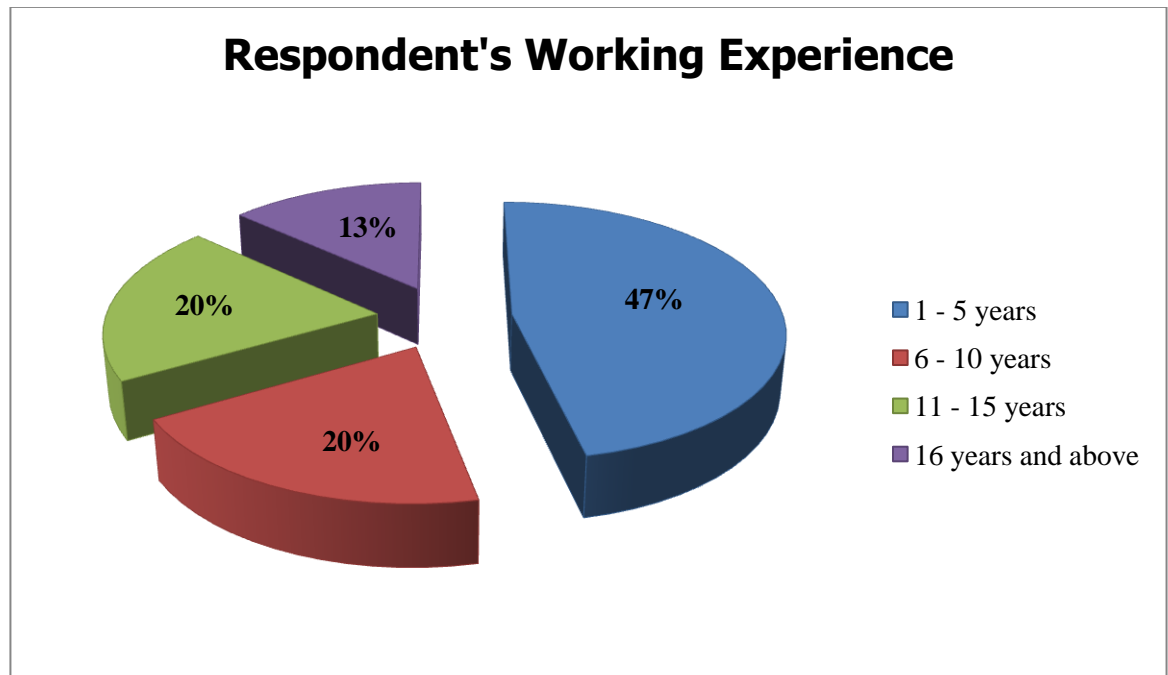


Figure 4.2: Respondent's Working Experience

Figure 4.2 shows the respondent's working experience. The pie chart is indicating the greatest number of the respondents working experience is at the range of 1 – 5 years which consists of 47 %. Whereas the lowest percentage of the respondent's working experience is at the range of 16 years and above. Next, the respondent's working experience at the range of 6 – 10 years and 11 to 15 years obtain the same percentage which is 20 %.

4.1.2.2 Section B: Issue related sustainable construction and green building materials

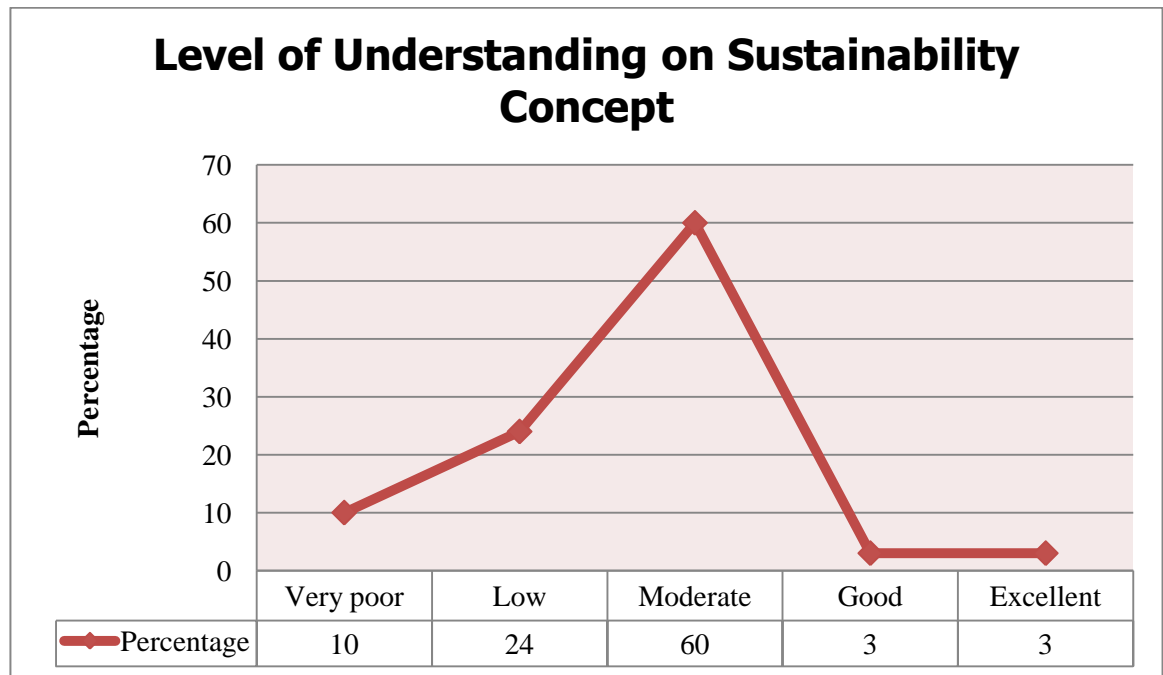


Figure 4.3: Level of Understanding on Sustainability Concept

Figure 4.3 shows the level of understanding on sustainability concept. Most of the respondents considered themselves to have moderate knowledge on sustainable concept which consists of 60 %. Then, it followed by low and very poor knowledge on sustainable concept which obtains 24 % and 10 % respectively. It is similar that merely 2 respondents, which are approximately 3 % of total respondents considered that they possessed good sustainable concept and excellent sustainable concept respectively.

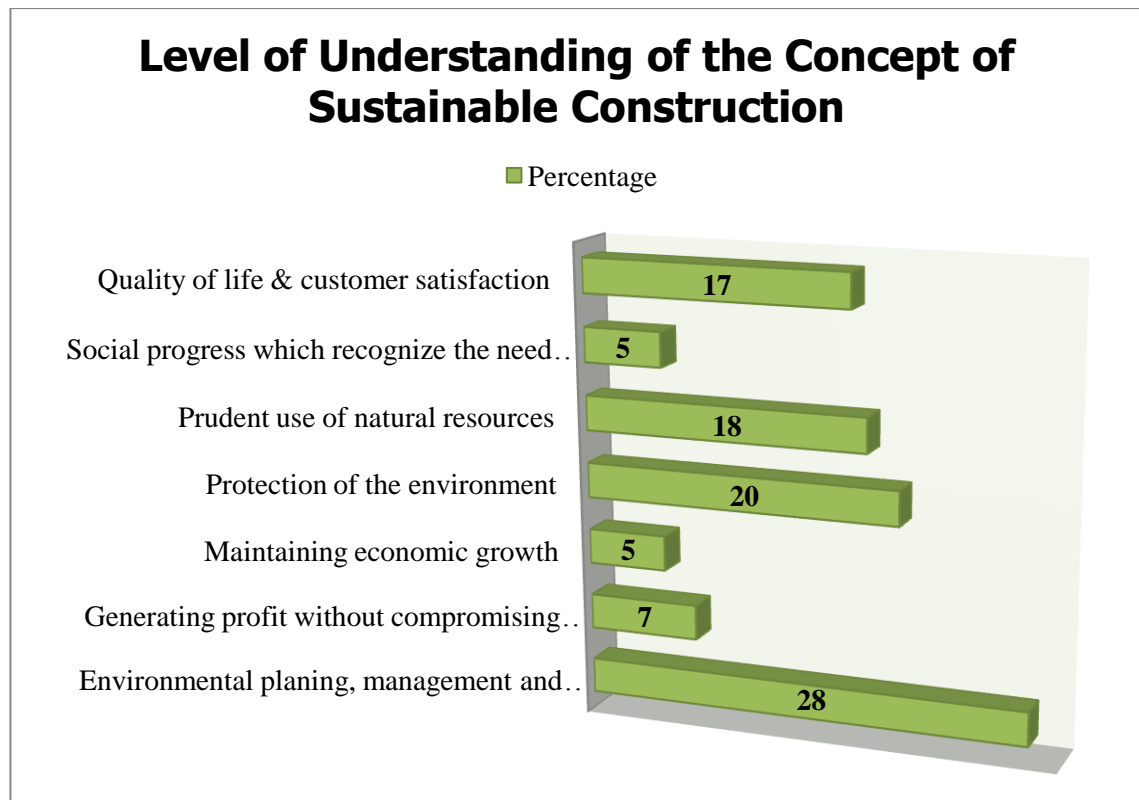


Figure 4.4: Level of Understanding of the Concept of Sustainable Construction

In order to investigate further what the respondents understand about the concept of sustainable construction, they were asked to select issues that match their understanding about the concept of sustainable construction. Issues that are related to environmental aspect of sustainability received highest percentage: environmental planning, management and control (28 %), protection of the environment (20 %) and prudent use of natural resources (18 %). Issues that related to social aspect of sustainability received moderate percentage: enhance the quality of life & customer satisfaction (17 %) and social progress which recognize the need of everyone (5 %). Lastly, the issues the related to economic aspect of sustainability received lowest percentage: generating profit without compromising future needs (7 %) and maintaining economic growth (5 %).

From this result, it shows that the majority of the respondents understand that sustainability is about protecting the environment but many are still unaware the sustainability is also about balancing social and economy aspects of construction.

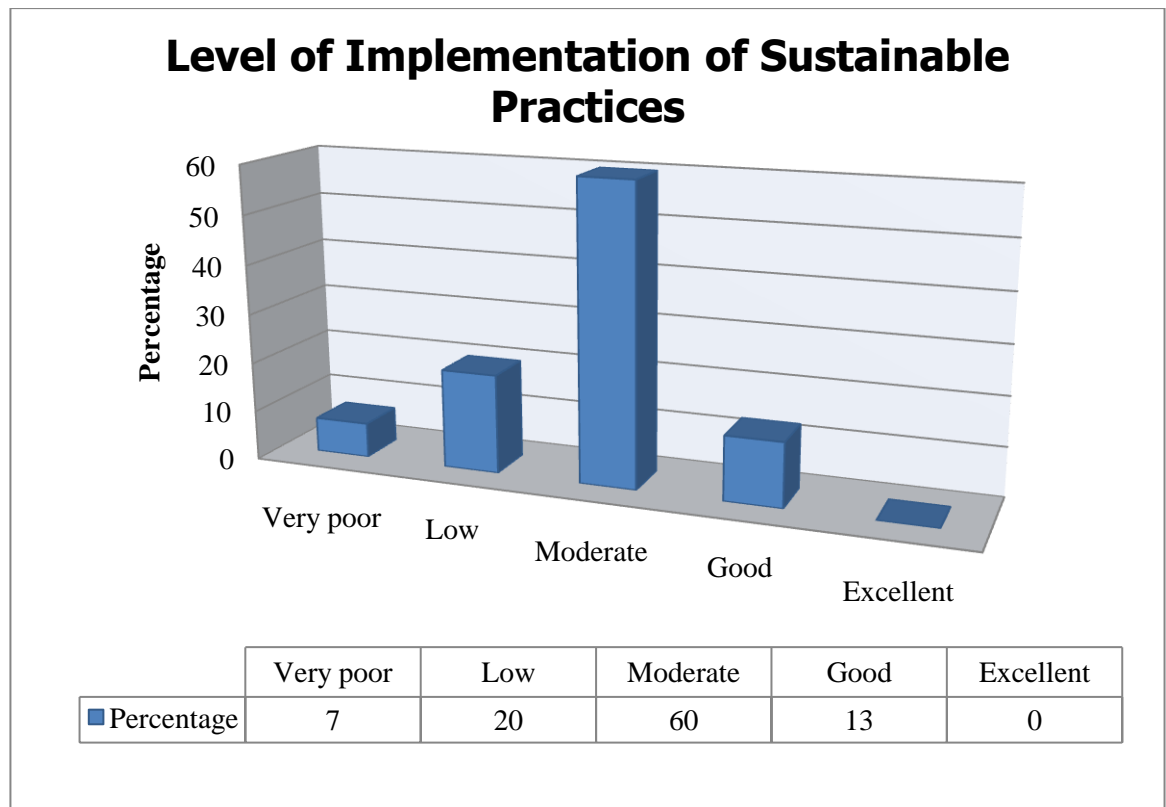


Figure 4.5: Level of Implementation of Sustainable Practices

The data analysis examines the respondent's level of implementation of sustainable practices. Figure 4.5 shows that the majority of respondents considered themselves the moderate level of implementation of sustainable practices and it consists of 60 %. Then, it followed by the low, good and very poor level of implementation of sustainable practices which consists of 20 %, 13 % and 7 % respectively. None of the respondents believed that the level of implementation of sustainable practices is excellent.

Table 4.1: Factors Hindered People from Regularly Incorporating Sustainable Strategies into Their Work

Factors Hindered People from Regularly Incorporating Sustainable Strategies into Their Work	Degree of importance quoted by respondents according to five Likert scales					Importance Index	Rank
	1	2	3	4	5		
Not sure where to get information on sustainable building methods	5	8	5	6	6	0.6000	5
Lack of technical understanding on the part of others on the project team	0	7	13	6	4	0.6467	4
Lack of training or education in sustainable design or construction	0	0	11	8	11	0.8000	2
Lack of “green” materials suppliers	4	14	9	0	3	0.4933	6
Lack of interest from others on the project team	0	2	17	9	2	0.6733	3
Lack of expressed interest from clients (owners or developers)	1	1	4	8	16	0.8467	1

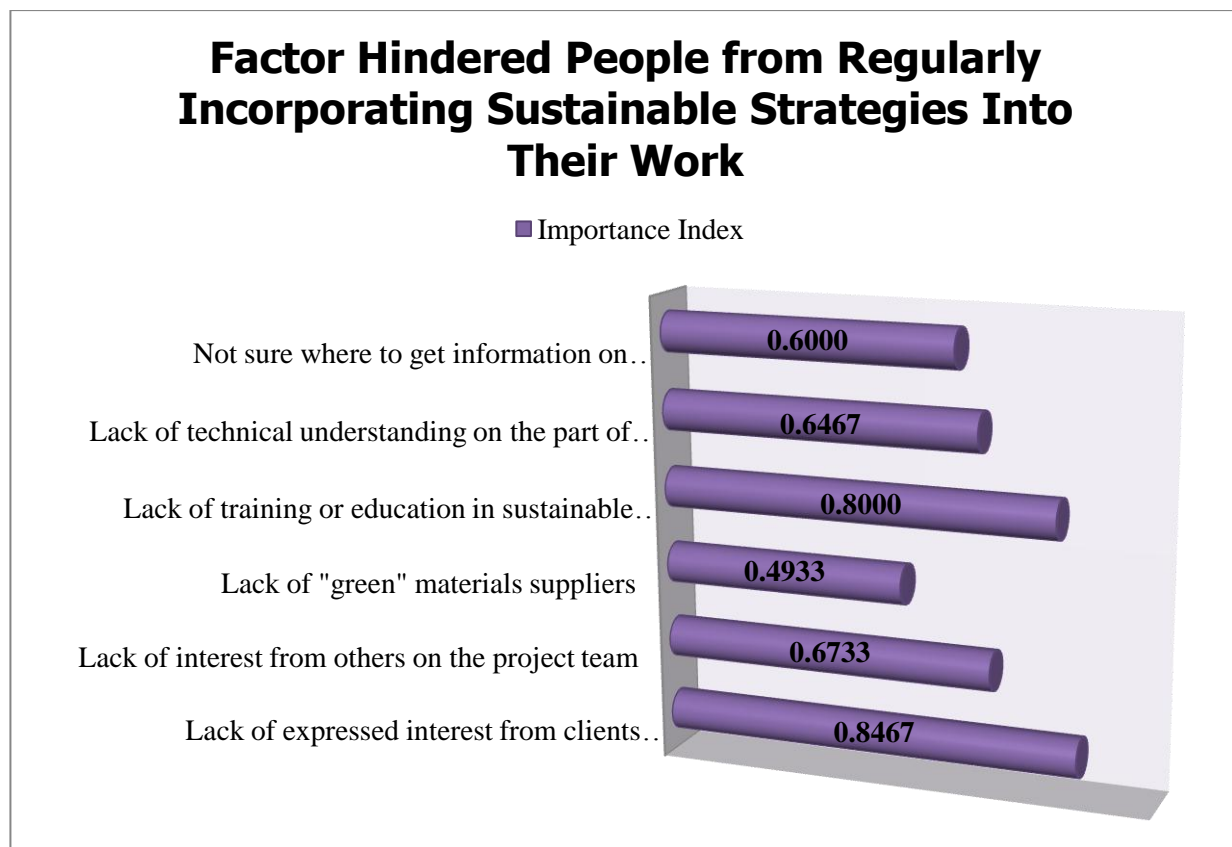


Figure 4.6: Factors Hindered People from Regularly Incorporating Sustainable Strategies into Their Work

Figure 4.6 shows the factors hindered people from regularly incorporating sustainable strategies into their work. The data collected from survey questionnaires which shows the majority respondents agreed that the main factor hindered people imposed the sustainable strategies into their work is lack of expressed interest from clients (owner or developers) which was first-ranked with the importance index of 0.8467.

Client is the main stakeholder or top management or pay master in a project and has the rights to make suggestions as to the design and construction of the project. Some of the respondents stated that sustainable construction is believed by many to be economically non-viable. Sustainable practices are believed to increase project cost because need to have higher capital upfront. Higher cost means higher price. If they pursue sustainability in the projects, they need to know that there is a market for it because technically, the cost will be transferred to the buyers.

The second-ranked with the importance index of 0.8000 is lack of training or education in sustainable design or construction. Then, it followed by third ranking which is lack of interest from others on the project team with the importance index of 0.6733 and lack of technical understanding on the part of others on the project team which is forth-ranked with the importance index of 0.6467. The fifth ranking is not sure where to get information on sustainable building methods with the importance index of 0.6000.

The last factor with the important index of 0.4933 is lack of “green” materials suppliers. This shows positive sign. The establishment of Malaysia Green Building Confederation’s (MGBC) is to promote green practice and become sustainability reference organization within the growing construction market sector. GreenPagesMalaysia is the first major project of MGBC. This project solves the problems of getting the latest issue on green building materials. It is a directory listing of Green Building materials and services that are currently available in Malaysia and is designed to serve the public by providing a source of information for Green Building materials.

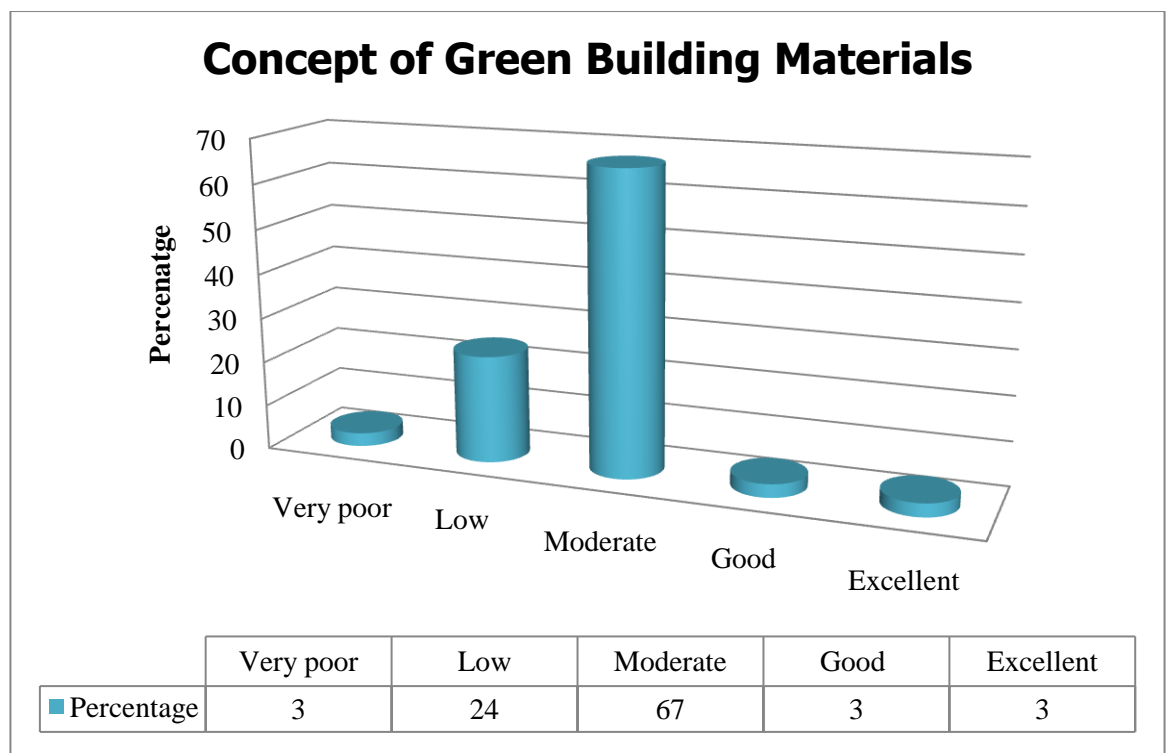


Figure 4.7: Concept of Green Building Materials

Figure 4.7 shows how familiar are the respondents with the concept of green building materials. Throughout the survey questionnaires, the result shows that majority respondents which are 20 respondents and represent by 67 % considered themselves the moderate level on the concept of Green Building materials. Then, it followed by low level on the concept of Green Building materials which attain 24 %. Next, it shows good sign that about 3 % of total respondents considered that they have good and excellent level on concept of Green Building materials respectively. However, equally on the opposite site, 3 % considered that they are still in very poor level on the concept of Green Building materials.

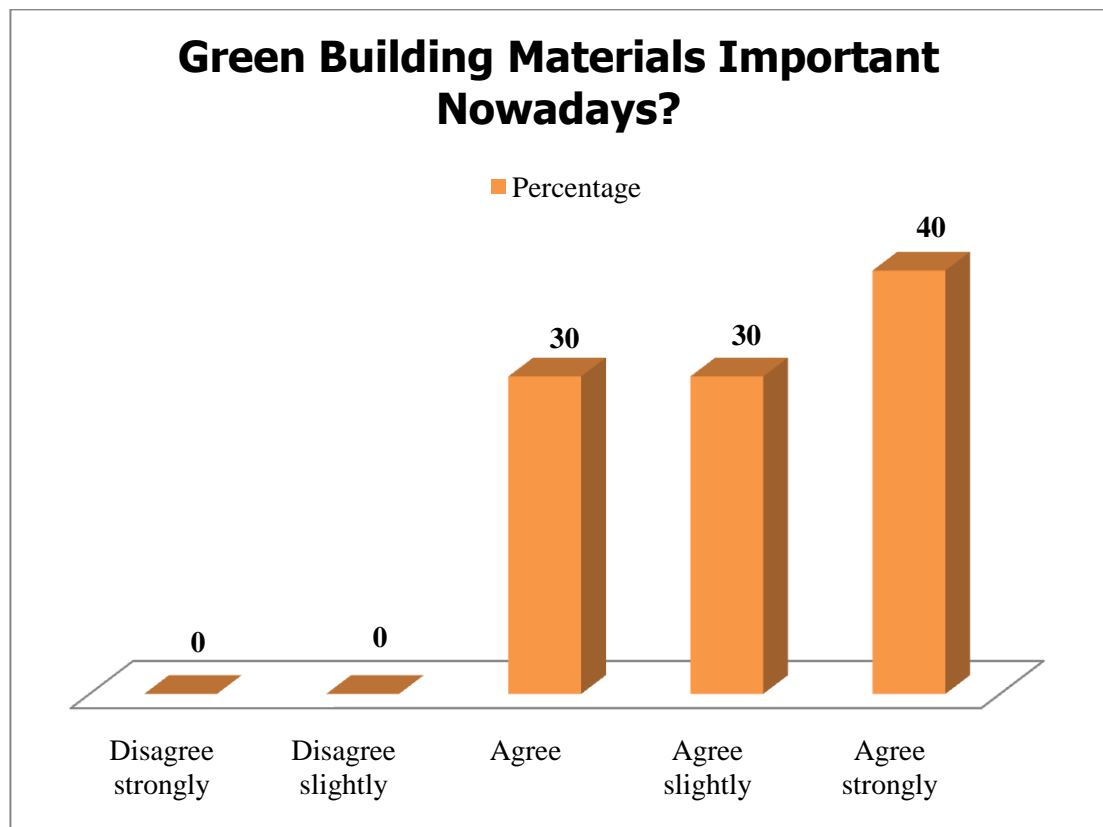


Figure 4.8: Green Building Materials Important Nowadays?

The data analysis examines the important of Green Building materials nowadays. From Figure 4.8 shows that majority of respondents agreed strongly that Green Building materials are important nowadays and it attain 40 %. Although some of the respondents might have the perception pertaining to Green Building materials are

expensive. In fact, they know that Green Building materials have good impact to the environment. They might have the good knowledge on sustainable concept, but they did not put it in practice or incorporating it in the projects. Knowing but not practicing is another major problem in sustainable concept implementation.

The second highest figure which is 30 % of the respondents agreed that Green Building materials are important nowadays. Meanwhile, the same figure goes to those that slightly agreed with the particular matter as well. None of the respondents disagreed that the Green Building materials are important nowadays.

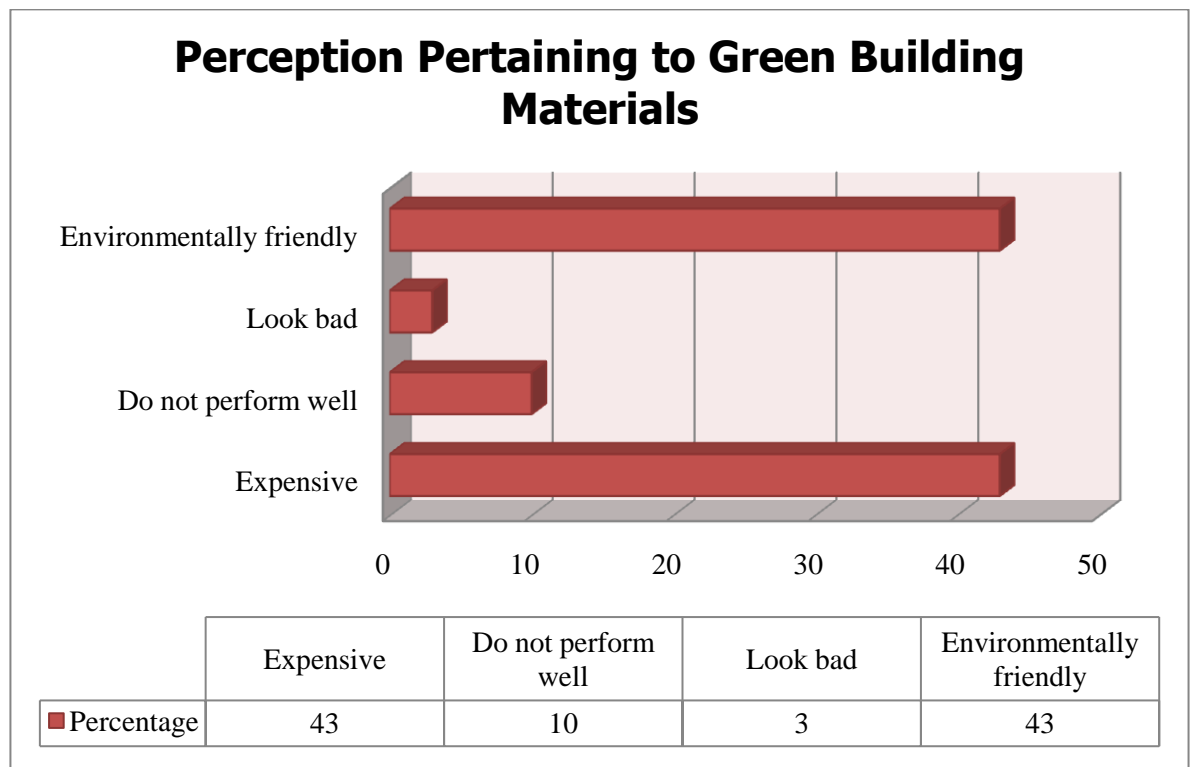


Figure 4.9: Perception Pertaining to Green Building Materials

Figure 4.9 shows the respondent's perception pertaining to Green Building materials. Throughout the survey questionnaires, it is clearly shows that 43 % of the respondent's perception pertaining to Green Building Materials is expensive. The majority of building owners, designers, engineers, contractors, manufacturers and building officials are receptive to protecting the environment but are not receptive to

using green materials to accomplish the task. The unfortunate perception is that Green Building materials is expensive. However, it equally on the opposite side which 43 % of the respondents agree that Green Building materials is environmentally friendly. Learning deeply about the green building materials can broaden human views and knowledge and can eliminate the accustomed misperceptions about the Green Building materials. They will learn and aware that Green Building materials is sustainable to environment.

Then, it followed by the perception that Green Building materials do not perform well. Next, about 3 % of the respondent's perception pertaining to Green Building materials is look bad. Decisions about aesthetic acceptability ultimately depend on personal perceptions. Sometimes, the project team worked on the projects where the client felt that the proposed green options appeared much more elegant than conventional construction materials. Conversely, they also have worked on projects where the very same green options were aesthetically unacceptable to the client.

Hence, understanding this perspective is essential for effectively resolving such concerns. It is necessary to get rid of the pervasive misperceptions about Green Building materials.

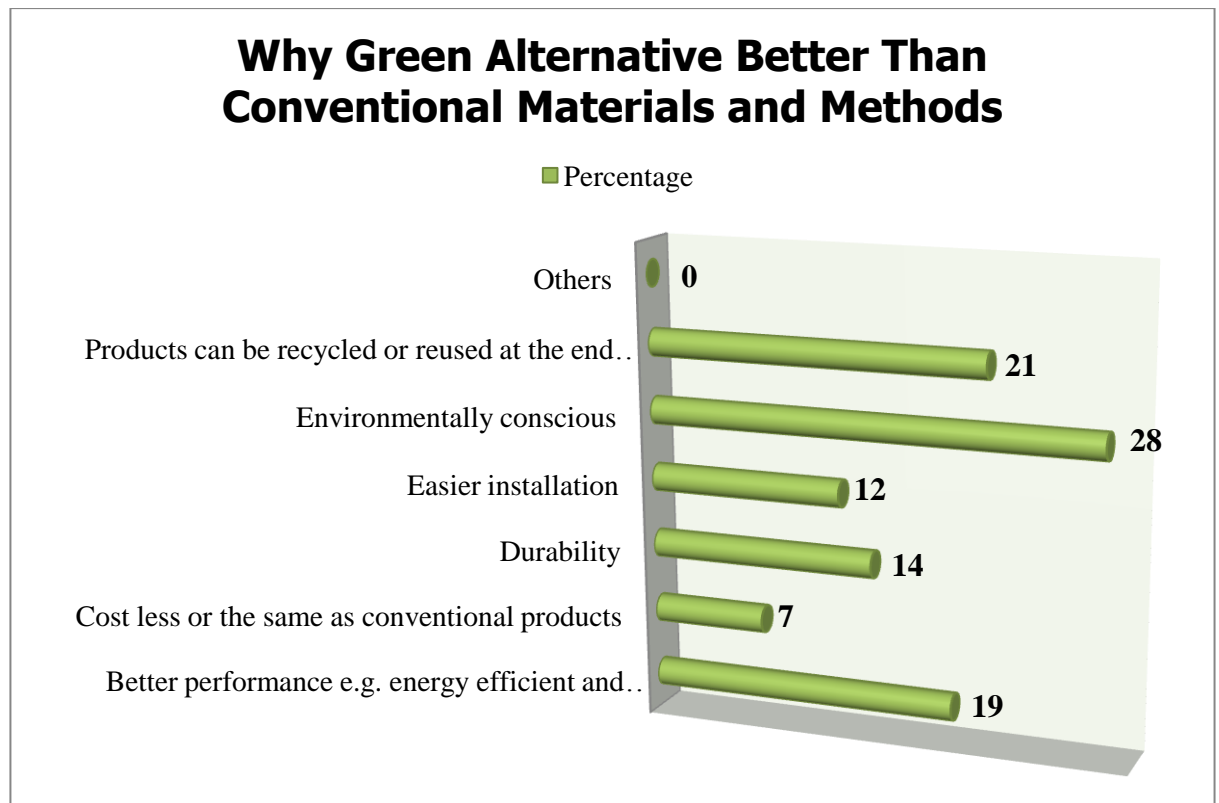


Figure 4.10: Why Green Alternative Better Than Conventional Materials and Methods

Figure 4.10 shows the reason why green alternative better than conventional materials and method. Throughout the survey questionnaires, majority of the respondents which add up to 28 % choose Green Building materials because of environmentally conscious. First message come across their mind about Green Building materials is low impact to environment. This is the fact and there are variety of advantages of Green Building materials than conventional materials and methods.

Second-ranked followed by the issue which the product can be recycled or reused at the end of its useful life in the building. This is important which can reduce the amount of waste ship off to landfills and removing the need to continually exploit new resources. It can reduce the impact on the environment.

Besides that, 19 % of the respondents agreed that Green Building materials have better performance such as energy-efficient and water-efficient. A Green Building material can earn high marks for resources management, impact on indoor

environmental quality (IEQ) and performance. A Green Building material such as Autoclaved Aerated Concrete (AAC) blocks which can contribute points to Non-residential New Construction (NRNC) EE1, EE5 and MR2 under Green Building Index (GBI) assessment criteria.

Next, it followed by 14 % and 12 % of the respondents who agreed that Green Building materials is durability and easier installation. Minority of the respondents which attain 7 % believed that Green Building materials is cost less or same as conventional products. In the other words, it means that majority of the respondents agreed that Green Building materials is expensive. Some of the Green Building materials might be slightly expensive at the early stage, but it will save a huge amount of money the rest of the building lifetime. For example, green lighting system, occupant can saves electrical energy as this system is using a hi-efficiency light bulb.

Table 4.2: Ranking of Green Building Materials

Ranking of Green Building Materials	Degree of importance quoted by respondents according to five Likert scales					Importance Index	Rank
	1	2	3	4	5		
Internal Wall Partition	1	3	14	4	8	0.7000	4
Ceiling	4	6	12	7	1	0.5767	6
Drywall	7	10	10	2	1	0.4667	8
Fibreglass	0	3	7	11	9	0.7733	2
High Volume Fly Ash Concrete	0	1	11	12	6	0.7533	3
Plastic, e.g. PVC	1	8	13	5	3	0.6167	5
Metal Roofing	0	2	2	14	12	0.8400	1
Wool Bricks	6	12	6	3	3	0.5000	7
Others	0	0	0	0	2	0.0667	9

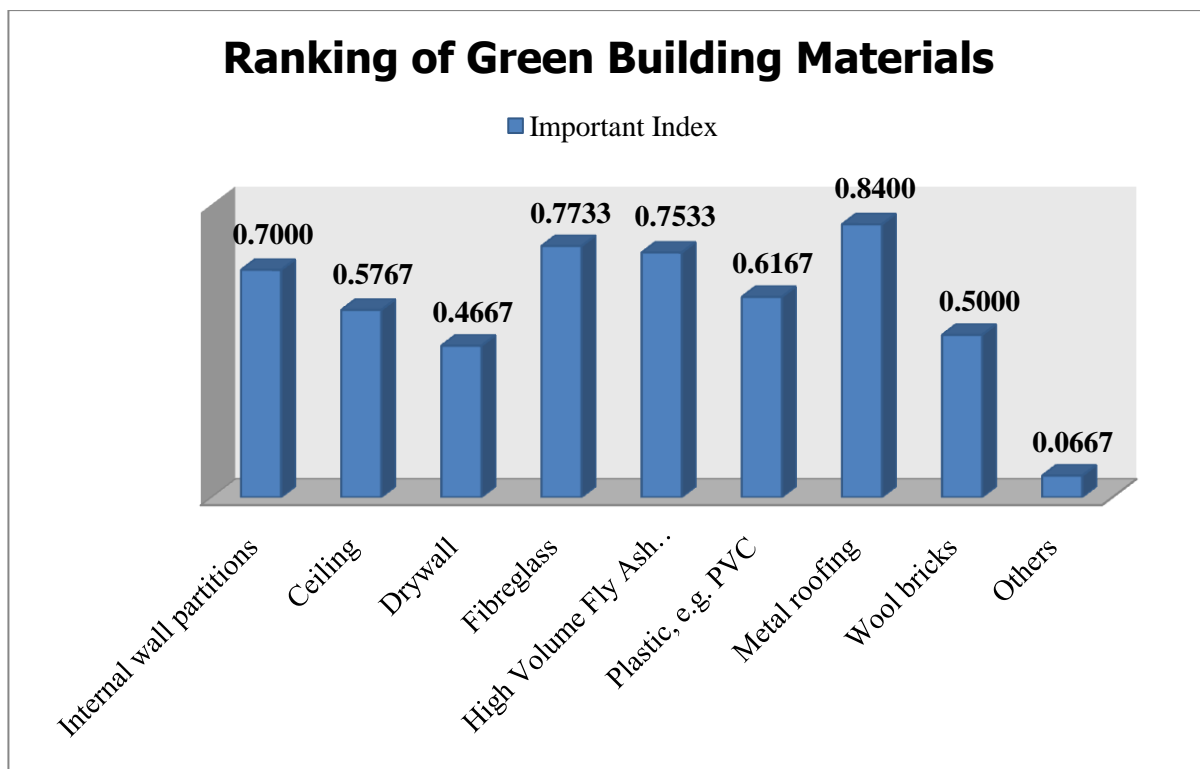


Figure 4.11: Ranking of Green Building Materials

The data analysis examines the ranking of green building materials. Figure 4.11 shows the majority respondents agreed that metal roofing is important green building materials amongst the others which was first-ranked with the importance index of 0.8400. Roofing is a major component of any structure and it is a component for which the product chosen can have a dramatic on the building's life and energy costs.

Metal roofing has first-ranked due to many benefits such as sustainability, have recycle content, low weight and others. The misperceptions that metal roofing is one that outdated and no longer in style can be eliminated. Nowadays, metal roofing has a wide variety colours and styles to meet any homeowner taste setting the home apart from the rest of the block. This issue enhances the homeowner to choose on metal roofing.

Then, it followed by fibreglass which second-ranked with the importance index of 0.7733. There are many uses for fibreglass such as thermal insulation, sound

insulation, reinforcement of various materials, sound absorption and others. This enhances the usability of the fibreglass.

Third ranking and fourth ranking attained by high volume fly ash concrete and internal wall partition with the importance index of 0.7533 and 0.7000. Green Building materials such as plastic, ceiling and wool bricks which were fifth, sixth and seventh-ranked with the importance index of 0.6167, 0.5767 and 0.5000 respectively. Drywall obtains the second last important index which was 0.4667 with the ranking at eight.

There are two respondents who give their suggestions and views on the other green building materials which is ranked last with the importance index of 0.0667. One of the respondents who is an engineer suggests that low E-façade glass can be considered as green building materials and important for a building. Ar. Von who is the MGBC president and GBI accreditation panel member suggest that glass, water fittings, air-conditioning equipment, air filters, light fittings and landscaping are important for a building.

Table 4.3: The Importance Criteria under Resources Assessment

The Importance Criteria under Resources Assessment	Degree of importance quoted by respondents according to five Likert scales					Importance Index	Rank
	1	2	3	4	5		
Low-impact systems and materials	0	2	17	5	6	0.7000	4
Minimal use of non-renewable	0	2	7	15	6	0.7667	3
Reuse of existing buildings	2	6	11	5	6	0.6467	5
Durability, adaptability and disassembly	0	2	1	9	18	0.8896	1
Recycling and composting facilities	0	0	6	7	17	0.8733	2

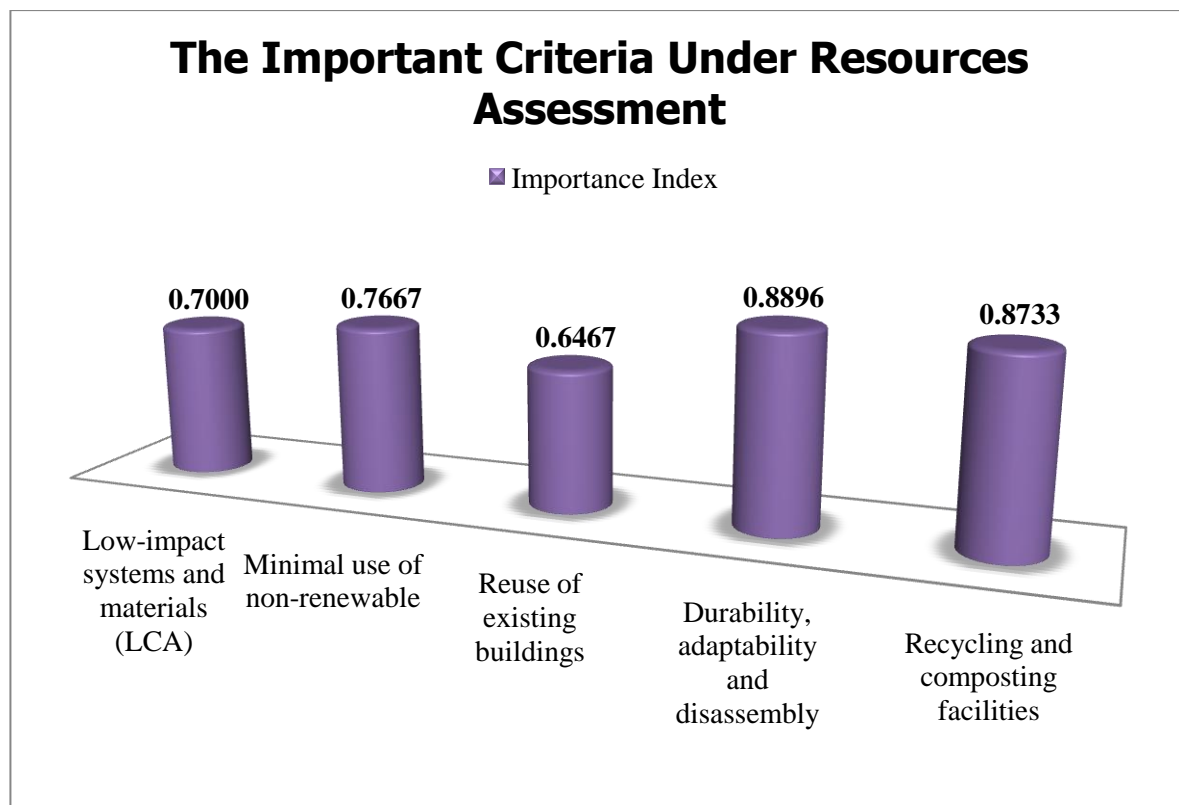


Figure 4.12: The Important Criteria under Resources Assessment

The data analysis examines the degree of importance criteria under resources assessment. Figure 4.12 shows the majority of the respondents agreed that criteria which is durability, adaptability and disassembly is important amongst the others criteria and first-ranked with the importance index of 0.8867.

The premature deterioration of buildings and buildings components has become an increasing problem in new and existing buildings. The cost for repetitive maintenance, repairs, premature replacement, potential health effects and occupant disruption of use has escalated to multibillion-dollar levels. The repairs have resulted in increased embodied energy, which over the expected lifetime of the building can far outweigh that of the originally constructed building. This has obvious impacts on the sustainability of the building industry. Hence, this might be one of the reasons the issue of durability, adaptability and disassembly first-ranked.

Then, it followed by second-ranked which is recycling and composting facilities with the importance index of 0.8733. In today's world the importance of

recycling is becoming greater of a concern both for the general public and also to the economy. Recycling along with reducing consumption is the best means to counter the damage human have been doing to the earth for centuries. Recycling is incredibly important as a means to reduce poisonous emissions into the atmosphere and also to spare the natural resources.

Next, with the importance index of 0.7667 and third-ranked is obtained by the criteria of minimal use of non-renewable. The criteria which is low-impact systems and materials (LCA) was forth-ranked with the important index of 0.7000. The criteria which are reuse of existing buildings which was last-ranked with the important index of 0.6467. The reason might be this criteria not as important as compared to the others criteria under resources assessment. However, the awareness of reuse of existing buildings is now increasing.

Paralleling the phenomenon of recycling used products into newly formed products, the building industry has witnessed the increase of whole buildings being recycled. In the residential market, it can be see that existing homes being added onto attic space being converted to living space and remodeling work being undertaken where previous homeowners might have chosen to move rather than be burdened with the daunting tasks involved in remodeling. It is clear that urban sprawl is offset and reduced by the renovation and reuse of existing structures. With lower interest rates, homeowners have steadily increased the volume of residential remodeling in today's market.

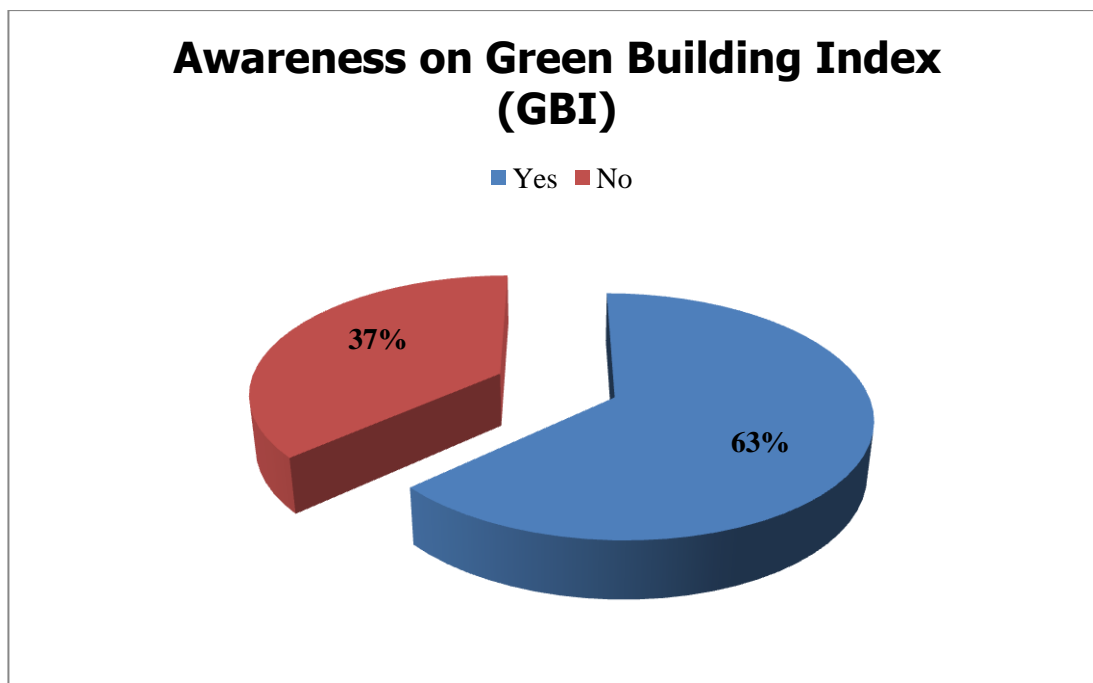


Figure 4.13: Awareness on Green Building Index (GBI)

Figure 4.13 shows the respondent's awareness on Green Building Index. 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 Developers, Architects, Engineers, Planners, Designers, Contractors and the Public about environmental issues and our responsibility to the future generations. The GBI rating tool provides an opportunity for developers and building owners to design and construct green, sustainable buildings that can provide energy savings, water savings, a healthier indoor environment, better connectivity to public transport and the adoption of recycling and greenery for their projects and reduce our impact on the environment.

Throughout the survey questionnaires, it is clearly shows that 63% of the respondent's have the awareness on Green Building Index (GBI). 37% which means 11 out of 30 respondents do not have any awareness on Green Building Index (GBI).

Table 4.4: The Importance Criteria under Green Building Index (GBI)

The Importance Criteria Under Green Building Index (GBI)	Degree of importance quoted by respondents according to five Likert scales					Importance Index	Rank
	1	2	3	4	5		
Innovation (IN)	0	6	10	6	8	0.7067	6
Water Efficiency (WE)	0	1	6	14	9	0.8067	3
Materials & Resources	0	5	9	7	9	0.7333	5
Sustainable Site Planning & Management (SM)	0	0	8	10	12	0.8267	2
Indoor Environmental Quality (EQ)	0	3	8	9	10	0.7733	4
Energy Efficiency (EE)	0	0	3	6	21	0.9200	1

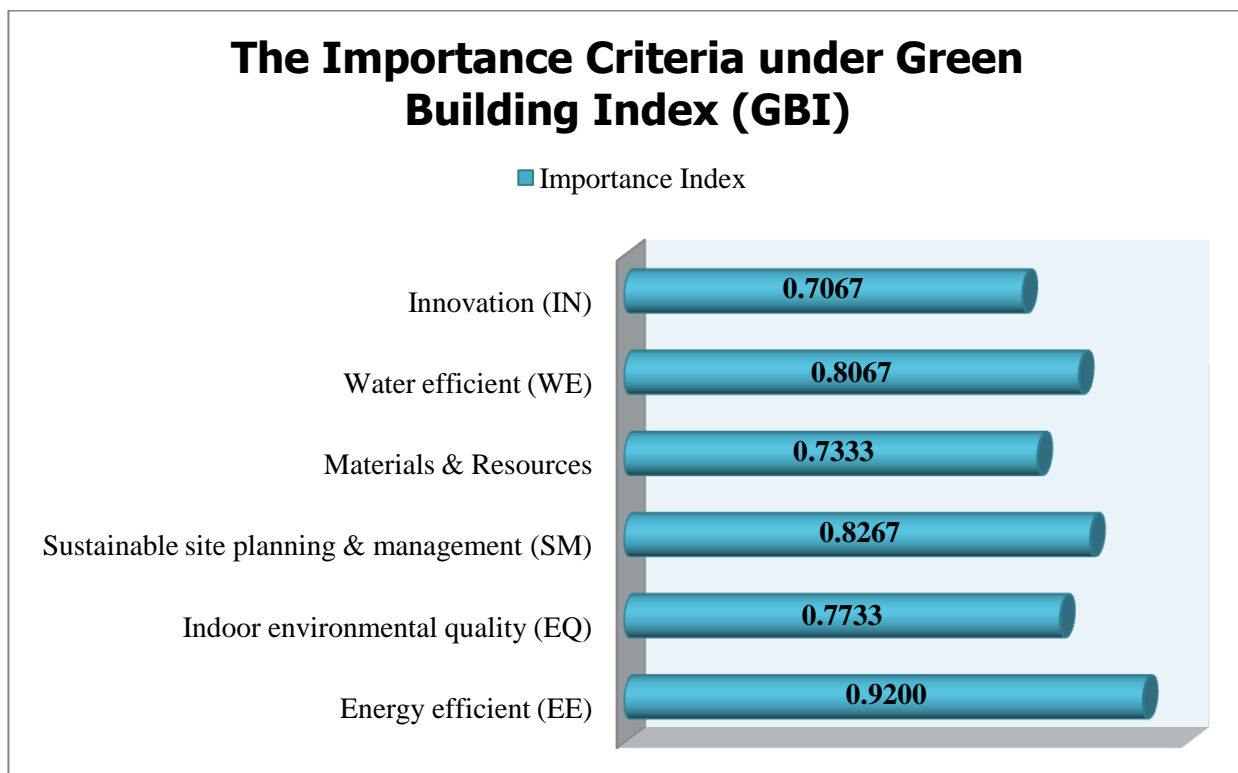


Figure 4.14: The Importance Criteria under Green Building Index (GBI)

The data analysis examines the degree of importance criteria under Green Building Index (GBI). Through the survey questionnaires, the result that gains is that energy efficient is the most important criteria that been choose by majority respondents and first-ranked with the importance index of 0.9200. Maximum points for energy efficiency under Green Building Index assessment criteria is 23 which is the highest points amongst the others criteria. It is clearly showed that energy efficiency had played an important role in a building. Energy efficiency are important means toward the development of sustainable energy and reducing the impacts of the energy sector on the environment and reduce requirements of planting up infrastructure facilities.

Then, it followed by water efficiency which was second-ranked with the importance index of 0.8267. Water efficient is also part of the green building concept. Optimizing water efficiency is another step in the direction of a green home. For example, water collection and reuse. There is no more cost effective water source than rain. If one rainstorm drops 1 inch of rain on the yard, it equivalent of over 250 bathtubs of water trickle by.

Next, indoor environmental quality was third-ranked with the importance index of 0.8067. Some peoples might argued that it is not only desirable, but also a fundamental human right to live and work in spaces with healthy indoor environments. Buildings enhance people's lives when they permit ample air circulation, maintain clean air and comfortable temperatures and allow individuals to have a sense of control over their own indoor experience.

Fourth and fifth-ranked attained by materials and resources and sustainable site planning & management with the importance index of 0.7733 and 0.7333. The last-ranked was represented by innovation with the important index of 0.7067. Maximum points for innovation under Green Building Index assessment criteria is only 6 which is the lowest points amongst the others criteria. This might be the reason which the parties might not have higher attention on this criteria if compared to others criteria.

However, every item under green building index (GBI) assessment criteria is important as the points collected is to determine the rating of a building such as certified, silver, gold and platinum.

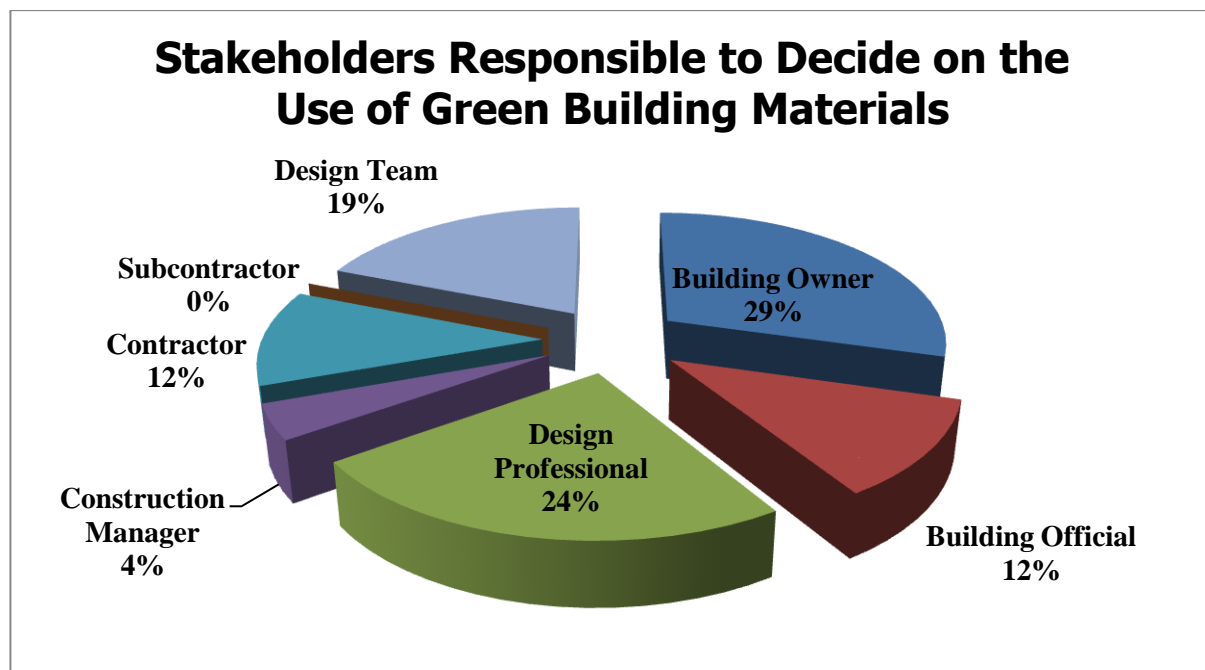


Figure 4.15: Stakeholder Responsible to Decide on the Use of Green Building Materials

Figure 4.15 analyses the stakeholders who are responsible to decide on the use of Green Building materials. Through the survey questionnaires, the majority of the respondents which was 29 % agreed that building owner is the main stakeholder to decide the use of green building materials. The building owner is the person whose idea the building was in the first place and also responsible for funding the construction of the project and for operating it once it is complete.

Next, the second-ranked is by the designs professional which achieve 24 %. Design professionals are the one who assess the available material options and evaluating the green information sources. They know where to obtain current standard of care information in order to be able to verify a manufacturer's claims. Nowadays, there are many website for design professional to search for the Green

Building materials as for example green pages Malaysia. Hence, this will be no problems to apply the Green Building materials to a building.

Then, it followed by third-ranked which is design team with 19 % of respondents. A good communication and understanding can help the design team on identify, specify and utilize green building materials effectively in a project. For example, the continuous updated of the green building materials by the manufacturer to the Architect can broaden him the knowledge and information on the materials or products and can apply them in a project effectively.

Forth-ranked represented by two types of stakeholders which are contractor and building official obtain the same percentage which is 12 %. Minority respondents believed that construction manager responsible to decide the use of green building materials which obtain 4 %. All the respondents believed that subcontractor not involve actively in decide the use of green building materials where subcontractor only enter the contract with contractor to perform a specific portion of the construction contract or to supply materials for a project.

Table 4.5: Media to Enhance the Awareness Level of Green Building Materials

Media to Enhance the Awareness Level of Green Building Materials	Degree of importance quoted by respondents according to five Likert scales					Importance Index	Rank
	1	2	3	4	5		
Government Intervention	0	0	2	8	20	0.9200	1
Experience	0	0	3	23	4	0.8067	3
Education through conferences, trainings, seminars or workshops	0	0	7	8	15	0.8533	2
Parties itself <i>(May have good knowledge on the concept but did not put it in practice in projects)</i>	0	0	6	18	6	0.8000	4

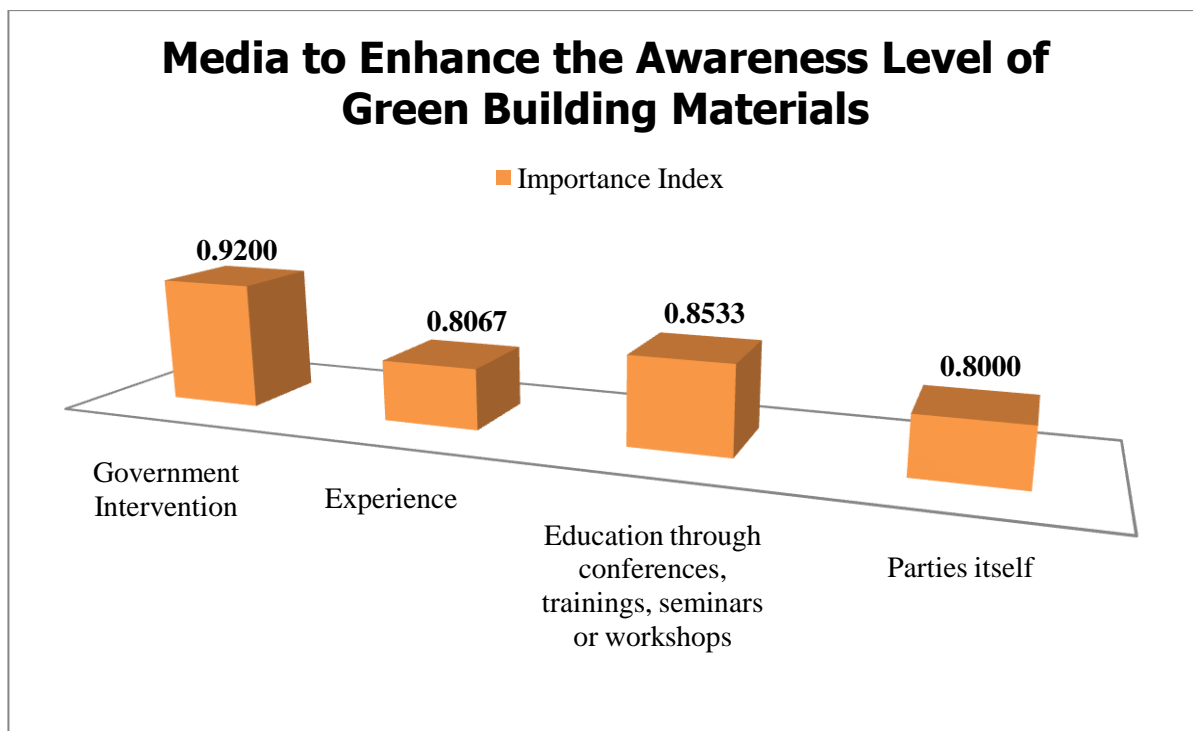


Figure 4.16: Media to Enhance the Awareness Level of Green Building Materials

Figure 4.16 requires the respondents to give their opinion which media enhance the awareness level of Green Building materials. Through the questionnaires, it shows that government intervention is the most important media amongst the others which to enhance the awareness level of green building materials with the importance index of 0.9200. Majority of the respondents believed that the government plays a bigger role in promoting sustainable construction, through actions such as through strong enforcement of legislation, devising new policy or giving incentives to the parties who want to pursue sustainability in their projects.

The second-ranked media is education through conferences, trainings, seminars or workshops with the importance index of 0.8533. Some of the respondents believed that through this media can enhance and increase the stakeholder's knowledge and awareness on the Green Building materials. Education should not limit to the construction players only but also expanded to the wider stakeholders.

Next, it followed by third-ranked media which is experience with the importance index of 0.8067. The younger generation, however, have been exposed about sustainable construction in their higher education level, however due to their lack of experience in the real world, they have problem disseminating their theoretical understanding of sustainability knowledge into practice.

The last-ranked with the importance index of 0.8000 is due to the parties itself. Parties may have good knowledge on the concept but did not put it in practice in projects. This issue will create problems and difficulty in implementing the sustainable concept.

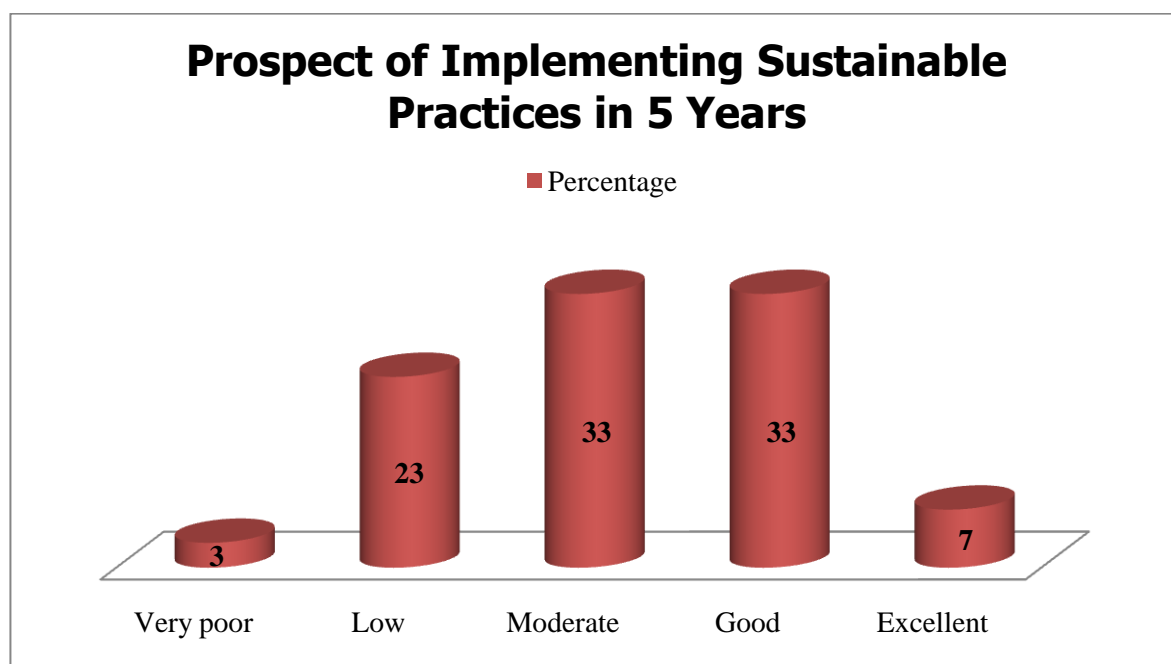


Figure 4.17: Prospect of Implementing Sustainable Practices in 5 Years

Finally, the respondents are request to give their opinion on the prospect of sustainable construction application in Malaysia in 5 years. Figure 4.17 shows that 33 % of the respondents believed that in 5 years, not much will change and the level is still moderate. However, equally on the opposite site, 33 % of the respondents believed that it will get better (good) on sustainable practices in Malaysia. About 23 % of the respondents believed that is will still be low. That is still good news that 7 %

of the respondents believed that the prospect of implementing sustainable practices in 5 years is excellent. There are few people which are 3 % who think that the future of sustainable construction is very poor.

4.1.3 Conclusion

The above discussion of findings explains the consequences with respect to achieving sustainable material for buildings that reflects sustainable development principles in construction industry in Malaysia. This chapter has related the analysis and conclusion from the outcomes of the distributed questionnaires. This questionnaires survey has opened a broader discussions and opinions from stakeholders in the Malaysia's construction industry. The derived findings could be used to propose new and better sustainable materials for sustainable building developments.

4.1.3.1 Section A: Respondent's background

Question 1: Nature of Business of Respondent's Company

The research shows that majority of the respondents which represent by 40 % are work at Architect firms. Then it followed by Consultant firms and Construction firms which is 33 % and 20 % respectively. Minority of the respondents are work at developer firms which only obtain 7 %.

Question 2: Respondent's working experience year

The result shows majority of the respondent's working experience is at the range of 1 - 5 years which represent by 47 %. Next, respondent's working experience at the range of 6 - 10 years and 11 - 15 years obtains by the same figure which is 20 %. The

least percentage of the respondent's working experience is at the range of 16 years and above and it consists of only 13 %.

4.1.3.2 Section B: Green Building Materials issues

Question 1: Level of Understanding on Sustainability Concept

Most of the respondents which represent by 60 % believed themselves to have moderate level of understanding on sustainability concept. Then, it followed by 24 % and 10 % of the respondents who considered themselves to have low and very poor level of understanding on sustainability concept. It is similar that merely 2 respondents, which are approximately 3 % of total respondents considered that they possessed good sustainable concept and excellent sustainable concept respectively.

Question 2: Understanding of the Concept of Sustainable Construction

Majority of the respondents believed that sustainable construction is about the environmental issue. The three highest ranking is environmental planning, management and control which consist of 28 %. Then, it followed by protection of the environment and prudent use of natural resources which represent by 20 % and 18 % respectively. Next, some of the respondents believed that sustainable construction related to the social issue. 17 % and 5 % of the respondents agree that sustainable construction is about the quality of life & customer satisfaction and social progress which recognize the need of everyone. Minority of the respondents relate their understanding of sustainable construction to economic issue. 7 % and 5 % of the respondents considered the sustainable construction is about generating profit without compromising future needs and maintaining economic growth.

Question 3: Level of Implementation of Sustainable Practices

18 out of 30 respondents considered they have the moderate level of implementation of sustainable practices which represent by 60 %. Then, it followed by the low, good and very poor level of implementation of sustainable practices which adds up to

20 %, 13 % and 7 % respectively. None of the respondents believed that the level of implementation of sustainable practices is excellent.

Question 4: Factor Hindered People from Regularly Incorporating Sustainable Strategies into Their Work

First-ranked factor is lack of expressed interest from clients (owners or developers) with the importance index of 0.8467. Then, it followed by lack of training or education in sustainable design or construction with the importance index of 0.8000 and lack of interest from others on the project team with the importance index of 0.6733. The forth-ranked and fifth-ranked factor is related with the lack of technical understanding on the part of others on the project team and not sure where to get information on sustainable building methods with the importance index of 0.6467 and 0.6000 respectively. The last-ranked factor is lack of “green” materials suppliers with the importance index of 0.4933.

Question 5: Concept of Green Building Materials

Majority respondents which represent by 67 % considered themselves to have the moderate level on the concept of Green Building materials. Then, it followed by low level on the concept of Green Building materials which attain 24 %. Next, it shows good sign that about 3 % of total respondents considered that they have good and excellent level on concept of Green Building materials respectively. However, equally on the opposite site, 3 % considered that they are still in very poor level on the concept of Green Building materials.

Question 6: The Important of Green Building Materials Nowadays

40 % of the respondents strongly agreed that Green Building materials are important nowadays. The second highest figure which is 30 % of the respondents agreed that Green Building materials are important nowadays. Meanwhile, the same figure goes to those that slightly agreed with the particular matter as well. None of the respondents disagreed that Green Building materials are important nowadays.

Question 7: Perception Pertaining to Green Building Materials

43 % of the respondent's perception pertaining to Green Building materials is expensive. However, on the opposite side, 43 % of the respondents agreed that Green Building materials is environmentally friendly. Next, it followed by 10 % of the respondents who have the perception that Green Building materials do not perform well. Last, there are 3 % of the respondent's perception pertaining to Green Building materials is look bad.

Question 8: Why Green Alternative Better Than Conventional Materials and Methods

Majority of the respondent which represent by 28 % choose Green Building materials because of environmentally conscious. 21 % of the respondents believe that Green Building materials is better than conventional materials because of the products can be recycled or reused at the end of its useful life in the building. Next, it followed by 19 % and 14 % of the respondents who believe that Green Building materials can provide better performance and better durability than conventional materials. 12 % of the total respondents choose Green Building materials because of the easier installation than conventional materials. Last, minority of the respondents which is 7 % believed that Green Building materials cost less or the same as conventional materials.

Question 9: Ranking of Green Building Materials

The top ranking is metal roofing with the importance index of 0.8400. The second ranking with the importance index of 0.7733 is fibreglass. The third and fourth ranking is high volume fly ash concrete and internal wall partition with the importance index of 0.7533 and 0.7000. Then it followed by plastic e.g. PVC and ceiling with the importance index of 0.6167 and 0.5767. Wool bricks and drywall was seventh ranking and eight ranking with the importance index of 0.5000 and 0.4667. One of the interviewees suggest that glass, water fittings, air-conditioning equipment, air filters, light fittings and landscaping are important for a building.

Question 10: The Important Criteria under Resources Assessment

Top ranking is durability, adaptability and disassembly with the importance index of 0.8896. Second ranking with the importance index of 0.8733 is recycling and composting facilities. The third ranking and fourth ranking is minimal use of non-renewable and low-impacts systems and materials with the important index of 0.7667 and 0.7000. The last ranking with the important index of 0.6467 is reuse of existing buildings.

Question 11: Respondent's awareness on Green Building Index (GBI)

63 % of the respondents know about Green Building Index (GBI). However, 37 % of the respondents have less awareness on Green Building Index (GBI).

Question 12: The Important Criteria under Green Building Criteria (GBI)

Majority of the respondents vote the energy efficiency as the most important criteria under Green Building Index (GBI). It obtains importance index of 0.9200. The second ranking and third ranking is sustainable site planning & management with the important index of 0.8267 and water efficiency with the importance index of 0.8067. Then, it followed by the criteria which is indoor environmental quality and materials & resources with the importance index of 0.7733 and 0.7333. The last ranking is innovation with the importance index of 0.7076.

Question 13: Stakeholders who responsible to Decide on the Use of Green Building Materials

29 % of the respondents agreed that building owner is the most important stakeholder in deciding on the use of Green Building materials. Then, it followed by design professional and design team which 24 % and 19 % of the respondents vote on it. There are 12 % of the respondents who agreed that contractor and building official are one of the important stakeholders to decide on the use of Green Building materials. Only 4 % of the respondents believed that construction manager play an important role in deciding on the use of Green Building materials. However, none of

the respondents agreed that the subcontractor is important to make decision on the use of Green Building materials.

Question 14: Media to Enhance the Awareness Level of Green Building Materials

The top ranking with the importance index of 0.9200 is government intervention. Second ranking is education through conferences, trainings, seminars or workshops with the importance index of 0.8533. Experience is third ranking with the importance index of 0.8067. The last ranking with the importance index of 0.8000 is parties itself, they may have good knowledge on the concept but did not put it in practice in projects.

Question 15: Prospect of Implementing Sustainable Practices in 5 Years

There are 33 % of the respondents believed that in 5 years, not much will change and the level is still moderate. Meanwhile, there also 33 % of the respondents believe that it will get better on sustainable practices in Malaysia. About 23 % of the respondents believed that is will still be low. However, 7 % of the respondents believed that the prospect of implementing sustainable practices in 5 years is excellent. There are few people which are 3 % who think that the future of sustainable construction is very poor.

4.2 Interview

4.2.1 Introduction

There are total of two interviewees had been conducted which are from different background. They have better knowledge on sustainable construction and involve in construct Green Building. The interview questions were prepared to obtain the information on sustainable construction and the green building materials.

The interview process has been conducted within the district of Kuala Lumpur. There a total of two participants had been interviewed for the evaluation of results. Based on their professional knowledge and invaluable experience, the results obtained are supportive and applicable.

The backgrounds of the interviews are briefly described in short notes as listed below. The background information is data on the interviewees name, profession, company name, and current position in company.

Table 4.6: Background of Interviewees

Interviewees Name	Profession	Company Name	Current Position
Ar. Von Kok Leong	Architect	MAA Sdn. Bhd.	Director
Ms. Ng Pek Har	Engineer	Web Structures (M) Sdn. Bhd.	Director

4.2.2 Summary of Interviews

4.2.2.1 Architect - Ar. Von Kok Leong

In the view of Ar. Von, he supports that sustainability construction is important nowadays. The Earth's ecosystems are now at a critical stage where they are not only being severely damaged but human activity currently leads to irreversible losses of critical (i.e. life-supporting) ecosystem functions. Buildings and construction works have the largest single share in global resource use and pollution emission. In order to save our environment, one of the ways is to use green building materials in construction industry.

However, Malaysia construction industry still encountered the problem of lacking people using green building materials. Ar. Von had given his opinion state that some of the people still hesitate using green building materials because of the lack of knowledge and the wrong perception of very high costs. Fortunately, Malaysia Green Building Confederation (MGBC) organise to help educate the public

on sustainability. As for the costs, Ar. Von hope that through wider usage and competition on green building materials, it will reduce and will no longer be an issue.

Malaysia Green Building Confederation (MGBC) mission is to driving force towards a sustainable built environment in Malaysia. As a president of MGBC and a director of an Architect firm, definitely Ar. Von will consider using green building materials in his design. He explains that architecture and the concept of sustainability go hand in hand. When architects design a new development, major issues regarding site selection, orientation, site context, passive design matters must be considered and applied in the designs. The suitability, costs, green alternatives (the raw materials used and the processes of manufacturing) and availability will be consider when determine the type of green building materials to be use in a building.

According to Ar. Von, it must first start with the Architect to determine the use of green building materials in a building. Architect will initiate the discussion on green building materials with client and other consultants. Next, he will have to confirm the availability of green building materials and clarify of specifications to bidder during the bidding. As there are various type of green building materials in the construction industry, Ar. Von suggest architects, consultants or other professionals can refer to Malaysia Green Building Confederation GreenPagesMalaysia (GPM) for a list of green building materials. The GreenPagesMalaysia (GPM) will be updated regularly with new listings.

When architects select green building materials, they need not to get any approval from local authorities. Local authorities do not specify any materials nor control the type of green building materials to be used. Besides that, Ar. Von also state that their design will follow some of the procedures or forms such as all the Green Building Index (GBI) rating tools which cover Malaysia codes and bylaws such as UBBL, QLASSIC, IBS and other relevant overseas codes like ASHRAE.

Ar. Von suggests using Industrialised Building System (IBS) Score form to evaluate a building. A sample of IBS Score form was included in Appendix H. Industrialisation process is an investment in equipment, facilities and technology with the objective of maximizing production output, minimizing labour resource and

improving quality while a building system is defined as a set of interconnected elements that join together to enable the designated performance of a building.

Higher IBS Score is a reflection of a higher reduction of site labour, lower wastage, less site materials, cleaner environment, better quality, neater and safer construction sites, faster project completion as well as lower total construction costs.

However, to determine how sustainable a building, Ar. Von recommends using Green Building Index (GBI) rating tools. A sample of GBI Assessment Criteria was included in Appendix G. He further explains on Green Building Index (GBI) which GBI is Malaysia's industry recognised green rating tool for buildings to promote sustainability in the built environment and raise awareness among Developers, Architects, Engineers, Planners, Designers, Contractors and the Public about environmental issues and responsibility to the future generations. The GBI rating tool provides an opportunity for developers and building owners to design and construct green, sustainable buildings that can provide energy savings, water savings, a healthier indoor environment, better connectivity to public transport and the adoption of recycling and greenery for their projects and reduce impact on the environment.

How a building being assessed for the criteria in a building, e.g. residential New Construction? Ar. Von had clearly explains on this statement. Firstly, the Architect and his Consultants have to come out with a concept design. Then, a GBI Facilitator will be engaged to work with the team to achieve a rating using the relevant GBI tool. The Facilitator submits to GBI the design for registration, and be followed by submission for Design Assessment (DA). Upon completion of the evaluation by GBI, a Provisional Certification will be given.

When the building has completed construction, GBI will come and conduct a Completion and Verification Assessment (CVA), and a Final Certification will be issued for the building.

Within the DA process, the Facilitator must prove that the design complies with the intents of the green assessment criteria for Energy Efficiency, Indoor

Environment Quality, Site Selection and Management, Water Efficiency, Materials and Resources, and Innovation. Points will be given based on the criteria, and the total points will determine whether the building is rated Certified, Silver, Gold or Platinum.

Before the interview ended, Ar. Von had given his view on the issue of sustainability in Malaysia. In his view, he state that Green Building Index (GBI) and Malaysia Green Building Confederation (MGBC) started only a little more than 2 years ago. In that short time, the ideas of green buildings have gained support from architects, engineers, designers, developers, builders, and government. He hopes to see green buildings become the norm and through education, he hope to see all of the parties in construction industry practice sustainability. The main driver of sustainability is the state of the environment around us. In the end, the environment will benefit, and in turn, all of us will benefit from a good, clean environment. The environment belongs to all of us, and it does not discriminate.

Critical Review

The Author agreed with Ar. Von that Malaysia Green Building Confederation (MGBC) had play an important role in promote the sustainable concept. It is important as MGBC to be the reference centre for sustainable building resources in Malaysia. Besides that, MGBC provide facilities interchange with other associations carrying on similar work or with Government, local authorities, educational and scientist bodies. Furthermore, it also is the platform for networking nationally and internationally. MGBC provide better understanding and knowledge to the parties in construction industry which can have a tangible positive impact on the built environment whilst achieving reduced costs and possibly multiple bottom lines. Managing built environment will inevitable has constructive effects to the earth.

4.2.2.2 Engineer - Ms. Ng Pek Har

Based on the interview from Ms. Ng, she comments that green building materials are important nowadays. However, there is still a lack of people using green building materials. Why? In the opinion of Ms. Ng, she state that because of a lack of interest in or demand for sustainable building from clients (owners/developers). Besides that, a lack of training and education in sustainable design/construction also become one of the reasons. The next problem is the failure of service fee structures to account for the recovery of long-term savings. Lastly, the higher costs (both real and perceived) of sustainable building options during the preliminary stage had encountered a problem.

In order building and construction instruction move towards sustainability in the built environment, it is necessary for people to steps outside the circle and tries something new. Ms. Ng says that there is no doubt that she will consider of using green building materials in her design as the usage of green building materials will have a lot of advantages. Firstly, it can increase the efficient of resource use such as energy, water and materials. Besides that, to improve the quality of human life while maintain the capacity of ecosystem during the building's lifecycle. Third, the usage of green building materials can harmonize with the local climate, traditions, culture and surrounding environment.

Ms. Ng had clarified the type of green building materials into four categories which are recycled materials, natural materials, renewable resources and reclaimed materials. Since there is very little for recycled materials, if any, extra material needed to make these already made building materials feasible in constructing buildings, there would be no extra depletion on the earth's resources. Old tires are a perfect example of green building products which can be used to create decorative elements like baseboards, insulation, and other things like pipe systems in the buildings such as homes. Natural materials can be used are normally environmentally friendly and can create a very good foundation for a comfortable office or a home.

The use of renewable resources not only creates a green environment but ensures that the future generations will get resources to use in their environmentally

friendly projects. The benefits of rescued building materials is the fact that there would be no extra manufacturing involved, neither will there be a consumption of fossil fuels in the course of the building project because the materials will not be transported from far-away places. Reclaimed bricks, timber, among other elements also reduce the cost of construction as the materials are normally available at an affordable rate compared to newly manufactured products.

Ms. Ng had further explained on how she relates the sustainability in her works. Firstly, she will design the buildings which built primarily with wood and it will have a lower embodied energy than those built primarily with brick, concrete or steel. Second, build with passive solar building design which is often implemented in low energy homes. Third, effective window replacement (day lighting) can provide more natural light and lessen the need for electric lighting during the day. Forth, in order to maximum extent feasible, facilities should increase their dependence on water that is collected, used, purified and reuse on-site.

Next, design the dual plumbing that recycles water in toilet flushing. Waste water may be minimized by utilizing water conserving fixtures such as ultra-low flush toilets and low-flow shower heads. Finally, building materials typically considered to be 'green' include rapidly renewable plant materials such as bamboo and straw, insulating concrete forms, recycled stone, recycled metal and other products that are non-toxic, reusable, renewable and/or recycled.

How can green building materials be used in the design and who is responsible to make decision on this? According to Ms. Ng, there is neither client nor architect to decide the use of green building materials. It shall be the team work where client and design team to discuss and achieve the final foal during the preliminary stage. The decision will be made after having discussion with the client and the project team pertaining to the aim, design concept and cost budget. During the bidding phase, architects have to ensure all bidder well known of their responsibility and to ensure all bidder aware of the design concept and project team's expectation for the green building.

Design professional will having discussion with the manufacturer or suppliers or project team on the specification and ability of the product before having a final decision on the materials selection. After selection on the materials, project teams have to make sure all materials shall be prepared with the specifications for ease of reference. Besides that, there will be some procedures or guidelines to be follow in the design. For an example, on site detention tank shall be design according to the MSMA guideline.

All team members of project team, building owners, developers and other parties are encouraged to use the Green Building Index to validate environmental initiatives at the design phase of new construction or base building refurbishment or construction and procurement phase of buildings. Use of the Green Building Index is encouraged on all such projects to assess and improve their environmental attributes.

Ms. Ng had briefly explains on the GBI Index. Interested parties should complete and submit the GBI application form to Green Building Index Sdn Bhd (GSB). A GBI facilitator will then be appointed for the project and undertake the Design Assessment for GSB. The GBI Facilitator will upon completion, table the assessment report to the GBIAP to register and award the certification. The provisional GBI Design Assessment certification will then be issued with the accompanying GBI score sheet to show the scores achieved.

The final GBI award will be issued by the GBIAP upon completion of this Completion & Verification Assessment (CVA). Buildings are awarded GBI - Platinum, Gold, Silver or Certified ratings depending on the scores achieved as shown in the following table. Buildings will have to be re-assessed every three years in order to maintain their GBI rating to ensure that the buildings are well-maintained.

Table 4.7: Green Building Index Classification

GREEN BUILDING INDEX CLASSIFICATION	
POINTS	GBI RATING
86 points and above	Platinum
76 to 85 points	Gold
66 to 75 points	Silver
50 to 65 points	Certified

As a conclusion, Ms. Ng gave her view on the issue of sustainability in Malaysia. She comments that there shall be institutional accommodation of sustainability discourse. Environmental conservation and pollution control constitute the underlying themes (vertical policy integration), horizontal integration of sustainable development is still minimal in Malaysia. The distinction between separate environmental issues and sustainability as an integrated policy is yet to be established. Next, there shall have the role of normative change. Malaysia lacks political commitment to sustainable development. Lastly, there should have legal change. There has been no comprehensive reform of environmental and natural resource legislation in the context of sustainable development.

Critical Review

The Author had made further literature review after this interview, the fact n figure were discovered. Based on budget 2010 and 2011, Malaysia seems to have paid more attention on sustainable development.

Malaysia has undergone over 50 years of rapid industrialization recording between 5% and 9% growth annually. Unfortunately, most of that development has been unsustainable at best and there is now a need for a holistic approach to sustainable development. Last year, tax breaks and incentives were introduced by the Government of Malaysia under the Budget 2010 to encourage the move towards green buildings under the heading of ‘Developing Green Technology’, and this

commitment was renewed by the Government in its Budget 2011. Government has introduced and pledged to maintain and proposed several significant improvements in terms of tax incentives, among others:

- i. Pioneer Status and Investment Tax Allowance for the generation of energy from renewable resources and energy efficiency activities until 31 Dec 2015.
- ii. Import Duty and Sales Tax exemption on equipment for the generation of energy from renewable resources and energy efficiency until 31 Dec 2015.
- iii. The Feed-in Tariff (FiT) Mechanism, under the Renewable Energy (RE) Act, will be implemented to allow RE generated by individuals and independent providers to be sold to electricity utility companies
- iv. Building owners obtaining GBI Certificate from 24 October 2009 until 31 December 2014 be given income tax exemption equivalent to the additional capital expenditure in obtaining such Certificates.
- v. Buyers of buildings and residential properties awarded the GBI certificates bought from real property developers be given stamp duty exemption on instruments of transfer of ownership of such buildings.

4.2.3 Conclusion

As a conclusion, both interviewees strongly agreed that green building materials are important in Malaysia nowadays. However, the advantages of green building materials have not been firmly seized due to the slow permeation of this concept among the construction practitioners.

Ar. Von had stated Malaysia Green Building Confederation (MGBC) is to promote green building programmes, technologies, design practices and processes as well as green labels in embracing responsible sustainable measures and other green requirements for environmental, social and economic benefits. MGBC as the lead green building non-governmental organisation in Malaysia encourages the establishment of building materials or products eco label framework and GreenPagesMalaysia represents the first

step in the move towards this. The market is ready for an initiative such as GreenPagesMalaysia for the listing of environmentally responsible Green Building materials or products or services.

However, Ms. Ng stated that more strategies and actions should be pursued actively to speed up the process in creating a sustainable-oriented construction industry, which is paramount towards building a sustainable future.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

In overall, this chapter summarizes the finding which was collected from the executed research. The conclusion for overall analysis result is summarized based on the research objectives. The problems and limitation arise while doing this research also stated in this chapter. The recommendation for research continuation also proposed in this chapter.

5.2 Research Contribution to the construction Industry

In order to promote the application of sustainable building in construction industry, the government should hold the campaign and exhibition on the sustainable building materials thru out the nation in order to enhance knowledge and awareness of the importance to response to sustainable development.

Government also should built their office or administration building by applying this concept in order to minimise the negative construction affect that in parallel also can enhance the responsibility towards sustainable development in this country.

The construction industry could make a new policy for the construction sectors that make builders and developers compulsory applying the sustainable materials for building and infra structure which indirectly controlled the environmental pollution.

5.3 Difficulties and Barriers Faced

This research is well executed and achieved the research objectives, however, there are also constraints that caused to limit the outcomes of this research.

Among the main problems was faced in this research process is to ensure the suitability of Green Building Materials to be use in Malaysia's Construction Industry. This research takes quite longer time to search all the information. Some of the Green Building Materials might not suitable to use in Malaysia which encounter the climate problems.

This problem had been address after having an interview with Ar. Von Kok Leong who is the president of Malaysia Green Building Confederation and Green Building Index (GBI) Accreditation Panel Member. He had suggest some of the websites where can search for the Green Building Materials to be used in Malaysia's Construction Industry.

Even in this research process are having difficulties which was stated above, it was resolved and not disturbed this research process. This difficulty, may use as guidance conduct future research.

5.4 Recommendations for Continuation Research

In order for the construction industry to move towards the expand use of Green Building Materials, the following recommendations have been proposed.

- a) Education and training should incorporate sustainable development concepts and made it well known and accepted by all people.
- Educating the construction players through conferences, trainings, seminars and workshops. The academician plays an active role in reaching to the construction players through collaboration and consultations works. However, education should not be limited to the construction players only. As the industry's supply is closely influenced by the demand for it, the education should be expanded to the wider stakeholders, which include the potential buyers as well. Raising buyers demand for sustainable houses for example, will push the housing developers to improve the specification of their houses which include certain sustainable elements to attract buyers.
- b) Designers adopting an integrated approach to design (integrated design approach)
- Designers control the design, planning and materials to meet time and budgetary constraints. Hence, it is important for him to approach the concept of green building materials in his design. According to Ar. Von, he stated that it must first start with the designers and his design will initiate the discussions on green building materials with the other Consultants and the Client.
- c) Manufacturers of building materials/products taking life cycle considerations as the basis of product development.
- The products should provide good measures of environmental performance, given that reducing any of these effects is a step in the right direction. It is important to note that the life cycle assessment of a product should take account of the production and use of other products required for cleaning or maintenance during its use phase.
 - The products shall provide environmental, social and economic benefits while protecting public health, welfare, and environment over their full commercial cycle, from the extraction of raw materials to final disposition.

- d) Government Intervention
- Government has a major role to play in encouraging sustainable construction, through actions such as through strong enforcement of legislation, devising new policy, or giving incentives to developers who want to pursue sustainability in their projects.
- e) Building owners and clients play important roles in disseminating the use of green building materials
- Building owners and clients as an important stakeholder whose idea the building was in the first place. He is also responsible for funding the construction of the project and for operating it once it is complete. If building owners or clients including environmental concerns in their design requirements and the design professional must recognize it and approach it in his design. Education should be expanded to the building owners and clients to raise their awareness on the sustainable concept such as insert the green building materials in their design.
- f) Building users should consider the environmental issues as one aspect of productivity
- Building users should direct aware on this issue. They should know the need to incorporate this issue in their projects. Hence, there are few ways which could speed up building users interest on the matter such as education level, media report and others.
- g) Initiatives involving planning and construction should be through adapted regulations, standards or fiscal measures and incentives
- It is important to stresses the need for enforcement through law and legislation. Government should monitoring and enforcement those several Act which focus on environment such as Environmental Protection Act.

h) Cost factor

- Some people believed that the use of green building materials will increase project cost because they need to have higher capital in front. Higher cost means higher price. For example, energy efficient products such as light fixtures and appliances must be evaluated in terms of life cycle because they generally are more expensive to purchase and sometimes to install, but less expensive to operate. Probably the single greatest reason is that these are new products, they must bear research and development costs and they do not have the economies of scale of the less efficient competitors. Happily, if the energy efficient rating is good, there is a quantifiable payback.
- According to Ar. Von who is president of Malaysia Green Building Council, the usage of green building materials is gaining momentum and through wider usage and competitions, the cost will reduce and will no longer be an issue.

i) International cooperation

- It is an important consideration linking local to global initiatives and facilitate collaboration and knowledge sharing between research organizations and role-players in the industry. Most importantly, organizations must possess adaptive that enables them to recognize the need for change and to respond to it appropriately.

j) Understanding sustainable construction through common definitions and language to address the issues

k) Improvement of the building construction process as opposed to the traditional methods

l) Building maintenance organizations should consider environmental consciousness as a factor of competitiveness

m) The development of technologies and tools to help in decision making in achieving sustainable building in Malaysia.

- n) Study the return benefits from using sustainable building assessment such as NABERS, LEED, and ECO-SPECIFIERS etc.

5.5 Conclusion for Overall Research Result

Based on the requirement in the objective 1, this research results gathered and analyses are achieve the requirements needed in objective 1 which is discuss about the issues of Green Building Materials in Construction Industry in Malaysia. This finding includes what is green building materials and why should use Green Building Materials. It includes the design and construction relationship between stakeholders and green building materials. Next, it also discuss on the environmental materials assessment.

For the objective 2 also achieved the goal where explain the construction process by adopt the use of Green Building Materials in a projects. The research explains the process of bidding and construction phase. This research also includes risk management for Green Building Materials.

Meanwhile for the objective 3, the findings show the suitability of sustainable materials to assess in the Construction Industry in Malaysia. This research contains several green building materials such as EconBlocks, paintings and others and discuss why the materials is green, its product features, applicable GBI credits and green label.

As the conclusion, the Author wish that the information in this report can help the future researchers embark research pertaining to this area of sustainable building and use the above suggestion to have some idea for the research direction.

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APPENDICES

APPENDIX A: Statement of Learning in the Course of the Project

This research provides an opportunity for the Author to develop interpersonal skills and communication skill as well. The Author learns how to effectively communicate with the respondents and interviewees as there are at different levels from the Author. The Author manages to experience the real-life working conditions and gained knowledge.

Through this research, the Author has developed team work with others. Team work enables the Author to distribute all the survey questionnaires to the respondents. Through their assistance and recommendations, the Author had succeeded in conducting interviews with the professionals.

This research trains the Author to be independent when facing problems. When the survey questionnaires were not returned on time, the Author had to follow up with the respondents in order can complete the data analysis. This trains the Author to be a better decision maker and solve problem by herself.

Besides that, this research has developed discipline where the Author can learn how to manage the time wisely. Proper time management will smoothen the progress and thus enable the completion of the research within the timeframe.

APPENDIX B: Project Definition Document

APPENDIX C: Record of Supervision or Meeting

APPENDIX D: Sample of Survey Questionnaire

APPENDIX E: Sample of Interview Questions

APPENDIX F: Sample Returned Questionnaires

APPENDIX G: Green Building Index (GBI) Assessment Criteria for Residential
New Construction (RNC)

APPENDIX H: Manual for Industrialised Building System (IBS) Content Scoring
System (IBS SCORE)

APPENDIX I: Analysis Techniques