GREEN BUILDING INDEX MALAYSIA - QUALITATIVE SURVEY ON VERNACULAR HOUSING TYPE IN MALAYSIA

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Green Building Index Malaysia – Qualitative Survey on Vernacular Housing Type in Malaysia

by

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CERTIFICATION OF APPROVAL

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Approved by,

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

AHMAD SYAFRI BIN ABDULLAH

ABSTRACT

Green Building Index Malaysia is a profession driven initiative to lead the property industry of Malaysia towards becoming more environmental friendly. To do this, they have introduced Green Building Index (M) Assessment Criteria for Residential New Construction for new residential construction to be built to be more environmental friendly. Vernacular architecture is a term used to categorize methods of construction which use locally available resources and traditions to address local needs. 4 building types, one including modern terrace house, while the others are vernacular architecture, are chosen so that it can be assessed by GBI (M) Assessment Criteria and scored accordingly to find out which one scores the highest. The feasibility of the assessment tools are also taken into consideration as this project is assessing existing buildings and not new construction. Some modifications are done to the assessment tools to make it more suitable to the project. The results from the project show that vernacular buildings scores much higher than the modern terrace house. This shows that vernacular residential buildings are much more environmental friendly than modern terrace house.

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List of Abbreviations

GBI	- Green Building Index
BREEAM	- Building Research Establishment Environmental Assessment Method
LEED	- Leadership in Energy and Environmental Design
GBTool	- Green Building Assessment Tool
CASBEE	- Comprehensive Assessment System for Building Environmental Efficiency
OTTV	- Overall Thermal Transfer Envelope

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Sustainable building, or green building is an outcome of design philosophy which focuses on increasing the efficiency of resource use of energy, water, and materials while reducing building impacts on human health and the environment during the building's lifecycle. This is done through better sitting, design, construction, operation, maintenance, and removal.

Green building is a concept idea of incorporating a wide spectrum of solutions and best-practices. Through green building is interpreted in many different ways, a common opinions is that they should be designed and operated to reduce the overall impact of the built environment on human health and natural environment by efficiently using energy, water, and other resources, while protecting occupant health and improving employee productivity, and also reducing waste, pollution and environmental degradation.(US EPA, August 2009)

The related concepts of sustainable development and sustainability are integral to green building. Effective green building construction can lead to reduced operating cost by increasing productivity and using less energy and water, improved public and occupant health due to improved indoor air quality, and reduced environmental impacts by lessening storm water runoff and the heat island effect. Practitioners of green building often seek to achieve not only ecological but aesthetic harmony between a structure and its surrounding natural and built environment, although the appearance and style of sustainable buildings is not necessarily distinguished from their less sustainable counterparts. A common misconception is that energy efficient buildings are also green buildings. While energy efficiency is an integral part of a sustainable building, energy efficiency alone does not qualify a building as green.

In Malaysia, the Standards and Industrial Research Institute of Malaysia (SIRIM) are the one that promotes green building techniques. Driven by environmental needs, Green Building Index (GBI) was jointly founded and developed by Pertubuhan Arkitek Malaysia (PAM) and the Association of Consulting Engineers Malaysia (ACEM) in 2009. GBI (M) is a profession driven initiative to lead the property industry towards becoming more environmental-friendly. It is intended to promote sustainability in the built environment and raise awareness among Developers, Architects, Engineers, Planners, Designers, Contractors and the Public about environmental issues. Malaysia's Green Building Index or GBI (M) will be the only rating tool for the tropical zones other than Singapore Government's GREENMARK. GBI (M) parameters are within the tropical climatic conditions. Its scoring priorities are very much customized for the current state of Malaysia. GBI (M) differs markedly from Singapore's GREENMARK thus understandably GBI (M) rating priorities should be like-wise customized to suit – both to Malaysian climate and also the current state of the country's development and existing resources. (GBI Malaysia Website, 2010)

Vernacular architecture is a term used to categorize methods of construction which use locally available resources and traditions to address local needs. Vernacular architecture tends to evolve over time to reflect the environmental, cultural and historical context in which it exists. It has often been dismissed as crude and unrefined, but also, with the current energy crisis and environmental needs, who highlight its importance in current design. (Holm, 2006)

The building knowledge in vernacular architecture is often transported by local traditions and is thus based largely - but not only - upon knowledge achieved by trial and error and handed down through the generations, which is in contrast to the geometrical and physical calculations that underlie architecture planned by architects.

1.2 Problem Statement

1.2.1 Problem Identification

This project attempts to use the Green Building Index (GBI) Malaysia to try to assess the vernacular housing type in Malaysia and compare it against the modern housing type in Malaysia. This is done by doing a qualitative survey using the GBI Assessment Criteria for Residential New Construction (RNC). The project aims to study whether our modern housing is Malaysia is better scoring in the Green Building Index (GBI) Malaysia against the vernacular housing type of Malaysia.

1.2.2 Significance of Project

The significance of this project is to find out whether our modern housing post a much higher scores than the vernacular housing of the past. As the vernacular housing is an old building, the project is done to find out, while using the Green Building index (GBI) Malaysia, whether it is a green building, and using this result to compare it with modern housing of Malaysia.

1.3 Objectives and Scope of Study

1.3.1 Objectives

The objectives of the project are as follows:

- To study the criteria feasibility of the Green Building Index (GBI) Malaysia Assessment Criteria for Residential New Construction (RNC).
- To apply the Green Building Index (GBI) Malaysia Assessment Criteria for Residential New Construction (RNC) on vernacular and modern housing types in Malaysia.
- To assess and compare the results between vernacular and modern housing types to finding which scores higher.

1.3.2 Scope of Project

The scope of the project is to assess vernacular and modern housing type in Malaysia with Green Building Index (GBI) Malaysia Assessment Criteria for Residential New Construction (RNC). After the assessment, the results will be analyzed and compared with each other to find out which housing is greener in terms of scoring in which its design does not cause more harm towards the environment.

1.3.3 Project Feasibility

This project will be carried out over two academic semesters. The main activities have been forecasted with a margin of planning error, which has also been included into the schedule. After analyze and study the schedule planning, the project is found to be feasible. Also included is the Gantt chart of project. (APPENDIX A)

CHAPTER 2

LITERATURE REVIEW

2.1 Vernacular Construction in Malaysia

Figure 1: A Traditional Malay House

Early Malay houses are build on timber stilts and made of materials which were easily available from the tropical forests around the location of the house, such as timber, bamboo, rattan, tree roots and leaves. Usually it will have pitched roofs, verandahs or porches in the front, high ceilings and lots of big openings for ventilation purposes. Although much of the characteristics are the same for all the Malay houses, there are some differences also that vary from state to state. (Assoc. Prof. Dr. A. Ghafar Ahmad, 2009)

The Malay architecture has been influenced by various cultures throughout the decades, such as, Indonesian Bugis, Riau and Java from the South; Siamese, British, Arab and Indian from the North; Portuguese, Dutch, Acheh, Minangkabau from the West; and Southern Chinese from the East. Due to this fact, the Malay vernacular architecture is influenced by these cultures and their architectures are also modified to suit the different cultures.

Factors that govern the styles of the Malay vernacular architecture:

- Climate

Malaysia is situated in the central part of the Southeast Asia, with it bordered by Thailand in the north and Singapore in the south. It is bordered by longitudes 100 degrees and 120 degrees east; and by Latitudes of the Equator and 7 degrees North. The country is sunny, hot and humid all year round with temperatures range from 25 °C to 36 °C. It has an annual rainfall from 80" to 100". Due to heavy monsoon rains, the roofs of the Malay vernacular houses are very steep so as to make sure the water does not seep inside the house. In some places, particularly low lying areas, flooding occurs after heavy rain falls. To solve this problem, some houses have used timber stilts to elevate the building above the ground level so that it is much higher that the flood level. For ventilation purposes, the houses have large openings on the sides and grilles are provided at high level in gable ends. Houses raised on stilts are provided with better natural ventilation as it is higher.

- Material Resources

Since Malaysia has a tropical climate, building materials such as timber, rattan, tree roots, bamboo and leaves are easily available and abundant from the tropical forests. In a traditional Malay house, timber is used for the building structures, rattan and tree roots are used for tieing up joints whereas bamboo and leaves are used for floors and walls.

- Malay way of Life (Culture & Religion)

In the Malay culture, to reflect its owners' high status, most houses and palaces are highly hand crafted and beautifully patterned and decorated. The Malays, as a Muslim, have also adopted the Islamic principle orientation of mosque, particularly the prayer halls as it has to be designed and faced towards Mecca. Traditional Malay houses also uses different floor levels to indicate different functions of the rooms. For instance, the verandah floor is raised lower than the living room floor. This is not only indicating the room functions but also giving a sense of spatial transition in the building.

- Foreign Influence

The colonization by the Portuguese, Dutch and British also influence the architecture of the Malay houses to the new technologies brought in by the foreigners. Examples of the roof made of leaves are replaced with zinc and clay tiles; timber stilts and ladder are replaced by brick and cement columns; glass for windows which are usually open; and nails used to tie the joints together, replacing rattan and tree roots. An example where one can see these features are at the Alor Setar's Balai Besar or Audience Hall in Kedah. It was built in 1898. It has clay tile roofs, brick and cement stairs, glass windows with brick and timber walls. Thorough these changes, the process of adopting new technologies to ancient architecture are not entirely a new idea. Malay Architecture has been modified by technological and cultural changes for centuries.

2.2 Green Building Index (GBI) Malaysia

Green Building Index (GBI) is an environmental rating system for buildings developed by PAM (Pertubuhan Arkitek Malaysia / Malaysian Institute of Architects) and ACEM (the Association of Consulting Engineers Malaysia). The Green Building Index is Malaysia's first comprehensive rating system and is used for evaluating the environmental design and performance of Malaysian buildings based on the six (6) main criteria's, which are Energy Efficiency, Indoor Environment Quality, Sustainable Site Planning & Management, Materials & Resources, Water Efficiency, and Innovation. The GBI is developed specifically for the Malaysian tropical weather, environmental and developmental context, cultural and social needs. The GBI initiative aims to assist the building industry in its march towards sustainable development. (GBI RNC Assessment Tools., June 2009)

The GBI environmental rating system is created to:

- Define green buildings by establishing a common language and standard of measurement;
- Promote integrated, whole-building design;
- Recognize and reward environmental leadership;
- Transform the built environment to reduce its environmental impact; and
- Ensure new buildings remain relevant in the future and existing buildings are refurbished and upgraded properly to remain relevant.

There are others environmental assessment tools available outside of Malaysia such as Building Research Establishment Environmental Assessment Method (BREEAM,UK), Leadership in Energy and Environmental Design (LEED,USA), Green Building Assessment Tool (GBTool, Canada and other), and Comprehensive Assessment System for Building Environmental Efficiency (CASBEE, Japan). These environmental tools are not suitable for Malaysia as these tools are design for temperate climate zones. The only other assessment tools which are in the tropical zone are Building and Construction Authority GREENMARK (BCA GREENMARK, Singapore). The main difference in these environmental tools is that it differs in its priorities when it comes to its scoring criteria, and it also suited to the country development and existing resources.

2.3 Vernacular Architecture through CASBEE

These studies are done by Shuzo MURAKAMI and Toshiharu IKAGA using the CASBEE system for vernacular architecture throughout the world. These architecture include Igloo from Canada, compound housing in Cameroon, Kasbah in Morocco, house with a wind catcher in Iran, stilt house in Malaysia, cave dwelling and modern Turkish home in Turkey, stilt house in Indonesia, and modern residential building in Hanoi. (Murakami and Ikaga, 2008)

Studies are done by assessing and scoring each of the architecture using CASBEE for Home Assessment Tools. Results showed vernacular housing to be either equal to or superior to modern housing in terms of environmental efficiency when both environmental load and environmental quality are taken into account. Vernacular architecture employs passive technology that was developed for such purposes as safety, hygiene, or comfort using the limited technical resources available in the days before modern technology existed. The way in which vernacular architecture and lifestyles defined by such architectures make effective use of passive design adapted to local climate and other conditions in cold and hot, arid and humid regions provide valuable hints for environmental design that offers great possibilities for improving architectural sustainability.

As these studies is in similar vein in what the author is trying to achieve in his project, the author is also trying to prove in that vernacular architecture is much more environmental friendly than modern housing type and will actually score higher in GBI scoring also.

2.4 Achieving Thermal Comfort in Malaysian Building

This seminar talks about bioclimatic design in which it can be conceptualized as building design that utilizes a range of biophysical elements that are drawn from the ecosphere – heat, light, landscape, air, rain and materials. (Sabarinah, Zaini, 2007)

Current themes on a range of such issues are:

- Climate type and requirements
- Adaptive thermal comfort
- Vernacular and contextual solutions
- Tools and assessment methods
- Microclimate: sun path, wind and rain
- Working with the elements, such as passive and active systems
- Development of a responsive form

The needs for bioclimatic design are:

- The rate of change in the level of climate variability and modification is increasing, requiring human adaptation to a rapidly warming world.
- The fundamental means to this adaptation is the adoption of more effective, and widely used, methods for passively cooling buildings.
- AC systems are increasingly seen as part of the climate change problem, as well as its solution. Not only is the rising cost of energy a problem, but the energy used to run these system is a major contributor to greenhouse gas emissions.
- It is imperative to create a new 'cool vernacular' building approach, which matches human and environmental needs.

From these, it takes example of Kuala Lumpur as the Malaysian climate for these studies. And it establishes that hot humid climates are distinguished by 2 features which are the climate is uncomfortable and is the most difficult to ameliorate by passive design, and many of the countries in the hot humid region are developing countries.

The ways to solve this are by looking at the design of vernacular urban shop houses. Strategic solution are by keeping out direct sunshine and heat, maximize natural ventilation, use orientation to best effect, roofs should be pitched to facilitate water drainage, and keeping mean radiant temperature as low as possible.

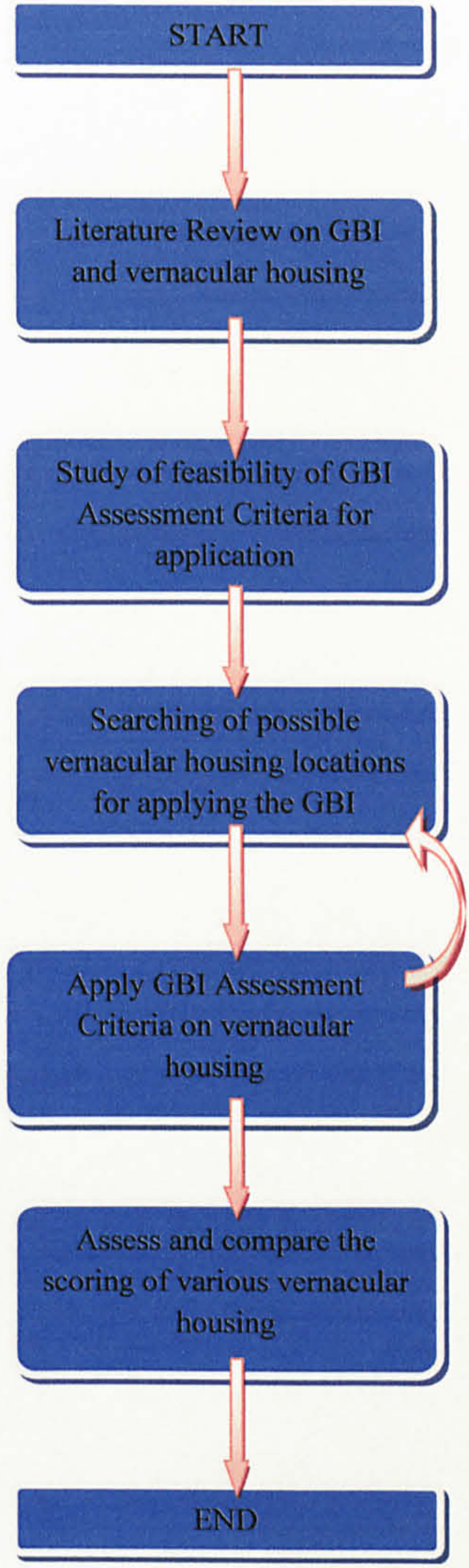
CHAPTER 3

PROJECT METHODOLOGY

3.1 Procedure Identification

In order to complete this project successfully, a systematic and structural project methodology in crucial. Thus, a thorough discussion been held with the supervisor to address this issue. When deciding on the project title, a brief study on the project title been held. This is to get a general/rough idea on the study area of this title. Upon completion on this study, a thorough literature survey thru all the available sources such as internet, online or printed journals, reference books and discussion with the supervisor. This definitely gives a deeper and more profound understanding on the topic. As the project progress, more literature reviews and discussion will be held to address all the arising problems. The project methodology can be generally divided into two main parts which for the first semester and the second semester. The literature review, gathering information, research and deciding on locations of assessment are the main target for the first semester, and the analysis of assessment and compiling of information are set for the second semester.

3.1.1 Flowchart of Methodology



3.1.2 The Literature Review

The literature review involves discussing on vernacular architecture in Malaysia as this is the type of building that will be included in the study as to find a much deeper understanding on the vernacular architecture in Malaysia and its characteristics.

Also in the literature review is the information regarding Green Building Index (GBI) Malaysia and its similar assessment tools across the world. Also reviewed is the difference between GBI and its counterpart, although not in depth.

CASBEE has done a similar project as to this survey but it involves vernacular architecture across the world. The project is done by using CASBEE Home and its discuss the advantages of using vernacular architecture design in modern design.

Another reviewed is a survey of achieving thermal comfort in Malaysia building. This study was done as to find out better ways to improve Malaysia building design. This also studies on the effect of materials on thermal building comfort.

3.2 Tools and Equipment

The assessment process of survey requires usage of Green Building Index (GBI) Assessment Criteria for Residential New Construction (RNC). Equipment to use are an anemometer (for measuring wind speed), a humidity meter (for measuring humidity of the air), a digital thermometer, a sound level meter (for measuring the sound insulation between rooms), and a measuring tape.

3.3 Gantt Chart

The Gantt Chart for this project is included in the Appendix.

3.4 Chosen Site

As the assessment process needed vernacular housing to be assesses, the author has chosen 4 buildings that are applicable to the project so that it can be assess. The buildings are:

- **i.** Tun Mahathir Mohamad Birth House (Traditional Malay House)
- **ii.** Syed Al Attas Mansion (Mansion)
- **iii.** Alif Café Restaurant (Shophouse)
- **iv.** Modern Terrace House

As all of the buildings are of different types, the author thinks that this will make the scoring be much varied between the buildings.

3.5 Building Profile

3.5.1 Tun Mahathir Mohamad Birth House

On 20th December 1925, Tun Dr. Mahathir Mohammad, the 4th Prime Minister of Malaysia was born in this house at No. 18, Lorong Kilang Ais, Alor Star, Kedah. This wooden house with the attap roof is bought by his father Mohamad Bin Iskandar from a person who wants to get his son married. This house is built in 1900. (Arkib Negara Malaysia, April 2010)

At the time of the purchase, the house was not painted and had no balcony or staircase in front. After several years, a renovation was carried out and the front portion was built. The house was also painted.

The house has only one room and has no electricity. Its floor was made of wood and its ceiling of white cloth.

Figure 2: Tun Mahathir Mohamad Birth House

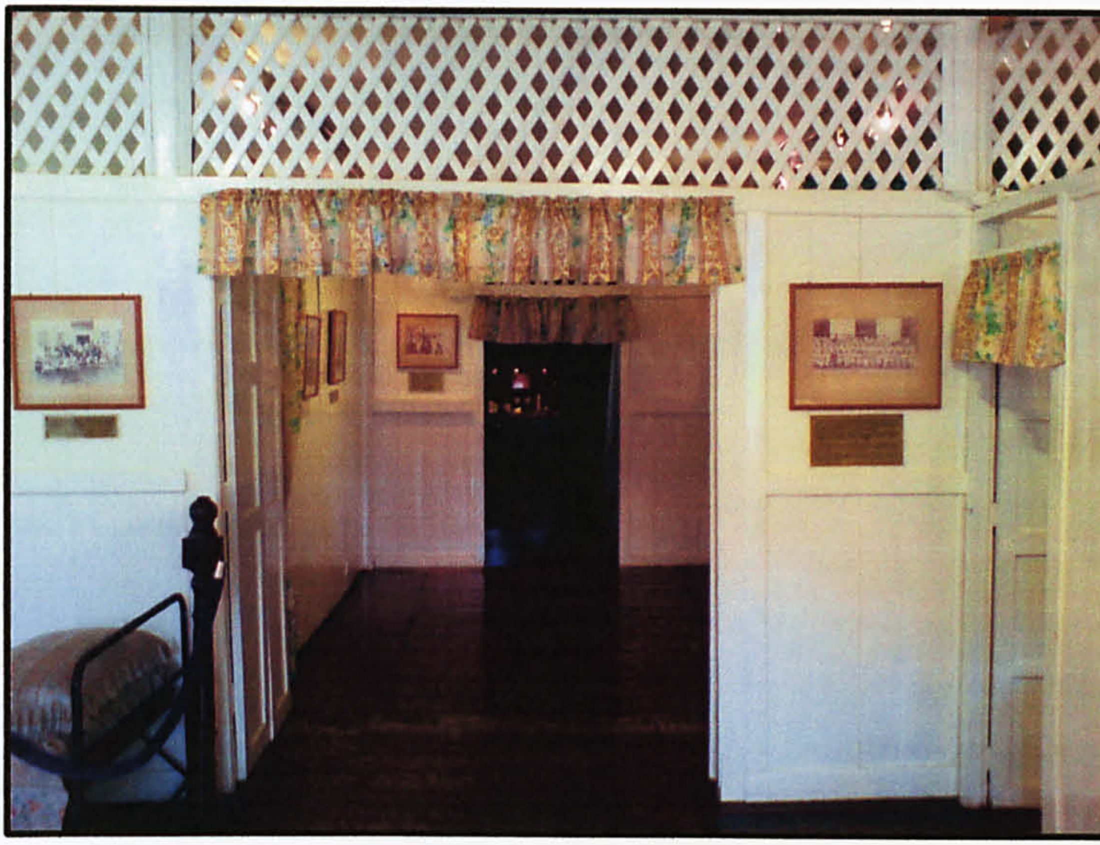


Figure 3: The interior of Tun Mahathir Mohamad Birth House

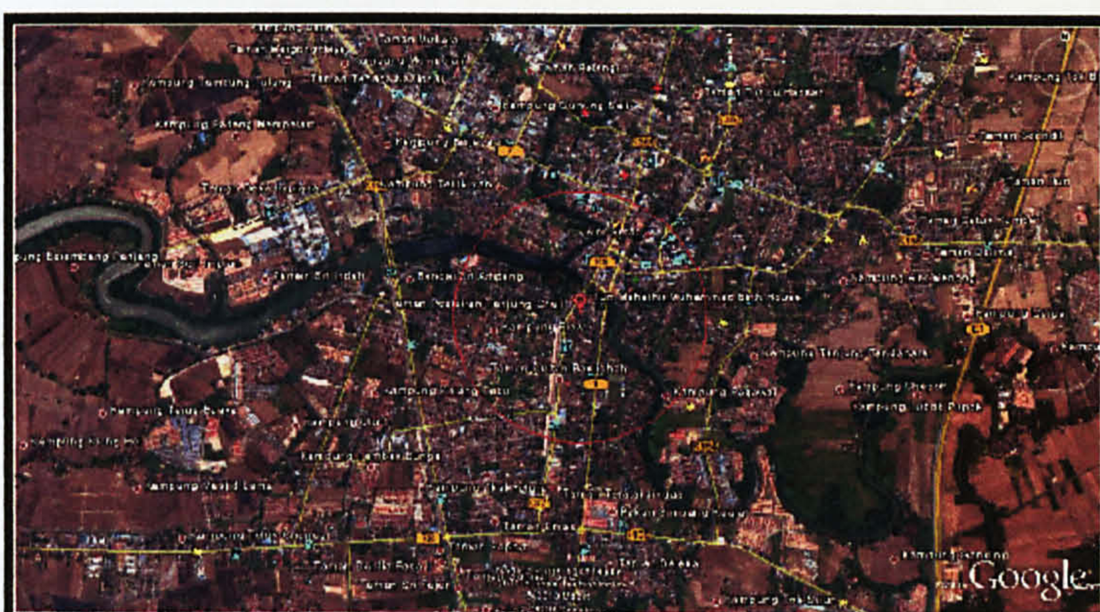


Figure 4: Satellite picture of Tun Mahathir Mohamad Birth House with a 1km radius ring

3.5.2 Syed Al Attas Mansion

The mansion was named after its owner, Syed Mohamad Al Attas, a spice trader of Arab-Malay mix from Acheh. He was a well-to-do philanthropist and one of the prominent leaders in the 19th century Penang Malay-Muslim community. As his family moved away in the 1930s, the mansion began to lose its luster. It was becoming dilapidated in the 1960s and was once even used by the Indian Chettiar community as a recycling center. (Penang Islamic Museum, April 2010)

Recognizing the historical value of the building, the Penang Heritage Center came to the rescue in 1995 to prevent further degradation. Its intervention could not have come at a better time as the building was once almost demolished to make way for a road construction project.

A full restoration work was carried out in 1996 with the funding from the Federal Government. Much needed technical assistance came by the way of Didier Repellin, the Chief Architect of Historical Monuments, Lyon, France.

Figure 5: Syed Al Attas Mansion

Figure 6: Satellite picture of Syed Al Attas Mansion with a 1km radius ring

3.5.3 Alif Café Restaurant

The building is located in the town of Gopeng and is from the time of pre-war shophouse. It is located along the main road in the town of Gopeng and is nearby to the Gopeng bus station. The building is now used as a restaurant.

This building is a 2 storey building and it has a floor area of $150m^2$. The materials used for this building are mostly bricks and mortar. The front part of the building is used as the dining area while at the back is the kitchen. The upper floors are used by the occupants as their living space.

Figure 7: Alif Café Restaurant

Figure 8: Satellite Picture of Alif Café Restaurant with a 1km radius ring

3.5.4 Modern Terrace House

The house is a one storey modern terrace house. It is located at Taman Siputeh Permai, Siputeh. As this is a new building, it is assumed that the neighborhood, in which the house is situated in, is built around 5-10 years ago. This house is a single storey house, which is build with concrete columns, beams and slabs. The house has a floor area of $60m^2$.

Figure 9: Modern Terrace House

Figure 10: Satellite picture of the Modern Terrace House with a 1km radius ring

3.6 Scoring Moderation

As this is also a study of the criteria feasibility, the scoring of the assessment tools are also moderated. Some of the criteria can be measured, while some of them can only be observed to score them. But there are some criteria, which cannot be scored either by measuring or observing. As a result of that, some criteria will be omitted from the assessment. The marks also will be adjusted to reflect this moderation. The full mark for the assessment is 100 points. After the moderation, it is found that the maximum marks that can be scored are only 76 points.

The list of the criteria which are observed, measured and omitted will be included in the Appendix.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Results

From the assessment that has been done at the site by using Green Building Index (GBI) Assessment Criteria for Residential New Construction (RNC), the results are then tabulated and are displayed below in the table and the graph:-

Type	Temp			Humidity			EE	EQ	SM	MR	WE	IN	TOTAL
	Inside	Outside	Difference	Inside	Outside	Difference	20	8	30	3	10	5	76
Tun Mahathir Mohamad Birth House	33.3°C	37.5°C	4.2°C	59.8%	54.5%	5.30%	13	6	26	2	0	4	51
Syed Al Attas Mansion	31.1°C	33.0°C	1.9°C	59.4%	56.5%	2.90%	13	5	27	2	1	2	50
Alif Café Restaurant	34.4°C	35.6°C	1.2°C	64.0%	64.8%	0.80%	13	4	18	1	0	2	38
Modern Terrace House	33.3°C	34.4°C	1.1°C	76.3%	73.5%	3.30%	15	3	7	1	0	0	26
Mean							13.50	4.50	17.00	1.50	0.25	2.00	
Mean(Vernacular)							30.33	11.00	49.00	3.67	1.00	5.33	
Max							15	6	25	2	1	4	
Min							13	3	7	1	0	0	

Legends:

- EE – Energy Efficiency
- EQ – Indoor Environmental Quality
- SM – Sustainable Site Planning & Management
- MR – Materials & Resources
- WE – Water Efficiency
- IN - Innovation

Table 1: Scores for the building using GBI (M) Assessment Criteria for Residential New Construction

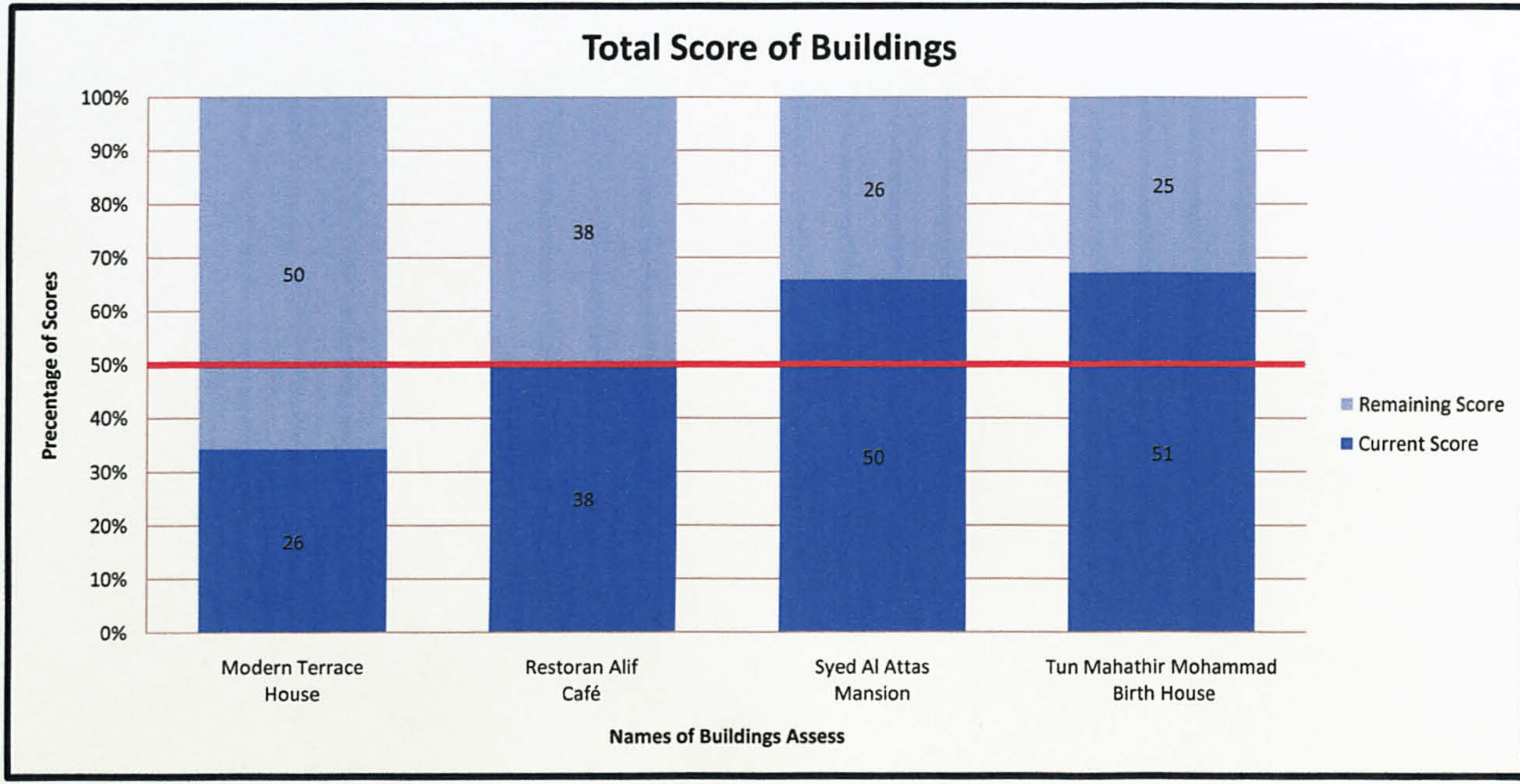


Figure 11: Graphical representation of the scoring

4.2 Discussion

The purpose of the project is to find out which of the building type, vernacular or modern housing, will score higher if the GBI (M) Assessment Criteria for Residential New Construction was used. As a way to measure if either the building will pass the assessment or not, GBI (M) has already provided its own rating tier in which a building score will be measured against and be given the respective rating. Below are the GBI ratings as found inside the manual.

GBI Rating	Points
Platinum	86+
Gold	76-85
Silver	66-75
Certified	50-65

Table 2: GBI Rating Classification

As the project did not use the full allocation of marks, which is 100 points, in which the project only uses 76 points, the GBI rating are modified to fit the requirement of the project. And also as the only purpose of this project as to find out which building scores higher, the only rating that is found suited to be used is the Certified rating. To suit it to the modified scoring as the total scores are much lower, it is found it is much suitable to change the scoring to 38 points, 50% of the total points.

4.2.1 Tun Mahathir Mohamad Birth House

From the results above, it shows that this building scores the highest amongst the other buildings. This shows that the traditional Malay house which was built a long time ago is environmentally friendly.

Of the entire assessment category, it scores the highest in Indoor Environmental Quality and the Innovation. As this is a Malay vernacular house, it has many windows and it is also raised on stilts. These may cause air to circulate more inside the house and also under the house. It is also found to be innovative as it is small and beautiful, uses passive cooling as the roof is much higher than normal houses and it also doesn't have a ceiling. It is also now used as a museum.

This building also shows the most difference between outside and inside temperature and relative humidity.

4.2.2 Syed Al Attas Mansion

From the results above, it shows that this building scores the second highest among the building types. Its scores are almost similar to Tun Mahathir Mohamad Birth House.

The only difference is that it scores in Water Efficiency and scores higher in Sustainable Site Planning & Management. It scores in Water Efficiency, where other building types failed, is that it uses water efficient fittings to control the volume of water used.

4.2.3 Alif Café Restaurant

For this building, it scores the third amongst the buildings that were being assessed. It scores better in Energy Efficiency and Sustainable Site planning & Management.

The score of Energy Efficiency is better because its scores on OTTV and ETTV which carries a lot of marks for Energy Efficiency. Most of the other buildings, according to the calculations done by the author, scores admirably in Energy Efficiency. It also scores better in Sustainable Site Planning & Management because it is situated in the middle of the town, and thus, making it much nearer to basic amenities and services.

4.2.4 Modern Terrace House

For the modern terrace house, we can observe that it scores the highest for Energy Efficiency. While this seem improbable, it could be possible. It excels than the other buildings because of the area of assessment of home office and connectivity. As it is a modern house, it could be said that it is built with the idea of home office in mind, with a high speed internet access available.

It scores the lowest marks in all of the other criteria being assessed. This supports the author's objective in finding out that vernacular architecture scores higher than modern housing.

As the discussions of the individual buildings assessed are done, it is found that the relative humidity and the temperature taken at the building site, outside and inside, also vary between buildings. The highest difference is at the Tun Mahathir Mohamad Birth House, which shows a remarkable 4.2°C, followed by Syed Al Attas Mansion at 1.9°C, Alif Café Restaurant at 1.2°C, and finally the modern terrace house at 1.1°C. The differences of relative humidity between the buildings are also big with 5.3% for Tun Mahathir Mohamad Birth House, 2.9% for Syed Al Attas Mansion, 0.8% for Alif Café Restaurant, and then the modern terrace house at 3.3%.

This shows that temperature and relative humidity also plays a part in assessing which house is better as it shows that Tun Mahathir Mohamad Birth House shows the largest difference in temperature and relative humidity.

For the calculation of OTTV, in which it is included in the Appendix, in which it shows that all the buildings posted very good scores, it can be because some of the buildings are connected to another building, thus removing a façade of the wall from calculation, which leads to lower OTTV value.

In the part of suitable site planning and management, the higher scores tends to be buildings which are located in the middle of city centers, this will make it much more nearer to basic amenities for people living in those houses to live.

While for the part of water efficiency, it is found that most of the buildings are not yet equipped with technology to make it much more water efficient. That is why most of the buildings scored zero for this part.

If using the modified GBI rating, the author has found that all vernacular buildings have at least reached the Certified rating while the modern terrace house failed to be certified.

CHAPTER 5

CONCLUSION & RECOMMENDATION

5.1 Conclusion

For the conclusion of this project, it is found that the objective of the project was completed successfully. The first was to study the criteria feasibility of Green Building Index (M) Assessment Criteria for Residential New Construction was feasible to be used for this project. This objective was completed successfully. The second objective is to assess vernacular and modern housing while using the assessment tools. This objective also has been performed successfully. The final one is to assess and compare the results between the vernacular and modern housing to find out which one scores higher. This objective has also been completed as the results have shown vernacular housing scores higher than modern housing. Which means the vernacular housing are more environmentally friendly than modern terrace house.

5.2 Recommendation

The author would like to place some recommendations on how this project can be improved in the future. The recommendations are:

- Moderations are needed if this assessment tools are going to be used for assessing existing buildings. As in its form right now, it is more towards assessing new construction.
- Create a new assessment tools which are already tailored for the Existing Residential Buildings
- More emphasis should also be put on the comfort of occupants. There is only one criterion under Indoor Environmental Quality which measures the comfort of the occupants.

CHAPTER 6

ECONOMIC BENEFITS

6.1 Economic Benefits

Economic benefits of building buildings up to the standard of GBI (M) are what the future of construction industry in Malaysia is heading towards. As these research have shown, vernacular buildings scores a much higher scoring if compared to normal, or modern building.

Thus, an economic benefit is that the modern developer or contractor can adopt some building techniques and design of vernacular building into their modern buildings. This will increase the scoring of the modern buildings and also make it more environmental friendly, which most people right now are more aware.

Another economic benefit from this research is that this will introduce GBI (M) to the contractors and developers by stating that what they are trying to do will improve the efficiency of the buildings that are being built. These will become a selling point for them in trying to sell the buildings to the customers.

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Appendix A
Gantt Chart

Timeline for Final Year Project II

No	Detail/Week	1	2	3	4	5	6	7	MSB	8	9	10	11	12	13	14	15	16
1	**Resuming work from FYP I**																	
2	**Progress Report II**																	
	Preparing Report																	
	Submitting Report																	
3	**Field Work**																	
4	**Poster Presentation**																	
	Preparing Poster																	
	Poster Exhibition																	
5	**Dissertaton**																	
	Preparing Soft Bound																	
	Handing in Soft Bound																	
6	**Oral Presentation**																	

done
process
milestone
preparation

MSB Mid Semester Break

Appendix B
Green Building Index
Assessment Criteria
for
Residential New Construction (RNC)

green
building
index

GBI ASSESSMENT CRITERIA
FOR
RESIDENTIAL NEW CONSTRUCTION (RNC)

FIRST EDITION | JUNE 2009 | VERSION 1.0

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CONTENTS

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INTRODUCTION

WHAT IS THE GREEN BUILDING INDEX (GBI)?

The Green Building Index is an environmental rating system for buildings developed by PAM (Pertubuhan Arkitek Malaysia / Malaysian Institute of Architects) and ACEM (the Association of Consulting Engineers Malaysia). The Green Building Index is Malaysia's first comprehensive rating system for evaluating the environmental design and performance of Malaysian buildings based on the six (6) main criterias of Energy Efficiency, Indoor Environment Quality, Sustainable Site Planning & Management, Materials & Resources, Water Efficiency, and Innovation.

The Green Building Index is developed specifically for the Malaysian tropical weather, environmental and developmental context, cultural and social needs.

The GBI initiative aims to assist the building industry in its march towards sustainable development. The GBI environmental rating system is created to:

- Define green buildings by establishing a common language and standard of measurement;
- Promote integrated, whole-building design;
- Recognise and reward environmental leadership;
- Transform the built environment to reduce it's environmental impact; and
- Ensure new buildings remain relevant in the future and existing buildings are refurbished and upgraded properly to remain relevant.

WHO CAN USE THE GREEN BUILDING INDEX?

GSB encourages all members of Project Teams, Building owners, Developers and other interested parties (including Contractors, Government and Design & Build Contractors) 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.

Use of the Green Building Index tool without formal certification by an independent accredited GBI Certifier does not entitle the user or any other party to promote the Green Building Index rating achieved. No fee is payable to GSB for such use, however formal recognition of the Green Building Index rating - and the right to promote same - requires undertaking the formal certification process offered by Greenbuildingindex Sdn Bhd.

All Green Building Index rating tools are reviewed annually; please forward any feedback to info@greenbuildingindex.org

PROJECT INFORMATION

PROJECT NAME	
PROJECT ADDRESS	
POSTCODE	
STATE	

APPLICANT	
CONTACT PERSON	

ARCHITECT	
CIVIL ENGINEER	
STRUCTURAL ENGINEER	
MECHANICAL ENGINEER	
ELECTRICAL ENGINEER	
QUANTITY SURVEYOR	
LAND SURVEYOR	
LANDSCAPE CONSULTANT	
OTHER SPECIALIST CONSULTANT(S)	
MAIN CONTRACTOR	
LOCAL AUTHORITY	
TOTAL GROSS FLOOR AREA	
LAND AREA FOR LANDED PROPERTY	

BUILDING DESCRIPTION	

ASSESSMENT CRITERIA

OVERALL POINTS SCORE

PART	ITEM	MAXIMUM POINTS	SCORE
1	Energy Efficiency	23	
2	Indoor Environmental Quality	11	
3	Sustainable Site Planning & Management	39	
4	Material & Resources	9	
5	Water Efficiency	12	
6	Innovation	6	
	TOTAL SCORE	100	

GREEN BUILDING INDEX CLASSIFICATION

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

ASSESSMENT CRITERIA SCORE SUMMARY

PART	CRITERIA	ITEM	POINTS	TOTAL
1	**EE**	**ENERGY EFFICIENCY**		
	EE1	Minimum EE Performance	3	23
	EE2	Renewable Energy	5	
	EE3	Advanced EE Performance based on OTTV & RTTV	10	
	EE4	Home Office & Connectivity	2	
	EE5	Sustainable Maintenance	3	
2	**EQ**	**INDOOR ENVIRONMENTAL QUALITY**		
	Air Quality, Lighting, Visual & Acoustic Comfort			11
	EQ1	Minimum IAQ Performance	2	
	EQ2	Daylighting	2	
	EQ3	Sound Insulation	2	
	EQ4	Good Quality Construction	1	
	EQ5	Volatile Organic Compounds	1	
	EQ6	Formaldehyde Minimisation	1	
	Verification			
	EQ7	Post Occupancy Evaluation: Verification	2	
3	**SM**	**SUSTAINABLE SITE PLANNING & MANAGEMENT**		
	Site Planning & Transport			39
	SM1	Site Selection	1	
	SM2	Public Transportation Access	12	
	SM3	Community Services & Connectivity	8	
	SM4	Open Spaces, Landscaping & Heat Island Effect	4	
	Site & Construction Management			
	SM5	Construction System & Site Management	3	
	SM6	Stormwater Management	3	
	SM7	Re-development of Existing Sites & Brownfield Re-development	4	
	SM8	Avoiding Enviromentally Sensitive Areas	2	
	SM9	Building User Manual	2	
4	**MR**	**MATERIALS & RESOURCES**		
	Reused & Recycled Materials			9
	MR1	Storage & Collection of recyclables	2	
	MR2	Materials Reuse and Selection	2	
	MR3	Construction Waste Management	2	
	Sustainable Resources			
	MR4	Recycled Content Materials	1	
	MR5	Regional Materials	1	
	MR6	Sustainable Timber	1	
5	**WE**	**WATER EFFICIENCY**		
	Water Harvesting & Recycling			12
	WE1	Rainwater Harvesting	4	
	WE2	Water Recycling	2	
	Increased Efficiency			
	WE3	Water Efficient Landscaping	2	
	WE4	Water Efficient Fittings	4	
6	**IN**	**INNOVATION**		
	IN1	Innovation in Design & Environmental Design Initiatives	5	6
	IN2	Green Building Index Facilitator (GBIF)	1	
			TOTAL POINTS	**100**

1 ENERGY EFFICIENCY (EE)

MINIMUM EE PERFORMANCE | RENEWABLE ENERGY | ADVANCED EE PERFORMANCE | HOME OFFICE & CONECTIVITY

23 POINTS

ITEM	AREA OF ASSESSMENT	DETAIL POINTS	MAX POINTS	SCORE
EE1	**MINIMUM EE PERFORMANCE**			
	Establish minimum Energy Efficiency (EE) performance to reduce energy consumption in buildings, thus reducing CO_2 emission to the atmosphere. Apply OTTV and RTTV formulas of MS 1525 for residential buildings OTTV ≤ 50 W/m², RTTV ≤ 25 W/m² Roof U ≤ 0.4 W/m²K (Lightweight) Roof U ≤ 0.6 W/m²K (Heavyweight)	3	3	
EE2	**RENEWABLE ENERGY**			
	Encourage use of renewable energy.		5	
	A) Low-rise (3-Storeys and below):			
	Where 1 kWp is generated by renewable energy, ***OR***	1		
	Where 40% of building energy consumption or 2 kWp (whichever is the lower) is generated by renewable energy, ***OR***	2		
	Where 60% of building energy consumption or 3 kWp (whichever is the lower), ***OR***	3		
	Where 80% of building energy consumption or 4 kWp (whichever is the lower), ***OR***	4		
	100% of building energy consumption or 5 kWp (whichever is the lower)	5		
	B) Hi-rise (Above 3-Storeys):			
	Where 0.5% of building energy consumption or 5 kWp (whichever is the higher) is generated by renewable energy, ***OR***	1		
	Where 1.0% of building energy consumption or 10 kWp (whichever is the higher), ***OR***	2		
	Where 1.5% of building energy consumption or 20 kWp (whichever is the higher), ***OR***	3		
	Where 2.0% of building energy consumption or 30 kWp (whichever is the higher), ***OR***	4		
	Where 2.5% of building energy consumption or 40 kWp (whichever is the higher)	5		
EE3	**ADVANCED EE PERFORMANCE BASED ON OTTV & RTTV**			
	Establish EE Performance to reduce dependence on Energy to keep indoor environment at satisfactory comfort level. Computed OTTV and RTTV to show lower dependence on Energy to maintain indoor thermal comfort.		10	
	OTTV ≤ 46 W/m² Lightweight Roof U-value ≤ 0.35 W/m²K Heavyweight Roof U-value ≤ 0.5 W/m²K	2		
	OTTV ≤ 44 W/m² Lightweight Roof U-value ≤ 0.30 W/m²K Heavyweight Roof U-value ≤ 0.4 W/m²K	4		
	OTTV ≤ 42 W/m² Lightweight Roof U-value ≤ 0.25 W/m²K Heavyweight Roof U-value ≤ 0.3 W/m²K	6		
	OTTV ≤ 40 W/m² Lightweight Roof U-value ≤ 0.2 W/m²K Heavyweight Roof U-value ≤ 0.2 W/m²K	8		
	OTTV ≤ 38 W/m² Lightweight Roof U-value ≤ 0.15 W/m²K Heavyweight Roof U-value ≤ 0.15 W/m²K	10		
EE4	**HOME OFFICE & CONNECTIVITY**			
	Encourage dual use spaces and working from Home thereby discourage avoidable commuting.		2	
	Multiple-use type developments, ***OR*** High speed internet access available at homes > 1MB/s	2		
EE5	**SUSTAINABLE MAINTENANCE**			
	Ensure that the building's energy related systems will continue to perform as intended beyond the 12 months Defects & Liability Period. Document Green Building Design features and strategies for user information and guide to sustain performance during occupancy.		3	
	Buildings With Common Management: 1. Provide a designated building maintenance office equipped with facilities (including tools and instrumentation) and inventory storage; 2. Provide evidence of documented plan for at least 3-year facility maintenance and preventive maintenance budget; ***OR***	3		
	Buildings Without Common Management: 1. Provide a evidence of documented plan for at least 3-year preventive maintenance budget.	3		
		ENERGY EFFICIENCY (EE) TOTAL	23	

2 INDOOR ENVIRONMENTAL QUALITY (EQ)

AIR QUALITY, LIGHTING, VISUAL & ACOUSTIC COMFORT | VERIFICATION

11 POINTS

ITEM	AREA OF ASSESSMENT	DETAIL POINTS	MAX POINTS	SCORE
AIR QUALITY, LIGHTING, VISUAL & ACOUSTIC COMFORT				
EQ1	**MINIMUM IAQ PERFORMANCE**			
	Establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in building, thus contributing to the comfort and well-being of the occupants		2	
	Meet the minimum requirements of ventilation rate in the local building code	1		
	Provide cross ventilation for all public and circulation spaces	2		
EQ2	**DAYLIGHTING**			
	Encourage and recognise designs that provide good levels of daylighting for building occupants. Demonstrate that a nominated percentage of the Habitable Rooms as defined under UBBL has a daylight factor in the range 1.0 – 3.5% as measured at floor level.		2	
	if > 50% of Habitable spaces, *OR*	1		
	if > 75% of Habitable spaces	2		
EQ3	**SOUND INSULATION**			
	Encourage and recognise building that is designed with adequate insulation between dwelling units. Ensure that the air bourne sound penetration between spaces are controlled within the following criteria.		2	
	Inter dwelling sound penetration between dewelling units < 45 dBAeq.	1		
	Intra dwelling air bourne sound penetration between walls in the same dwelling unit should not exceed the following values: Bedroom < 40 dBAeq Other areas < 30 dBAeq	1		
EQ4	**GOOD QUALITY CONSTRUCTION**			
	Encourage and recognise good quality construction – first time right – that does not require re-work that wastes materials and labour.		1	
	Subscribe to independent method to assess and evaluate quality of workmanship of building project based on CIDB's CIS 7: Quality Assessment System for Building Construction Work (QLASSIC). Must achieve a minimum score of 70%	1		
EQ5	**VOLATILE ORGANIC COMPOUNDS**			
	Encourage and recognise projects that reduce the detrimental impact on occupant health from finishes emitting internal air pollutants. Reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants. Volatile Organic Compound (VOC) content to comply with requirements specified in international labelling schemes recognised by GBI. ***0.5 point is awarded for each of the following up to a maximum of 1 point:*** 1. Low VOC paint and coating 2. Low VOC carpet or flooring 3. Low VOC adhesive and sealant *OR* no adhesive and sealant used.	1	1	
EQ6	**FORMALDEHYDE MINIMISATION**			
	Reduce the exposure of occupants to formaldehyde and promote good indoor air quality in the living space. Products with no added urea formaldehyde are to be used. ***0.5 point is awarded for each of the following up to a maximum of 1 point:*** 1. Composite wood and agrifiber products defined as: particleboard, medium density fiberboard (MDF), plywood, wheatboard, strawboard, panel substrates and door cores; 2. Laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies; 3. Insulation foam; 4. Draperies	1	1	
VERIFICATION				
EQ7	**POST OCCUPANCY EVALUATION: VERIFICATION**			
	Provide for the assessment of comfort of the building occupants over time.		2	
	Commit to implement a post-occupancy comfort survey of building occupants within a period of 12 months after occupancy. This survey should collect anonymous responses about thermal comfort, visual comfort and acoustic comfort in a building. This should include an assessment of overall satisfaction with thermal, visual and acoustic performance and identification of thermal-related, visual-related and acoustic-related problems.	1		
	Develop a plan for corrective action if the survey results indicate that more than 20% of occupants are dissatisfied with the overall comfort in the building. This plan should include measurement of relevant environmental variables in problem areas.	1		
	INDOOR ENVIRONMENTAL QUALITY (EQ) TOTAL		**11**	

3 SUSTAINABLE SITE PLANNING & MANAGEMENT (SM)

SITE PLANNING & TRANSPORT | SITE & CONSTRUCTION MANAGEMENT

39 POINTS

ITEM	AREA OF ASSESSMENT		DETAIL POINTS	MAX POINTS	SCORE
SITE PLANNING & TRANSPORT					
SM1	**SITE SELECTION & PLANNING**				
	Proposed development is appropriate for the site and complies with the Local Plan or Structure Plan for the area. **The proposed building must comply with the following requirements:** 1. The Structure Plan for the area *AND/OR* The Local Plan where available 2. Infrastructure requirement is available for the area.		1	1	
SM2	**PUBLIC TRANSPORTATION ACCESS**				
	Encourage the selection of sites close to transport hubs and the planning of new housing areas to encourage the use of public transport. This is to reduce the current and future heavy dependence on private transport, which is the greatest contributor to Green House Gas (GHG) emission. Points are awarded according to proximity of the development to public transport hubs and quality of the access to the transport hub. For new housing areas, the provision of transport hubs for the housing concerned with proper shelter, amenities, shuttle facilities and parking facilities are encouraged. Points are awarded according to the subsection categories. **NOTE: SELECT EITHER SM2A & SM2B *OR* SM2C & SM2D**			12	
	SM2A	**Distance from Mass Transport Station/Hub to building within 1km (50% of points if from Shuttle Bus Stop)**			
		0 - 250m	8	8	
		251 - 500m	6		
		501 - 750m	4		
		751m - 1km	2		
	SM2B	**Walkway from building to Mass Transport Station if less than 750m from Mass Transport Station**			
		Dedicated footpath	2	4	
		Covered walkway	3		
		Covered walkway that incorporates provision for the handicapped	4		
		OR			
		Sheltered and secured waiting area for shuttle van or bus in the residential building if more than 750m from Mass Transport Station	4		
	SM2C	**Transport Terminal within the Residential Area with covered seating and waiting area for a minimum of 10% of the total number of residential units**			
		Score is average of points of all residential units in the residential area as for **SM2A**	8	8	
	SM2D	**Walkway from building to Transport Terminal if less than 750m from Transport Terminal:**			
		Dedicated footpath	2	4	
		Covered walkway	3		
		Covered walkway that incorporates provision for the handicapped	4		
		OR			
		Car park provision next to Transport Terminal:			
		Car park provision for at least 20% of total number of residential units not more than 250m from the Terminal	4		
		OR			
		Designated bicycle lane provision in at least 90% of the Residential area and a Secured bicycle parking area in the Transport Terminal for 10% of the total number of residential units:			
		Provision of Bicycle Lanes	2		
		AND Provision of Bicycle Parking Area	2		

Continued on next page >>

ITEM	AREA OF ASSESSMENT	DETAIL POINTS	MAX POINTS	SCORE
SM3	**COMMUNITY SERVICES & CONNECTIVITY**			
	Encourage the selection of sites close to basic community amenities and the planning of new residential areas to encourage the provision of local amenities. This is to reduce the current and future heavy use of private transport after working hours, which is the greatest contributor to GHG emission. Points are awarded according to proximity of the development to community amenities. Points are awarded according to the subsection categories.		8	
SM3A	Basic Amenities as listed below are provided or are available within 750m of the residential units ***(Less 1 point if more than 750m away):*** 1. Grocery Store or Mini-market 2. Restaurant or Coffee Shop 3. Surau or Mosque 4. Playground or Public Park	4		
SM3B	Other Amenities as listed below are provided or are available within 750m of the residential units ***(0.5 point per item or equivalent up to maximum of 2 points. Less 0.5 point if more than 750m away):*** 1. Clinic or Medical Center 2. Police Station or Police Pondok 3. School or Creche 4. Bank, Post Office or ATM	2		
SM3C	Additional Amenities as listed below are provided or are available within 750m of the residential units ***(0.5 point per item or equivalent up to maximum of 2 points. Less 0.5 point if more than 750m away):*** 1. Library 2. Community Center or Hall 3. Wet Market or Supermarket 4. Barber Shop 5. Laundry	2		
SM4	**OPEN SPACES, LANDSCAPING AND HEAT ISLAND EFFECT**			
	Development should have smaller footprints and more landscaping, thereby reducing the well known effects of heat islands around hard scaped areas.		4	
	Provision of landscaping with indigenous plants to 10% of total development area	1		
	Provision of additional similar landscaping of every extra 5%: ***1 point up to a maximum of 3 points***	3		
SITE & CONSTRUCTION MANAGEMENT				
SM5	**CONSTRUCTION SYSTEM & SITE MANAGEMENT**			
	Encourage IBS and reduce on-site construction. Reduce material wastage and construction wastage to landfill sites. Reduce the polluting effects of construction and from workers during construction.		3	
	Reduce pollution from construction activities by controlling pollution from waste and rubbish from workers. Create and implement a Site Amenities Plan for all construction workers associated with the project. **The plan shall describe the measures implemented to accomplish the following objectives:** 1. Proper accommodation for construction workers at the site or at temporary rented accommodation nearby. 2. Prevent pollution of storm sewer or receiving stream by having proper septic tank. 3. Prevent polluting the surrounding area from open burning and proper disposal of domestic waste. 4. Provide adequate health and hygiene facilities for workers on site.	1		
	CIDB IBS score ≥ 50%, ***OR***	1		
	CIDB IBS score ≥ 70%	2		
SM6	**STORM WATER MANAGEMENT**			
	Manage surface water run off from developments. Reduce the pollution and storm water loading of the river systems from the development. Reduce flood risk. Retain rainwater for recycling and appropriate use.		3	
	Complies with MASMA minimum requirements	1		
	Exceeds MASMA requirements by 30%: ***entitled to 2 additional points pro rated for lower values***	2		
SM7	**RE-DEVELOPMENT OF EXISTING SITES & BROWNFIELD SITES**			
	Discourage development in environmentally sensitive areas. Encourage re-development of existing sites. Reward rehabilitation of Brownfield site and development in the rehabilitated sites.		4	
	Re-development of exisitng sites or refurbishment of existing building	2		
	Rehabilitation of brownfield sites	2		
SM8	**AVOIDING ENVIROMENTALLY SENSITIVE AREAS**			
	Avoid development of inappropriate sites and reduce the environmental impact from the location of a building on a site.		2	
	Do not develop buildings, hardscape, roads or parking areas on portions of sites that meet any one of the following criteria: • Prime agriculture land as defined by the Town and Country Planning Act • Land that is specifically identified as habitat for any species threatened or endangered lists • Within 30 meters of any wetlands as defined by the Structure Plan of the area. ***OR*** within setback distances from wetlands prescribed in state or local regulations, as defined by local or state rule or law, whichever is more stringent: • Previously undeveloped land that is within 15 meters of a water body, defined as seas, lakes, rivers, streams and tributaries which support or could support fish, recreation or industrial use. • Land which prior to acquisition for the project was public parkland, unless land of equal or greater value as parkland is accepted in trade by the public landowner. • Land which is classified as Class IV (steeper than 30 degrees)	2		
SM9	**BUILDING USER MANUAL**			
	Document Green Building Design features & strategies for user information and guide to sustain performance during occupancy. Provide a Building User Manual which documents passive and active features that should not be downgraded.	2	2	
	SUSTAINABLE SITE PLANNING & MANAGEMENT (SM) TOTAL		**39**	

4 MATERIALS & RESOURCES (MR)

REUSED AND RECYCLED MATERIALS | SUSTAINABLE RESOURCES

9 POINTS

ITEM	AREA OF ASSESSMENT	DETAIL POINTS	MAX POINTS	SCORE
REUSED AND RECYCLED MATERIALS				
MR1	**STORAGE & COLLECTION OF RECYCLABLES**			
	Facilitate the reduction of waste generated by construction that is hauled and disposed off in landfills and recycling after occupancy.		2	
	During Construction, provide dedicated area(s) and storage for collection of non-hazardous materials for recycling.	1		
	During Building Occupancy, provide permanent recycle bins.	1		
MR2	**MATERIALS REUSE AND SELECTION**			
	Reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources. Integrate building design and its buildability, with careful selection of building materials in relation with embodied energy and durability of the materials to lower carbon content and better building life cycle.		2	
	Use salvaged, refurbished or used materials such that the sum of these materials constitutes at least 1% (based on cost) of the total materials for the project. The used, refurbished and new building materials concerned are to be assessed for eco preferred content, durability, the product manufacturer's environmental management system and whether the product is modular and/or designed for disassembly. To include reusability and the number of cycles on the usage (minimum 15 cycles) of temporary materials; such as temporary formwork system, temporary framing or support system, etc. ***0.5 point for 1.0% and additional 0.25 point for every additional 0.5% up to a maximum of 2 points.***	2		
MR3	**CONSTRUCTION WASTE MANAGEMENT**			
	Divert construction debris from disposal in landfill and incinerator. Redirect recyclable recovered resources back to manufacturing process. Redirect reusable materials to appropriate sites.		2	
	Recycle and/or salvage at least 50% of non-hazardous construction debris. Develop and implement a construction waste management plan that, at a minimum identifies the materials to be diverted from disposal and whether the materials will be sorted on site or co-mingled. Quantify by measuring total tonnage of waste or truck loads of waste disposal. ***1 point for 50% and additional 0.25 point for every additional 5% up to a maximum of 2 points.*** ***If project uses high level of prefabrication with IBS score > 70, 1 point for every 10% increase in prefabrication up to a maximum of 2 points.***	2		
SUSTAINABLE RESOURCES				
MR4	**RECYCLED CONTENT MATERIALS**			
	Increase demand for building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials.		1	
	Use materials with recycled content such that the sum of post-consumer recycled plus one-half of the pre-consumer content constitutes at least 10% (based on cost) of the total value of the materials in the project. Recycled content shall be defined in accordance with the International Organization of Standards Document. ***0.5 point for 10% and 0.25 point for every additional 5% up to a maximum of 1 point.***	1		
MR5	**REGIONAL MATERIALS**			
	Increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the use of indigenous resources and reducing the environmental impacts resulting from transportation		1	
	Use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500km of the project site for a minimum of 20% (based on cost) of the total material value. Mechanical, electrical and plumbing components shall not be included. Only include materials permanently installed in the project. ***0.5 point for 20% and 0.25 point for every additional 5% up to a maximum of 1 point.***	1		
MR6	**SUSTAINABLE TIMBER**			
	Encourage environmentally responsible forest management: Where ≥ 50% of wood based materials and products used are certified. *These components include, but are not limited to, structural framing and general dimensional framing, flooring, sub-flooring, wood doors and finishes. To include wood materials permanently installed and also temporarily purchased for the project. Compliance with Forest Stewardship Council and Malaysian Timber Certification Council requirements.* ***Where the project has no timber content, this credit may be transferred to MR5***	1	1	
	MATERIALS & RESOURCES (MR) TOTAL		9	

5 WATER EFFICIENCY (WE)

WATER HARVESTING & RECYCLING | INCREASED EFFICIENCY

12 POINTS

ITEM	AREA OF ASSESSMENT	DETAIL POINTS	MAX POINTS	SCORE
WATER HARVESTING & RECYCLING				
WE1	**RAINWATER HARVESTING**			
	Encourage rainwater harvesting that will lead to reduction in potable water consumption:		4	
	Rainwater harvesting that leads to ≥ 10% reduction in potable water consumption, **OR**	1		
	Rainwater harvesting that leads to > 30% reduction in potable water consumption, **OR**	2		
	Rainwater harvesting that leads to > 40% reduction in potable water consumption, **OR**	3		
	Rainwater harvesting that leads to > 50% reduction in potable water consumption	4		
WE2	**WATER RECYCLING**			
	Encourage water recycling that will lead to reduction in potable water consumption:		2	
	Treat and recycle ≥ 5% wastewater leading to reduction in potable water consumption, **OR**	0.5		
	Treat and recycle ≥ 10% wastewater leading to reduction in potable water consumption, **OR**	1		
	Treat and recycle ≥ 20% wastewater leading to reduction in potable water consumption, **OR**	1.5		
	Treat and recycle ≥ 30% wastewater leading to reduction in potable water consumption	2		
INCREASED EFFICIENCY				
WE3	**WATER EFFICIENT LANDSCAPING**			
	Encourage the design of system that does not require the use of potable water supply from the local water authority:		2	
	Reduce potable water consumption for landscape irrigation by ≥ 50% (e.g. through use of native or adaptive plants to reduce or eliminate irrigation requirement, **OR**	1		
	Do not use potable water at all for landscape irrigation	2		
WE4	**WATER EFFICIENT FITTINGS**			
	Encourage reduction in potable water consumption through use of efficient devices:		4	
	Reduce annual potable water consumption by > 10%, **OR**	1		
	Reduce annual potable water consumption by > 30%, **OR**	2		
	Reduce annual potable water consumption by > 40%, **OR**	3		
	Reduce annual potable water consumption by > 50%	4		
	WATER EFFICIENCY (WE) TOTAL		**12**	

6 INNOVATION (IN)

INNOVATION INITIATIVES | MAINTENANCE PROGRAM & GREEN BUILDING INDEX FACILITATOR

6 POINTS

ITEM	AREA OF ASSESSMENT	DETAIL POINTS	MAX POINTS	SCORE
IN1	**INNOVATION IN DESIGN & ENVIRONMENTAL DESIGN INITIATIVES**			
	Provide design team and project the opportunity to be awarded points for exceptional performance above the requirements set by GBI rating system: ***1 point for each approved innovation and environmental design initiative up to a maximum of 5 points, such as:*** • Innovative planning that displays "less is more" and "small is beautiful"; • Rehabilitation of existing buildings for re-use in innovative ways; • Innovative use of building features to passively cool the building • Heat recovery system (contributing to at least 10% of total required capacity); • Mixed mode / low energy ventilation system; • Waterless urinals (fitted to all male toilets); • Central waste conveyance system; • Central vacuum system	5	5	
IN2	**GREEN BUILDING INDEX FACILITATOR (GBIF)**			
	Green Building Index Facilitator to support and encourage the design integration required for Green Building Index rated buildings and to streamline the application and certification process.		1	
	At least one principle participant of the project team shall be a Green Building Index Facilitator.	1		
	INNOVATION (IN) TOTAL		**6**	

Appendix C

Revise Assessment Criteria

For

Measurement/Observation/Omitted

1. Energy Efficiency

Measurement	Observation	Unable to Measure or Observed
Minimum EE Performance	Renewable Energy	Sustainable Maintenance
Advanced EE Performace Based on OTTV & RTTV	Home Security & Connectivity	

2. Indoor Environmental Quality (EP)

Measurement	Observation	Unable to Measure or Observed
Daylighting	Minimum IAQ Performance	Volatile Organic Compounds
Sound Insulation	Formaldehyde Minimization	Good Quality Construction
Post Occupancy Evaluation: Verification		

3. Sustainable Site Planning & Management

Measurement	Observation	Unable to Measure or Observed
Open Spaces, Landscaping and Heat Island effect	Public Transportation Access	Construction System and Site Management
	Community Services & Connectivity	Building User Manual
	Re-Development of Existing & Brownfield Sites	Storm Water Management
	Avoiding Environmentally Sensitive Areas	Site Selection & Planning

4. Materials & Resources (MR)

Measurement	Observation	Unable to Measure or Observed
	Recycled Content Materials	Storage & Collection of Recycleables
	Regional Materials	Materials Reuse & Selection
	Sustainable Timber	Construction Waste Management

5. Water Efficiency (WE)

Measurement	Observation	Unable to Measure or Observed
	Rainwater Harvesting	Water Recycling
	Water Efficiency Landscaping	
	Water Efficient Fittings	

6. Innovation

Measurement	Observation	Unable to Measure or Observed
	Innovation in Design & Environmental Design Initiatives	Green Building Index Facilitator

Appendix D

OTTV

Calculations

Alif Café Restaurant

	ELEVATION	Façade Area (A) m^2	Constant	Solar Absorption Factor (α)	Window to Wall Ratio (WWR)	(1-WWR)	U-Value W/m^2k (Uw)	Orientation Correction Factor(CF)	Shading Coeff ($SC=SC_1 \times SC_2$)	Thermal Transfer Value (OTTV)	A x OTTV
HEAT CONDUCTION THROUGH WALLS	North	225	15	0.4	0.08	0.92	0.84	NA	NA	4.64	1043.28
	South	0	15	0	0	0	0.84	-	-	0.00	0.00
	East	37.5	15	0.4	0.72	0.28	0.84	-	-	1.41	52.92
	West	37.5	15	0.4	0.16	0.84	0.84	-	-	4.23	158.76
	TOTAL WALL OTTV	15 x α x (1-WWR)U									1254.96
HEAT CONDUCTION THROUGH WINDOWS	North	225	6	NA	0.08	NA	6	NA	NA	2.88	648.00
	South	0	6	-	0	-	6	-	-	0.00	0.00
	East	37.5	6	-	0.72	-	6	-	-	25.92	972.00
	West	37.5	6	-	0.16	-	6	-	-	5.76	216.00
	TOTAL WINDOW OTTV	6 x WWR x U									1836.00
SOLAR HEAT GAIN THROUGH WINDOWS	North	225	194	NA	0.08	NA	NA	0.83	0.4	5.15	1159.34
	South	0	194	-	0	-	-	0.85	0	0.00	0.00
	East	37.5	194	-	0.16	-	-	1.15	0.4	14.28	535.44
	West	37.5	194	-	0.72	-	-	1.14	0.4	63.69	2388.53
	TOTAL SOLAR HEAT GAIN	194 x CF x WWR x SC								83.13	4083.31
OVERALL BUILDING OTTV		300								23.91	7174.27

Syed Al Attas Mansion

	ELEVATION	Façade Area (A) m^2	Constant	Solar Absorption Factor (α)	Window to Wall Ratio (WWR)	(1-WWR)	U-Value W/m^2k (Uw)	Orientation Correction Factor(CF)	Shading Coeff ($SC=SC_1 \times SC_2$)	Thermal Transfer Value (OTTV)	A x OTTV
HEAT CONDUCTION THROUGH WALLS	North	0	15	0	0	0	0	NA	NA	0.00	0.00
	South	60	15	0.15	0.23	0.77	2.91	-	-	5.04	302.49
	East	84	15	0.15	0.10	0.90	2.91	-	-	5.89	494.99
	West	0	15	0	0	0	0	-	-	0.00	0.00
	TOTAL WALL OTTV	$15 \times \alpha \times (1\text{-WWR})U$									797.49
HEAT CONDUCTION THROUGH WINDOWS	North	0	6	NA	0	NA	0	NA	NA	0.00	0.00
	South	60	6	-	0.23	-	3.39	-	-	4.68	280.69
	East	84	6	-	0.10	-	3.39	-	-	2.03	170.86
	West	0	6	-	0	-	0	-	-	0.00	0.00
	TOTAL WINDOW OTTV	6 x WWR x U									451.55
SOLAR HEAT GAIN THROUGH WINDOWS	North	0	194	NA	0	NA	NA	0.83	0	0.00	0.00
	South	60	194	-	0.23	-	-	0.85	0.3	11.38	682.69
	East	84	194	-	0.08	-	-	1.15	0.3	5.35	449.77
	West	0	194	-	0	-	-	1.14	0	0.00	0.00
	TOTAL SOLAR HEAT GAIN	194 x CF x WWR x SC								16.73	1132.46
OVERALL BUILDING OTTV		144								16.54	2381.49

Tun Mahathir Birth House

	ELEVATION	Façade Area (A) m^2	Constant	Solar Absorption Factor (α)	Window to Wall Ratio (WWR)	(1-WWR)	U-Value W/m^2k (Uw)	Orientation Correction Factor(CF)	Shading Coeff ($SC=SC_1 \times SC_2$)	Thermal Transfer Value (OTTV)	A x OTTV
HEAT CONDUCTION THROUGH WALLS	North	22.8	15	0.9	0.07	0.93	3.39	NA	NA	42.56	970.40
	South	15.3	15	0.15	0.31	0.69	3.39	-	-	5.26	80.52
	East	46.2	15	0.15	0.15	0.85	3.39	-	-	6.48	299.53
	West	55.8	15	0.15	0.17	0.83	3.39	-	-	6.33	353.26
	TOTAL WALL OTTV	15 x α x (1-WWR)U									1703.72
HEAT CONDUCTION THROUGH WINDOWS	North	22.8	6	NA	0.07	NA	3.39	NA	NA	1.42	32.46
	South	15.3	6	-	0.31	-	3.39	-	-	6.31	96.47
	East	46.2	6	-	0.15	-	3.39	-	-	3.05	140.96
	West	55.8	6	-	0.17	-	3.39	-	-	3.46	192.95
	TOTAL WINDOW OTTV	6 x WWR x U									462.84
SOLAR HEAT GAIN THROUGH WINDOWS	North	22.8	194	NA	0.07	NA	NA	0.83	0.25	2.82	64.25
	South	15.3	194	-	0.31	-	-	0.85	0.25	12.78	195.53
	East	46.2	194	-	0.15	-	-	1.15	0.25	8.37	386.52
	West	55.8	194	-	0.17	-	-	1.14	0.25	9.40	524.48
	TOTAL SOLAR HEAT GAIN	194 x CF x WWR x SC								33.36	1170.78
OVERALL BUILDING OTTV		140.1								23.82	3337.33

Modern Terrace House

	ELEVATION	Façade Area (A) m^2	Constant	Solar Absorption Factor (α)	Window to Wall Ratio (WWR)	(1-WWR)	U-Value W/m^2k (Uw)	Orientation Correction Factor(CF)	Shading Coeff ($SC=SC_1 \times SC_2$)	Thermal Transfer Value (OTTV)	A x OTTV
HEAT CONDUCTION THROUGH WALLS	North	17.5	15	0.15	0.33	0.67	2.86	NA	NA	4.31	75.45
	South	17.5	15	0.15	0.51	0.49	2.86	-	-	3.15	55.18
	East	42	15	0.15	0.09	0.91	2.86	-	-	5.86	245.95
	West	0	15	0	0	0	0	-	-	0.00	0.00
	TOTAL WALL OTTV	$15 \times \alpha \times (1-WWR)U$									376.58
HEAT CONDUCTION THROUGH WINDOWS	North	17.5	6	NA	0.33	NA	6	NA	NA	11.88	207.90
	South	17.5	6	-	0.51	-	6	-	-	18.36	321.30
	East	42	6	-	0.09	-	6	-	-	3.24	136.08
	West	0	6	-	0	-	0	-	-	0.00	0.00
	TOTAL WINDOW OTTV	$6 \times WWR \times U$									665.28
SOLAR HEAT GAIN THROUGH WINDOWS	North	17.5	194	NA	0.33	NA	NA	0.83	0.2	10.63	185.98
	South	17.5	194	-	0.51	-	-	0.85	0.25	21.02	367.93
	East	42	194	-	0.09	-	-	1.15	0.2	4.02	168.66
	West	0	194	-	0	-	-	1.14	0	0.00	0.00
	TOTAL SOLAR HEAT GAIN	$194 \times CF \times WWR \times SC$								35.67	722.57
OVERALL BUILDING OTTV		77								22.91	1764.43