

THE ECO-LABELING ON SUSTAINABLE ROOF MATERIALS

NORFATIHA BINTI HAMZANI

UNIVERSITI TEKNOLOGI MALAYSIA

DECLARATION OF THESIS ~~/ UNDERGRADUATE PROJECT PAPER AND COPYRIGHT~~

Author's full name : NORFATIHA BT HAMZANI

Date of birth : 25 JUNE 1985

Title : THE ECO-LABELING ON SUSTAINABLE ROOF MATERIALS

Academic Session: 2008/2009

I declare that this thesis is classified as :

CONFIDENTIAL

(Contains confidential information under the Official Secret Act 1972)*

RESTRICTED

(Contains restricted information as specified by the organization where research was done)*

OPEN ACCESS

I agree that my thesis to be published as online open access (full text)

I acknowledged that Universiti Teknologi Malaysia reserves the right as follows:

1. The thesis is the property of Universiti Teknologi Malaysia.
2. The Library of Universiti Teknologi Malaysia has the right to make copies for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified by :

SIGNATURE

NORFATIHA HAMZANI
850625115088

SIGNATURE OF SUPERVISOR

DR. ROZANA ZAKARIA

Date :

Date :

NOTES : * If the thesis is CONFIDENTIAL or RESTRICTED, please attach with the letter from the organization with period and reasons for confidentiality or restriction.

THE ECO-LABELING ON SUSTAINABLE ROOF MATERIALS

NORFATIHA BINTI HAMZANI

A dissertation submitted in partial fulfillment of the
requirements for the award of the degree of
Master of Science (Construction Management)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

NOVEMBER 2008

DECLARATION

“I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in term of scope and quality for the award of the degree of Master of Science (Construction Management)”

Signature :

Name : DR. ROZANA BINTI ZAKARIA

Date : 28th NOVEMBER 2008

I declare that this thesis entitled
“The Eco-Labeling On Sustainable Roof Materials”
is the result of my own research except as cited in the references.

The thesis has not been accepted for any degree and is
not concurrently submitted in candidature of any other degree.

Signature :

Name : NORFATIHA BINTI HAMZANI

Date : 28th NOVEMBER 2008

DEDICATION

Thanks a million to:

MY SUPERVISOR- DR.ROZANA ZAKARIA

MY FAMILY-MAK, ABAH, MAMAT, PIPI, KORI, HANAN, DANNY, FAZRUL

MY GRANDPARENT- TOKWAN, TOKKI, KIANAN, TOKMEK

ALL OF MY FRIENDS

AND MYSELF....HEHE LOVE U ALL VERY MUCH MUAH2...

ACKNOWLEDGEMENT

Alhamdulillah with the blessed of Allah s.w.t has giving me enough knowledge and time to complete this program. I would like to take this chance to express and record my gratitude towards my Final Year Project supervisor Dr. Rozana binti Zakaria, for the time she allocated and all her guidance, encouragement, and friendship. Without her guidance in preparation, this thesis may not as perfect as presented here. All the help rendered by other lecturers who involve directly or indirectly were also very much appreciated. The time spent in doing this program gives memories that would last for forever.

I would also dedicate special thanks to all the respondents who involved in my questionnaires survey and for their constructive criticisms to enrich the findings of this study. Additionally, a special thanks to all my beloved friends who have encouraged and support with some beneficial tips in regards to finish this thesis.

A special thanks to my family members who supported in very positive minded, and encouraging me throughout my research and my study at Universiti Teknologi Malaysia, Johor. Thank you very much.

ABSTRACT

Construction industry is a major sector that needed the consideration of sustainable development agenda through sustainable construction. The sustainable construction therefore has several approaches on eco-friendly building, which focuses on harmony environment. These can be applied through the choices of material and construction methods that resulted in low level of environmental impacts worksites. The sustainable construction agenda involves optimal management of energy, water, waste management, maintenance and comfort improvements such as thermal and acoustic performance, visual and odour aspects through having good quality living. This research therefore is aim to classify sustainable characteristics or eco-friendly elements that can be utilised onto eco-labeling of roof materials through develop the assessment checklist guideline. This research therefore is focusing on roof materials of steep slope roof system that suitable with the tropical Malaysian climate. The data was gathered using the matrix checklist of sustainable characteristics for roof materials. The data then after was analysed using content analysis method and statistical analysis. This study found Clay Tiles, Fiberglass Insulation, Steel Roof Truss, Fiberglass Roofing Tissues and Aluminium drainage materials were the most sustainable roof materials that suited for a steep slope roof system. The simplified matrix checklist of sustainable roof materials then after is produced as the final result of this study that may benefit for construction industry references.

ABSTRAK

Industri pembinaan adalah sektor utama yang perlu menitikberatkan agenda kelestarian pembangunan menerusi kelestarian pembinaan. Kelestarian pembinaan mempunyai beberapa pendekatan ke atas bangunan yang eko-mesra dimana ia fokus terhadap persekitaran yang harmoni. Ini dapat diaplikasikan melalui pemilihan bahan-bahan dan kaedah pembinaan yang memberi impak paras terendah terhadap persekitaran tapak-tapak kerja. Agenda kelestarian pembinaan melibatkan pengurusan tenaga, air, pengurusan sisa, penyelenggaraan yang optimum dan meningkatkan keselesaan seperti tenaga haba dan bunyi, visual dan aspek binaan melalui penyediaan tempat tinggal yang berkualiti. Penyelidikan ini bermatlamat untuk mengklasifikasikan ciri-ciri kelestarian yang boleh digunakan untuk tujuan eko-label bahan bina. Ini membangunkan suatu panduan penilaian di mana senarai semak untuk menentukan bahan-bahan binaan bumbung yang lestari dapat disediakan. Skop penyelidikan ini memfokuskan kepada bahan-bahan binaan bumbung bagi sistem bumbung curam yang sesuai digunakan dalam cuaca tropika di Malaysia. Data-data yang diperolehi menggunakan senarai semak matriks yang mengandungi ciri-ciri lestari untuk bahan-bahan bumbung. Data-data ini kemudiannya dianalisa menggunakan kaedah analisis kandungan dan analisis statistik. Penemuan dalam penyelidikan ini mendapati *Clay Tiles*, *Fiberglass Insulation*, *Steel Roof Truss*, *Fiberglass Roofing Tissues* dan *Aluminium drainage* adalah bahan binaan bumbung yang paling lestari. Matrik senarai semak yang telah dikemas kini yang akan digunakan untuk mengenalpasti bahan-bahan binaan bumbung yang lestari adalah hasil dari penyelidikan ini. Semoga ianya akan menjadi rujukan serta memberi faedah kepada industri pembinaan.

TABLE OF CONTENT

CHAPTER	TITLE	PAGE
	DECLARATION	ii
	DEDICATION	iv
	ACKNOWLEDGEMENT	v
	ABSTRACT	vi
	ABSTRAK	vii
	TABLE OF CONTENT	viii
	LIST OF TABLES	xvi
	LIST OF FIGURES	xviii
1	INTRODUCTION	1
	1.1 General Background	1
	1.2 Problem Statement	2
	1.3 Aim of the Research	5
	1.4 Objective of the Research	6
	1.5 Scope of the Study	6
	1.6 Importance of Study	7
	1.7 Overview of Research Methodology	7
	1.7.1 Initial Stage	8
	1.7.2 Second Stage- identifying and collecting data.	8
	1.7.3 Third Stage – Analyse, commentary and summarise the data	9
	1.7.4 Final Stage – Research’s findings writing	10
	1.8 Expected Findings	10
	1.9 Summary of Chapters	11
	1.10 Conclusion	13

1.11 Definition	14
2 SUSTAINABLE BUILDING	16
2.1 Introduction	16
2.2 Sustainable Development	19
2.2.1 Implication of “Going Green”	22
2.3 Sustainable Construction	24
2.4 Sustainable Building	28
2.4.1 Principles of Sustainable Design	32
2.4.2 The Importance of Sustainable Building	35
2.5 Sustainable Materials	35
2.5.1 Use Recycled Materials	36
2.5.1.1 Design for Recycling	37
2.5.2 Material Selection and Specification	39
2.6 Application of Environmental Assessment	
Method of Sustainable Building	41
2.6.1 Environmental Building Assessment Methods	54
2.6.2 Consideration of Design Tools Criteria in Environmental Assessment Method for Sustainable Building	55
2.6.3 Existed Environmental Assessment Method	57
2.7 Eco-Labeling and Eco-friendly Materials	64
2.7.1 Types of Environmental Labels	67
2.7.2 Verification of Labeling Claims	69
2.7.3 Examples of Environmental Labels in Canada	72
3 SUSTAINABLE ROOF OF BUILDING	73
3.1 Roof Parts and Materials	73
3.1.1 Roof Terminology	77
3.1.2 Roof’s Functional Requirement	79
3.1.2.1 Strength and Stability	80

3.1.2.2	Resistance to Weather	80
3.1.2.3	Durability and Freedom from Maintenance	82
3.1.2.4	Fire Safety	83
3.1.2.5	Resistance to the Passage of Heat	84
3.1.2.6	Resistance to the Passage of Sound	86
3.1.3	Types of Roof	87
3.1.3.1	Single Roofs	88
3.1.3.2	Double Roofs	90
3.1.3.3	Trussed/ Framed Roof	91
3.1.3.4	Flat Roof	93
3.1.3.5	Sloping Roof	97
3.1.3.6	Pitched Roof	98
3.1.3.7	Medium and Large Span Roof	100
3.1.3.8	Green Roof	114
3.1.3.8.1	Extensive Green Roofs	115
3.1.3.8.2	Intensive Green Roofs	116
3.1.3.8.3	Typical Construction	117
3.1.3.8.4	Advantages of Green Roofs	119
3.1.4	Roof System Types	121
3.1.5	System Selection Criteria	125
3.1.5.1	System Demise	126
3.1.5.2	Contractor Familiarity and Availability	127
3.1.5.3	Maintenance Intensity	128
3.1.5.4	Nearby Government Roofs	129
3.1.5.5	Technical Considerations	129
3.1.5.6	Cost	130
3.1.5.7	Warranty	132
3.1.5.8	Implications of Sustainable Roof Design	132
3.1.6	Commercially Available Roofing Materials	133
3.1.7	Roof Finishes	134
3.1.7.1	Roof Drainage	135

3.2	Summary of the Chapter	137
4	RESEARCH METHODOLOGY	139
4.1	Introduction	139
4.2	Research Design Flow Chart	141
4.3	Research Methodology Flow Chart	142
4.4	Content Analysis Flowchart	143
4.5	Data Collection	145
4.6	Development Questionnaires	146
4.7	How to Conduct Survey	147
4.8	Observation of Roof Catalogues	148
4.9	Analysis of Data Collection	148
4.9.1	Analysis Method	149
4.10	Summary of the Chapter	151
5	DATA COLLECTION AND ANALYSIS	152
5.1	Introduction	152
5.2	Findings for Objective 1	153
5.3	Findings for Objective 2	156
5.4	Findings for Objective 3	162
5.4.1	Result of Research Analysis	162
5.4.1.1	Section A : Respondent's Demography	163
5.4.1.1.1	Analysis of Respondents Employment	163
5.4.1.1.2	Analysis of Respondents Gender	164
5.4.1.1.3	Analysis of Respondent's Working Experiences	165
5.4.1.1.4	Analysis Level of Understanding on Sustainable Concept	166
5.4.1.2	Section B : Roof Matrix Checklist	168
5.4.1.2.1	Roof Covering Materials	168
5.4.1.2.2	Insulation Materials	170

5.4.1.2.3	Roof Truss	171
5.4.1.2.4	Roof Underlays	172
5.4.1.2.5	Roof Drainage	173
5.4.1.3	Analysis on Sustainable Elements of Roof Covering	174
5.4.1.3.1	Ranking of Sustainable Elements on Roof Covering	176
5.4.1.4	Analysis on Sustainable Elements of Insulation Materials	179
5.4.1.4.1	Ranking of Sustainable Elements on Insulation Materials	181
5.4.1.5	Analysis on Sustainable Elements of Roof Truss	184
5.4.1.5.1	Ranking of Sustainable Elements on Roof Truss	186
5.4.1.6	Analysis on Sustainable Elements of Roof Underlays	189
5.4.1.6.1	Ranking of Sustainable Elements on Roof Underlays	191
5.4.1.7	Analysis on Sustainable Elements of Drainage Material	194
5.4.1.7.1	Ranking of Sustainable Elements on Roof Drainage	196
5.4.2	The Most Sustainable Roof Material's Identified	199
5.4.2.1	Roof Tile Clay	199
5.4.2.2	Fiberglass Insulation Material	200
5.4.2.3	Steel Roof Truss	201
5.4.2.4	Fiberglass Roofing Tissues (Roof Underlays)	202
5.4.2.5	Aluminium Roof Drainage	204
5.5	Updated Sustainable Matrix Checklist Integration for Roof Materials	205

5.6	Conclusion	206
5.7	Section C : Respondent Opinion on Suitability of Matrix Checklist Usage	207
5.7.1	Question	207
5.7.2	Result	207
5.7.3	Overall Respondent's Opinion	210
5.7.4	Analysis	211
5.8	Conclusion of Analysis	212
6	DISCUSSION OF FINDINGS	213
6.1	Introduction	213
6.2	Macro findings - The Overall Requirements for Sustainable Roof Materials Selection.	214
6.2.1	The Suitability of Sustainable Elements Apply on Roof Materials	214
6.2.2	Roles and Responsible of Contractor versus Client's Requirements	215
6.2.3	Potential Barriers to use the Matrix Checklist	216
6.2.4	The Importance Usage of Matrix Checklist to select the most Sustainable Roof Materials	217
6.3	Micro Findings – Research Findings from all around Malaysia	218
6.3.1	Awareness of the Sustainability Principles usage in Malaysia Construction Industry	218
6.4	Conclusions	220
7	CONCLUSION AND RECOMMENDATIONS	221
7.1	Introduction	221
7.2	Research Contribution to the Construction Industry	222
7.3	Research Contribution to the Public/ Study	222
7.4	Difficulties and Barriers Faced	223

7.5 Recommendations for Continuation Research	224
7.6 Conclusion for Overall Research Result	225

REFERENCES	226
Appendices	234

LIST OF TABLES

TABLE NO.	TITLE	PAGE
2. 1	Triple bottom line of sustainable development	17
2. 2	Summary of environmental building performance assessment methods	42
3. 1	Sustainable roof material's elements	138
4. 1	Sustainable Characteristic Matrix Checklist	144
4. 2	Ranking criteria (using Likert Method Scale)	144
5. 1	Employment Position	160
5. 2	Respondent's Gender	161
5. 3	Respondent's working experiences	162
5. 4	Respondent's Level of understanding on Sustainable Concept	164
5. 5	Roof covering materials	165
5. 6	Insulation Materials	167
5. 7	Roof truss	168
5. 8	Roof underlays	169
5. 9	Roof Drainage	170
5. 10	Sustainable Elements of Roof Covering	171
5. 11	Sustainable Elements of Roof Covering	172
5. 12	Sustainable Elements of Insulation Materials	176
5. 13	Comparison between sustainable characteristics from questionnaire analysis and catalogue's specification for Fiberglass insulation.	180
5. 14	Sustainable Elements of Roof Truss	181

5. 15	Comparison between sustainable characteristics from questionnaire analysis and catalogue's specification for Steel Roof Truss	185
5. 16	Sustainable Elements of Roof Underlays	186
5. 17	Comparison between sustainable characteristics from questionnaire analysis and catalogue's specification for Fiberglass roofing tissue	190
5. 18	Sustainable Elements of Roof Drainage	191
5. 19	Comparison between sustainable characteristics from questionnaire analysis and catalogue's specification for Aluminium roof drainage.	195
5. 20	Updated Sustainable Matrix Checklist	202
5. 21	Active responses respondent's opinion on suitability of matrix checklist usage	203
5. 22	Negative/passive responses respondent's opinion on suitability of matrix checklist usage	205

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
2. 1	Illustration energy performance of sustainable building	28
3. 1	Illustration of roof structure	73
3. 2	Pitched roof structure	77
3. 3	Lean to Roof	89
3. 4	Single roof structure	89
3. 5	Double Roof structure	90
3. 6	Timber and steel roof trusses	92
3. 7	Timber and concrete flat roofs	94
3. 8	Lead Flat Roofs	95
3. 9	Zinc and Copper Flat Roofs	96
3. 10	Sloping roof	98
3. 11	Northlight roof structure	101
3. 12	Northlight roof (side view)	101
3. 13	Northlight roof drawing	102
3. 14	Monitor roof	103
3. 15	Monitor roof (front view)	103
3. 16	Diagram of Portal Frame	104
3. 17	Span portal frame superstructure	104
3. 18	The TWA Flight Center Building - thin-shell structure	108
3. 19	Shell roof structure	108
3. 20	Folded plate slab	110
3. 21	Folded plate slab structure	111
3. 22	Grid structure roof illustration	111
3. 23	Main Railroad Station, Berlin, Germany	112

3. 24	Munich Olympic Stadium	113
3. 25	Extensive green roofs	115
3. 26	Typical extensive green roof	116
3. 27	Intensive green roofs	117
3. 28	Green roof in Europe	119
3. 29	Modified bitumen was field-coated	128
5. 1	Construction Roof Materials Life Cycle	156
5. 2	Respondent's Employment	161
5. 3	Respondent's Gender	162
5. 4	Respondent's working experiences	163
5. 5	Respondent's Level of understanding on Sustainable Concept	164
5. 6	Roof covering materials	166
5. 7	Insulation Materials	167
5. 8	Roof truss	168
5. 9	Roof underlays	169
5. 10	Roof Drainage	170
5. 11	Bar Chart of Sustainable Elements on Roof Covering	173
5. 12	Bar Chart Sustainable Elements on Insulation Material	178
5. 13	Bar Chart Sustainable Elements on Roof Truss	183
5. 14	Bar Chart Sustainable Elements on Roof Underlays	188
5. 15	Bar Chart Sustainable Elements on Roof Drainage	193
5. 16	Roof clay tile	196
5. 17	Fiberglass Insulation Material	197
5. 18	Steel Roof Truss	198
5. 19	Fiberglass Roofing Tissues	199
5. 20	Aluminium Roof Drainage	201
5. 21	Active responses respondent's opinion on suitability of matrix checklist usage	206

CHAPTER 1

INTRODUCTION

1.1 General Background

Construction sector has an important role to play in delivering sustainable development. The sustainable development is the initiative to meet the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland, 1987). This response to sustainable development helps to minimise the negative environmental impact of buildings performance. The construction building is achievable by enhancing efficiency and moderation in the use of sustainable materials (Kohler, 1999). The environmental impact of construction, green buildings, designing for recycling and eco-labeling of building materials have captured the attention of building professionals across the world in responding to sustainable development (Rees et. al, 1999). Thus far, from these initiatives of sustainable development the Environmental Building Assessment (EBA) has emerged as one of the major issues in order to build up the sustainable construction (Hudson et. al, 2000).

The emergence and evolution of EBA responds to a tension between the desire for objective, scientifically rigorous and stringent performance criteria with the desire

for practical, transparent, simple to understand criteria that ask the industry to respond to manageable step changes in practice. EBA methods were conceived as being voluntary and motivational in their application and their current success can be either taken as a measure of how proactive the building industry is in creating positive change or its responsiveness to market demand. However, public authorities are increasingly using market-based tools as a basis for specifying a minimum environmental performance level for their building (Raymond et. al, 1990).

An initiative of EBA has been put into the ideas of green building development. The green building brings together a vast array of practices and techniques to reduce and ultimately eliminate the impacts of buildings on the environment and human health. But effective green buildings are more than just a random collection of environmental friendly technologies. They require careful, systematic attention to the full life cycle impacts of the resources embodied in the building and to the resource consumption and pollution emissions over the buildings complete life cycle.

Responses to sustainable development can be applied through sustainable building. By using selected sustainable materials whenever possible, the sustainable building will make a significant contribution to its overall impact on the environment. As the results it will provide the healthy living of the occupants of the building.

The characteristics of sustainable materials must be non-toxic, recycled and recyclable, renewable, local, standard sizes, modular, pre-cut (reduces waste), certified wood, durable and long lasting and etc. BREEAM, NABERS, Green Star, LEED, HK-BEAM and Eco-specifier are assessment tool that identified the classification of sustainable materials applied to the building.

The shift from 'green building' to 'sustainable building' entails a number of great challenges and opportunities for the developers and users of planning and building assessment tools. The current assumption is that a new generation of building assessment tools is required to meet the current and forthcoming requirements associated with the description and assessment of each building's contribution to sustainable development. Based on the available building assessment tools it can classify and give some ideas of sustainable characteristics for construction roof materials in this study in order to create an eco-labeling for sustainable roof materials.

1.2 Problem Statement

Building in Malaysia, currently had no permanent identification of sustainable building. Malaysian building development currently using Uniform Building by Law (UBBL) as a guideline, whilst as compared to European Union, they have their Green Building Program and Energy Efficiency Program. Lack of sustainable building identification in Malaysia led to poor building design that resulted inefficiency of energy and material usage. Material used and resources selection are importance in sustainable building, thus it will reduce habitat destruction and control depletion of natural resources. By building labeling, the way to construct the building will response to

sustainable site development, water efficiency, energy efficiency, indoor environmental quality and directly helps to reduce global warming. The materials with specific characteristics such as durable, comfortable and environmental friendly are the key variables of high performance of sustainable building efforts.

Malaysia need to develop its own building assessment, aiming essentially at accelerating the adoption of green building practices by the building sector concerned (Yeoh, 2005). Building materials in Malaysia are various types. This research, therefore, will conduct an eco-labeling for roof materials. It is led to identify the sustainable characteristics/ properties/ eco-friendly of roof are suitable used for a building. This labeling identification then will helps in future development of sustainable building assessment for Malaysia. This research will encourage the building stakeholders involve in building development seriously and take part using sustainable label which it additionally also enhance awareness and knowledge of Malaysian citizen on sustainable building.

This research focused on roof due to it is an important part of the building and plays a major role in providing a shelter and at the same time concern about the building envelope and energy. The building envelope is the separation between the interior and the exterior environments of a building. It serves as the outer shell to protect the indoor environment as well as to facilitate its climate control. The design of the supporting structure will be governed by the shape and geometry and the layout of the structural system for the building, the climatic conditions and the site environment and so on. The roof, insulation, and ventilation must all work together to keep the building free of moisture and provide protection from the heat. The roof design of a building can impact the buildings thermal insulation which is an important factor to achieving thermal comfort for its occupants. Insulation reduces unwanted heat loss or gain and can decrease the energy demands of heating and cooling systems. It related to the issues of adequate ventilation and the level of sound insulation (Wikipedia, 2008).

There are a few numbers of roofing choices available for high-performance buildings such as new roof shingles on the market today, which have produced electricity using solar technology. The building performances are more refer to the breathable qualities which endow with vapour permeability, hygroscopicity and capillarity in order to avoid interfaces. It allowed moisture or thermal conflict emerges, and to spread moisture load away from vulnerable area (Padfield, 1999). Roof technology also has reflective roofing materials or coatings that can help send the heat back into the sky rather than into the building. In the design of the building, roofing materials should be integrated into the whole-building design where sustainable identification has been put into consideration. So, the building construction's materials has an important role to play in delivering sustainable living which reflects to social, economic and environmental reasons (Brudtland, 1987).

1.3 Aim of the Research

The aim of this research is to classify sustainable characteristics/ eco-friendly elements of roof materials which can be used to develop the matrix checklist of sustainable roof materials.

1.4 Objective of the Research

The goal of the research is to achieve objectives listed below:

1. To identify the importance of the Sustainable Building (SB).
2. To identify the application of sustainable building assessment.
3. To develop the sustainable characteristics/eco-friendly elements of roof materials and produce the matrix checklists in order to identify sustainable roof materials.

1.5 Scope of the Study

The limitation of this research is focusing on roof materials included insulation materials that are suitable for the Malaysian climate. Type of roof system that will be analysed is focusing on steep slope roof system. This type of roof are common roof structures used in Malaysia, which is including five main parts which are; the (i) roof covering, (ii) roof insulation, (iii) roof underlays, (iv) roof trusses and (v) roof drainage. The identification of sustainable elements of roof materials identified using content analysis from journals and observation through the roof material catalogue's specification. The sustainable matrix checklist is developed and then distributed to various parties participate in Malaysian construction industry.

1.6 Importance of Study

The results from this study can be a guidance and reference sources to all parties involved in the construction industry such as architect, contractors and clients which need to consider the sustainable characteristics/ eco-friendly elements to construct the building. Sustainable characteristics/ eco-friendly roof also can give comfort to the occupants and protect the environment from the pollution, shelter from the rain and rainwater collection for domestic use, shade from the sun and UV protection, skylights for daylighting deep within buildings, surface for energy collection, solar hot water and photovoltaic. Roof form can be designed to minimise wind turbulence, wind driven stack ventilation, thermal and environmental barrier. Roof provides space for the most important insulation (Green Building Press, 2007).

1.7 Overview of Research Methodology

The research methodology are created to draft the necessary planning which should be done systematically to complete this research until achieve the determined objectives. The planning is very importance to make sure the smooth work while collecting and analyse the data for this research. Besides that, it is also can save a lot of time and cost. This methodology consists of four stages:

1.7.1 Initial Stage

a) Initial discussion

The initial discussion carried out the overview on issues related to this study. This discussion done using a brainstorming meeting and exchanging ideas within supervisors and others professional related parties.

b) Literature review

In this literature review, discussion covered the definition of the Sustainable Development (SD), Sustainable Building (SB), Sustainable Materials, Eco-labeling materials and the roof part structures. It is also discussed about the available Sustainable Building Assessment as the tools to assess the implementation of eco-labeling scheme for construction materials. The literature review will be captured through books, journals and previous thesis from Perpustakaan Sultanah Zanariah (PSZ) and various online sources.

1.7.2 Second Stage- identifying and collecting data.

In this stage the study will involves the process of collecting information. The important data that helps to achieve the objectives of this research are divided into two categories which are primer data and secondary data.

i. Primer data

The sources of primary data are from construction roof material suppliers, manufacturers and also the developers. The primary data will be gained by distributing the proposed sustainable matrix checklist. It is very important to know the ideas and opinion about the roof properties and also observation from the catalogue of construction material products of roof materials and structure.

ii. Secondary data

The secondary data will be collected by browsing websites and database to get understanding and information about the sustainability concept, foreign environmental building assessment, roof system and materials.

1.7.3 Third Stage – Analyse, commentary and summarise the data

In this stage, the data or information collected from stage one and two will be compiled and summarised to develop the research findings. The data collected are analysed using the qualitative method (content analysis technique) and also quantitative method (calculated by SPSS 11.5 software and Microsoft Excel XP 2003). An analysis for every type of construction roof's materials will be produced in final sustainable matrix checklist. This final sustainable matrix checklist will present precisely the characteristics/ eco-friendly elements of sustainable roof materials.

1.7.4 Final Stage – Research’s findings writing

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 objectives.

1.8 Expected Findings

The first expected findings is to list out the importance of sustainable building. By identifying what is the importance of sustainable building, this will helps the researcher to identify the elements of sustainable roof materials. The element identification can be done by referring to other advanced countries which have their own labeling scheme such as LEED and BREEAM. These elements should cover economy of resource, durability, comfort and environmental design.

Then the second expected finding is to identify the application of sustainable building assessment. This data collection can be collect based on the observation and understanding of the available foreign sustainable building assessment such as LEED, NABERS, BREEAM, ECO-SPECIFIERS and GREENSTAR assessment method.