

ENERGY AWARENESS AND ENERGY-USE BEHAVIOUR OF STUDENTS IN
MALAYSIAN UNIVERSITY

NG SOCK YEN

UNIVERSITI TEKNOLOGI MALAYSIA

ENERGY AWARENESS AND ENERGY-USE BEHAVIOUR OF STUDENTS IN
MALAYSIAN UNIVERSITY

NG SOCK YEN

A thesis submitted in fulfillment of the
requirements for the award of the degree of
Master of Science (Facilities Management)

Faculty of Geoinformation and Real Estate
Universiti Teknologi Malaysia

AUGUST 2012

To my dearest dad, mum, sister, brother and friends

ACKNOWLEDGEMENT

As a result of the completion of this research, I wish to take this opportunity to express my warmest and sincere gratitude to my supervisor, Dr. Choong Weng Wai who has always been so encouraging throughout the completion of this project. I am so thankful for his commitment and his guidance in contributing towards my understanding and thoughts. Without his sincere motivation and guidance I might not be able to finish this project.

Nevertheless, I would also like to take this opportunity to extend my gratitude to my beloved parents, sister, brother, friends who are my pillar of hope and strength. Thank you for being there whenever I need assistance and moral support. Your endless love, sacrifices and encouragement has made me a stronger person, thank you.

I also intend to express my gratitude to all respondents who had participated, who were willing to help and cooperate with me in making this thesis a success. Their feedbacks and cooperation in providing sufficient and adequate information are much appreciated.

I must mention that there are many others, too numerous to mention by name here, who assisted me in various ways either providing ideas or morally supported me during the period of struggle in order to complete this project. Thank you very much.

ABSTRACT

The Malaysia Ministry of Education has urged all education centres to conserve energy. Energy wastage tends to happen in Malaysian university due to lack of energy awareness and inefficient use of energy among the students. Raising appropriate energy awareness and improving energy-use behaviour among students can improve the energy performance of university. However, we only can manage what we have measured. Therefore, without knowing the level of energy awareness and energy-use behaviour, it is difficult for the implementer to plan and to provide a better energy conservation programme. This research has three objectives. Firstly is to assess energy awareness among students in Malaysian University. Secondly is to assess energy-use behaviour of students in Malaysian University. Thirdly is to determine the relationship between energy awareness and energy-use behaviour. Questionnaire was developed based on previous related research, and submitted for expert verification. The refined questionnaires were distributed among five research universities, namely Universiti Teknologi Malaysia, Universiti Putra Malaysia, Universiti Kebangsaan Malaysia, Universiti Sains Malaysia, and Universiti Malaya. The total numbers of respondents are 2,000. The analysis was carried out by using frequency analysis, cross tabulation analysis and ANOVA. This study has established a sample of comprehensive energy awareness and energy-use behaviour survey questionnaire for students in Malaysian University. The results reveal that energy awareness and energy-use behaviour among students in Malaysian University are moderate. Also, the results indicate that higher level of energy awareness can be associated with better energy-use behaviour. It is suggested that in future research, a wider scope of respondents are needed, including academic staff and supporting staff.

ABSTRAK

Kementerian Pendidikan Malaysia menggalakkan semua institusi pendidikan untuk berjimat dalam penggunaan tenaga. Pembaziran tenaga biasanya berlaku di kalangan universiti di Malaysia kerana kekurangan kesedaran tentang tenaga dan pembaziran tenaga di kalangan mahasiswa. Peningkatan kesedaran tentang tenaga dan perilaku penggunaan tenaga yang cekap di kalangan mahasiswa boleh meningkatkan kecekapan tenaga di universiti. Namun begitu, kita hanya boleh mengurus apa yang kita dapat ukur. Oleh itu, tanpa pengetahuan tentang kesedaran tenaga dan perilaku penggunaan tenaga, ia akan menyukarkan program penjimatan tenaga untuk dilaksanakan. Kajian ini mempunyai tiga objektif. Pertama adalah mengkaji tentang kesedaran tenaga di kalangan mahasiswa universiti-universiti penyelidikan di Malaysia. Kedua adalah mengkaji tentang kesedaran perilaku penggunaan tenaga di kalangan mahasiswa universiti-universiti penyelidikan di Malaysia. Ketiga adalah untuk menentukan hubungan antara kesedaran tenaga dan perilaku penggunaan tenaga. Soal selidik dibangun berdasarkan kajian lepas yang berkaitan, dan diserahkan kepada pakar-pakar untuk pengesahan. Soal selidik yang disahkan diedarkan kepada lima universiti penyelidikan dan jumlah responden adalah sebanyak 2,000. Kaedah analisis yang digunakan adalah taburan frekuensi, analisis tabulasi silang dan varians satu arah. Kajian ini telah menghasilkan satu sampel soal selidik yang komprehensif tentang kesedaran tenaga dan perilaku penggunaan tenaga di kalangan mahasiswa di universiti-universiti Malaysia. Hasil kajian menunjukkan bahawa kesedaran tentang tenaga dan kelakuan penggunaan tenaga di kalangan mahasiswa-mahasiswa dari universiti-universiti di Malaysia adalah pada tahap sederhana. Selain itu, keputusan juga menunjukkan bahawa tahap kesedaran tenaga yang lebih tinggi boleh dikaitkan dengan tahap kelakuan penggunaan tenaga yang lebih baik. Adalah dicadangkan penyelidikan masa depan merangkumi skop responden yang lebih meluas, termasuk staf akademik dan staf sokongan.

TABLE OF CONTENTS

CHAPTER	CONTENTS	PAGE
	TITLE	i
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	ABSTRAK	vi
	TABLE OF CONTENTS	vii
	LIST OF FIGURES	xv
	LIST OF TABLES	xviii
	LIST OF ABBREVIATIONS	xx
	LIST OF APPENDICES	xxi
1.0	INTRODUCTION	1
	1.1 Introduction	1
	1.2 Problem Statement	1
	1.3 Research Objectives	7
	1.4 Scope of Study	7
	1.5 Significance of Study	7
	1.6 Research Methodology	9
	1.7 Layout of Chapters	11

2.0	LITERATURE REVIEW	13
2.1	Introduction	13
2.2	Definition of Energy	13
2.3	Definition of Energy Conservation	14
2.4	Definition of Energy-use Behaviour	14
2.5	Energy Efficiency	14
2.6	Energy Management	15
2.6.1	Structural Energy Conservation Method	16
2.6.2	Non-Structural Energy Conservation Method	17
2.7	Scholarly Review	19
2.8	Common Electrical Appliances in University	23
2.9	Summary	27
3.0	RESEARCH METHODOLOGY	29
3.1	Introduction	29
3.2	Research Flow Chart	29
3.3	Stage I: Background of Study	32
3.4	Stage II: Literature Review	32
3.5	Stage III: Energy Awareness and Energy-use Behaviour Questionnaire Development	33
3.5.1	Questionnaire Designation	33
3.5.2	Expert Review	35
3.5.3	Pilot Study	41
3.5.4	Improved Questionnaire	42
3.6	Stage IV: Energy Awareness and Energy-use Behaviour Assessment	42
3.6.1	Survey Method	42
3.6.2	Sampling	43

3.6.3	Method of Data Analysis	44
3.7	Summary	47
4.0	ENERGY AWARENESS OF STUDENTS IN MALAYSIAN UNIVERSITY	48
4.1	Introduction	48
4.2	Respondent Background Analysis	48
4.2.1	Respondent's Profile According to Gender	49
4.2.2	Respondents' Profile According to Age	49
4.2.3	Respondents' Profile According to Education Level	50
4.2.4	Respondents' Profile According to CGPA	51
4.2.5	Respondents' Profile According to Nationality	52
4.2.6	Respondents' Profile According to Staying at Hostel	53
4.2.7	Respondents' Profile According to University	53
4.3	Results of Respondents' Energy Awareness	54
4.3.1	Awareness of the Average Electricity Rate for Domestic Residential Usage in Malaysia	54
4.3.2	Awareness of the Current Price of Petrol (RON 95) in Malaysia	55
4.3.3	Awareness of the Primary Resource for Generating Electricity in Malaysia	56
4.3.4	Awareness of the Highest Energy Consumption/Usage in Malaysia	57
4.3.5	Awareness of Degree of Acceptable Comfort Temperature in Malaysia	58
4.3.6	Awareness of the Meaning of the Term "Phantom Load"	59

4.3.7	Awareness of the Percentage of Reduction in Carbon Dioxide Emissions was Promised by our Prime Minister with the Board during the United Nations Framework Convention on Climate Change 2009.	60
4.3.8	Awareness of Computer Efficient	61
4.3.9	Awareness of Laptop is More Efficient in Comparing with Desktop	62
4.3.10	Awareness of the Type of Efficient Artificial Lighting	63
4.3.11	Awareness of Release of CO ₂ When Consumption of 1MWh of Electricity	64
4.3.12	Awareness of Turning On/Off Too Frequent Would Damage the Electrical Appliances	65
4.3.13	Awareness of Component of Desktop that Consumes Energy the Most	66
4.3.14	Awareness of Efficiency of Operating Washing Machine	67
4.3.15	Awareness of Lighting Efficiency	68
4.3.16	Awareness of Energy Consumption between Steam Iron and Dry Iron	69
4.3.17	Awareness of Air Conditioning System	70
4.3.18	Awareness of TV or Monitor Screen	71
4.3.19	Awareness of Refrigerator	72
4.3.20	Awareness of Charging Mobile Phone	73
4.3.21	Awareness of Negative Impacts on the Environment Caused by High Energy Use	74
4.3.22	Energy Awareness of Students in Malaysian University	75
4.4	Summary	76

5.0	ENERGY-USE BEHAVIOUR OF STUDENTS IN MALAYSIAN UNIVERSITY	77
5.1	Introduction	77
5.2	Respondents' Energy-use Behaviour	77
5.2.1	Energy-use Behaviour of Turn off Computer	78
5.2.2	Energy-use Behaviour of Adjust the Temperature of Air Conditioner	78
5.2.3	Energy-use Behaviour of Raise the Temperature to Reduce the Over Cooling	79
5.2.4	Energy-use Behaviour of Turn Off the Lights When Daylight is Available	80
5.2.5	Energy-use Behaviour of Set the Computer to Hibernate Mode After 10 Minutes of Inactivity Automatically	81
5.2.6	Energy-use Behaviour of Turn Off the Lights and Fans When Leave the Room for About Ten Minutes	82
5.2.7	Energy-use Behaviour of Consider the Energy Efficiency Label When Purchasing an Electrical Appliances	83
5.2.8	Energy-use Behaviour of Close the Doors and Windows When Turn On Air Conditioning System	84
5.2.9	Energy-use Behaviour of Turn the Television or Video into Standby Mode When Leaving	85
5.2.10	Energy-use Behaviour to Turn Off the Corridor's Light During Day Time	86
5.2.11	Energy-use Behaviour of Unplug Mobile Phone When it is Fully Charge	87

5.2.12	Energy-use Behaviour of Operate Washing Machine	88
5.2.13	Share with Friends on Energy Savings Knowledge Tips	89
5.2.14	Energy-use Behaviour of Buy Energy Efficiency Electrical Appliances Even if it is Slightly More Expensive	90
5.2.15	Energy-use Behaviour of Students in Malaysian University	91
5.3	Summary	92
6.0	RELATIONSHIP BETWEEN ENERGY AWARENESS AND ENERGY-USE BEHAVIOUR OF STUDENTS IN MALAYSIAN UNIVERSITIES	93
6.1	Introduction	93
6.2	Determine the Differences between Respondents' Profiles of Energy Awareness	93
6.2.1	Respondents' Energy Awareness as According to Gender	94
6.2.2	Respondents' Energy Awareness According to GPA	95
6.2.3	Respondents' Energy Awareness According to University	96
6.3	Respondents' Energy-use Behaviour According to Respondents' Profile	97
6.3.1	Respondents' Energy-use Behaviour According to Gender	97
6.3.2	Respondents' Energy-use Behaviour According to Current GPA	98

6.3.3	Respondents' Energy-use Behaviour According to University	99
6.4	Classify Respondents' Energy Awareness and Energy-use Behaviour	100
6.4.1	Cross Tabulation: Acceptable Comfort Temperature and Adjust the Temperature to Maintain Comfort	101
6.4.2	Cross Tabulation: Computer Saving and Set the Computer to Hibernate Mode	102
6.4.3	Cross Tabulation: Turn off the Lights and Fans When Leave the Room for About 10 Minutes	104
6.4.4	Cross Tabulation: Close the Doors and Windows When You Turn On the Air Conditioning System	105
6.4.5	Cross Tabulation: Turn the Television or Video into Standby Mode When Leaving	107
6.4.6	Cross Tabulation: Energy Awareness and Energy-use Behaviour about Charging Mobile Phone	108
6.4.7	Cross Tabulation: Energy Awareness and Energy-use Behaviour about Washing Machine	110
6.5	Comparison of Self-evaluating and Peers Evaluating of Energy-use Behaviour	111
6.6	Summary	112
7.0	CONCLUSION AND RECOMMENDATION	113
7.1	Introduction	113
7.2	Achievements of Research Objectives	113
7.2.1	Objective One: To Assess Energy Awareness of Students in Malaysian Universities.	114
7.2.2	Objective Two: To Assess Energy-use Behaviour of Students in Malaysian Universities	115

7.2.3	Objective Three: To Determine the Relationship Between Energy Awareness and Energy-use Behaviour	117
7.3	Limitations of Study	118
7.4	Recommendations for Further Studies	118
REFERENCES		120

LIST OF FIGURES

FIGURE	TITLE	PAGE
1.1	Flow Chart of Research Stage	10
3.1	Research Flow	30
4.1	Respondents' Profile According to Gender	49
4.2	Respondent's Profile According to Age	50
4.3	Respondents' Profile According to Education Level	51
4.4	Respondents' Profile According to CGPA	52
4.5	Respondents' Profile According to Nationality	52
4.6	Respondents' Profile According to Hostel	53
4.7	Respondents' Profile According to University	54
4.8	Awareness of Average Electricity Rate for Domestic Residential Usage in Malaysia	55
4.9	Awareness of the Current Price of Petrol (RON 95) in Malaysia	56
4.10	Awareness of the Primary Resource for Generating Electricity in Malaysia	57
4.11	Awareness of Energy Consumption in Malaysia	58
4.12	Awareness of Degree of Comfort Temperature in Malaysia	59
4.13	Awareness of Meaning of the Term "Phantom Load"	60
4.14	Awareness of Percentage of Reduction in Carbon Dioxide Promised by Prime Minister	61

FIGURE	TITLE	PAGE
4.15	Awareness of Computer Efficient	62
4.16	Awareness of Laptop is More Efficient in Comparing with Desktop	63
4.17	Awareness of the Type of Efficient Artificial Lighting	64
4.18	Awareness of Release of CO ₂ When Consumption of 1MWh of Electricity	65
4.19	Awareness of Turning On/Off Too Frequent Would Damage the Electrical Appliances	66
4.20	Awareness of Component of Desktop that Consumes Energy the Most	67
4.21	Awareness of Efficiency of Operating Washing Machine	68
4.22	Awareness of Lighting Efficiency	69
4.23	Awareness of Energy Consumption between Steam Iron and Dry Iron	70
4.24	Awareness of Air Conditioning System	71
4.25	Awareness of TV or Monitor Screen	72
4.26	Awareness of Refrigerator	73
4.27	Awareness of Charging Mobile Phone	74
4.28	Awareness of Negative Impacts on the Environment Caused by High Energy Use	75
4.29	Total Score of Respondent's Energy Awareness	76
5.1	Energy-use Behaviour of Turn off Computer	78
5.2	Energy-use Behaviour of Adjust the Temperature of Air Conditioner	79
5.3	Energy-use Behaviour of Raise the Temperature to Reduce the Over Cooling	80
5.4	Energy-use Behaviour of Turn Off the Lights When Daylight is Available	81

FIGURE	TITLE	PAGE
5.5	Energy-use Behaviour of Set the Computer to Hibernate Mode After 10 Minutes of Inactivity Automatically	82
5.6	Energy-use Behaviour of Turn Off the Lights and Fans When Leave the Room for About Ten Minutes	83
5.7	Energy-use Behaviour of Consider the Energy Efficiency Label When Purchasing an Electrical Appliances	84
5.8	Energy-use Behaviour of Close the Doors and Windows When Turn On Air Conditioning System	85
5.9	Energy-use Behaviour of Turn the Television or Video into Standby Mode When Leaving	86
5.10	Energy-use Behaviour to Turn Off the Corridor's Light During Day Time	87
5.11	Energy-use Behaviour of Unplug Mobile Phone When it is Fully Charge	88
5.12	Energy-use Behaviour of Operate Washing Machine	89
5.13	Share with Friends on Energy Savings Knowledge Tips	90
5.14	Energy-use Behaviour of Buy Energy Efficiency Electrical Appliances Even if it is Slightly More Expensive	91
5.15	Total Score of Respondent's Energy-use Behaviour	92
6.1	Comparison of Self-Evaluating and Peers Evaluating of Energy-use Behaviour	112

LIST OF TABLE

TABLE	TITLE	PAGE
2.1	Common Electrical Appliances in University	23
3.1	Experts' Review for the Respondents' Background	37
3.2	Experts' Review for the Respondents' Energy Awareness	38
3.3	Experts' Review for the Respondents' Energy-use Behaviour	40
3.4	Experts' Review for the Respondents' Opinion	41
6.1	Descriptive analysis of Gender	94
6.2	ANOVA of Gender	94
6.3	Descriptive analysis of CGPA	95
6.4	ANOVA of CGPA	95
6.5	Descriptive analysis of University	96
6.6	ANOVA of University	96
6.7	Descriptive Analysis of Gender	97
6.8	ANOVA of Gender	98
6.9	Descriptive Analysis of CGPA	99
6.10	ANOVA of CGPA	99
6.11	Descriptive analysis of University	100
6.12	ANOVA of University	100

TABLE	TITLE	PAGE
6.13	Cross Tabulation: Energy Awareness and Energy-use Behaviour about Air Conditional System	101
6.14	Air Conditional System: Chi Square Test	102
6.15	Cross Tabulation: Energy Awareness and Energy-use Behaviour about Computer Saving When Away	103
6.16	Computer Saving: Chi Square Test	103
6.17	Cross Tabulation: Energy Awareness and Energy-use Behaviour about Lighting	104
6.18	Lighting: Chi Square Test	105
6.19	Cross Tabulation: Energy Awareness and Energy-use Behaviour about Air Conditioning System	106
6.20	Air Conditional System: Chi Square Test	106
6.21	Cross Tabulation: Energy Awareness and Energy-use Behaviour about Television and Video	107
6.22	Television and Video: Chi Square Test	108
6.23	Cross Tabulation: Energy Awareness and Energy-use Behaviour about Charging Mobile Phone	109
6.24	Mobile Phone: Chi Square Test	109
6.25	Cross Tabulation: Energy Awareness and Energy-use Behaviour about Washing Machine	110
6.26	Washing Machine: Chi Square Test	111

LIST OF ABBREVIATIONS

CAFM	Computer Aided Facilities Management
CMEADP	Conceptual Model of Energy Awareness Development Process
CO ₂	Carbon Dioxide
CPU	Central Processing Unit
GDP	Gross Domestic Product
HVAC	Heating, Ventilation and Air Conditioning
IT	Information Technology
MIEEIP	Malaysia Industrial Energy Efficiency Improvement Project
O&M	Operations and maintenance
QS	Quacquarelli Symonds
UKM	Universiti Kebangsaan Malaysia
UM	Universiti Malaya
UPM	Universiti Putra Malaysia
USM	Universiti Sains Malaysia
UTM	Universiti Teknologi Malaysia

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix A	Questionnaire	127
Appendix B	SPSS Results	135

CHAPTER 1

INTRODUCTION

1.1 Introduction

Energy is the capacity of a physical system to perform work. It exists in the form of heat, kinetic or mechanical energy, light, potential energy, electrical, and other forms. Energy plays an important role in our daily routine. As a result of the rapid economic growth in the past, the usage of electrical for the last two decades has increased rapidly in Malaysia. Those who live in developed countries take energy very much for granted whereas the energy wastage issues arise continuously. This might be due to lack of awareness of the importance of energy and lack of appropriate energy-use behaviour.

1.2 Problem Statement

Brundtland report (1987) by the World Commission defined sustainable development as a development that meets the needs of the present without compromising the ability of future generation to meet their own needs. The world is now taking a prominent concentration on the sustainable issues, notably the energy sustainability issues. Malaysia has shown its commitment on sustainable issues by

signing 26 principles of the Stockholm Declaration and action Plan since 1971 (Hezri and Mohd Nordin, 2006). Through embracing the sustainable concept, the government has given a great attention to the call of Agenda 21 which emphasizes on the development of tool for sustainable development. Sustainable energy use specifically, has been considered as potential indicators for inclusion of sustainable development indicators for Malaysia developed of the EPU's consideration (LESTARI, 1999). As Omer (2008) substantiate, buildings are responsible for approximately 40% of the total world annual energy consumption. To maintain the sustainability of energy, Omer (2008) suggested that it is desirable to reduce energy consumption and to reduce the rate of depletion of world energy reserves and pollution of the environment.

Since the oil crisis in the 1970s, energy conservation and secure of energy supply has become a global concern (Gardner and Stern, 2002). Many countries are figuring on how to focus on new and sustainable sources of energy. Among the most effective ways to achieve a sustainable energy development is through energy conservation as it can extend the time in order for the world to resolve the energy issues.

Energy conservation is any deliberate action taken to reduce energy consumption such as avoiding use, finding alternative uses which require less energy, reducing dependence on the more costly less available sources, developing and utilizing more efficient energy using devices and processes (Hall and Hinman, 1983).

The usage of energy will be lesser if societal demand for energy can be reduced or if growth in demand can be slowed down. Energy usage is expected to increase rapidly in the 21st century, as mainly due to the expansion of the economies of developing nation (Lincoln, 2006). This makes energy conservation an important part of the debate over climate change and the replacement of non-renewable resources with the renewable energy sources. Energy conservation among consumers is often advocated as a cheaper or more environmentally sensitive alternative to increase energy production. Through implementation of the energy conservation, energy consumption and energy demand per capita will be reduced and thus offsets some of the growth in energy supply which needed to keep up with

population growth. This reduces the rise in energy costs, and the need for new power plants and energy imports. The reduction of energy demand provides more flexibility in choosing the most preferred methods of energy production.

Energy conservation can be achieved through proper energy management. What is energy management? Kennedy and Turner (1984) defined that energy management is “the judicious and effective use of energy to maximize profits or minimize costs and enhance competitive positions”. This definition is also agreed by Thumann and Metha (1997) which defined energy management as the effective use of energy to maximize profits and to enhance competitive positions.

Malaysia Industrial Energy Efficiency Improvement Project (MIEEIP) (2006) states that “Energy management is an activity to optimize the use of energy by avoiding waste of energy”. Energy management is essential to ensure the efficiency of energy used, reduce energy cost and improve environmental quality. Energy management activity will not percolate to industries unless senior business executives are convinced with the potential of energy management in real terms. Sensitization of senior executives and government administrations through training programmes and awareness programmes can only improve the commitment for energy conservation and management. Energy management is needed more in the developing countries since they need more energy to increase Gross Domestic Product (GDP) compared to the developed countries. Energy wastage and inefficient energy-use are major environment problems that need more attention compared to energy generation (Bowonder, 1984).

Technology approach and behavioural approach are two common ways in energy management (Mohon *et.al.*, 1983). These two approaches are also known as structural and non-structural energy conservation methods. Al-Mofleh *et.al.* (2009) explains the two methods is electrical energy conservation in Malaysia by the integration of three tools: (1) Use of more efficiency electrical equipment; (2) Application of passive energy technology in buildings, such as insulation, evaporative cooling, ventilation and solar heating; (3) Supportive tools such as public awareness, energy codes, regulations, energy information and databases. The use of more efficiency electrical equipment and application of passive technology in

buildings are categorized as structural energy management whereas supportive tools such as public awareness, energy codes, regulation, etc are termed as non-structural energy conservation method.

Technology fixed is an instrumentation based by using tools or technology to conserve energy. These include the introduction of new processes, change to automation systems, or installation of large energy-saving devices such as heat recovery systems, new building designs, inverter, pre-heater, motion sensor, building envelope systems and etc. Basically, the structural energy conservation method can be divided into three types: (1) use of technology in generating energy; (2) use of technology in improving energy efficiency and (3) use of technology in managing and monitoring energy usage. However, the technological approach refers to the application of technology instrumentations which normally involve the large-scale of investment and the initial cost of technological approach is high and not suitable for an organization which has a limited budget. Furthermore, the technological approach can conserve the energy effectively and yet does not mean that it has any behavioural changes among the users. In this case, it means that users still continue to waste energy.

A sustainable future cannot be secured by relying only on the structural energy conservation methods, the non-structural energy conservation method must be taken into consideration as well. Non-structural energy conservation method include: (1) integrating energy conservation concept in the management and co-curriculum and (2) improving energy awareness and energy-use behaviour among users.

The Malaysia Ministry of Education has started to urge all education centers to save energy (The Star, September 13, 2007) as the expensive monthly electrical utilities bill has become the major concern of many parties in universities. In order to create the energy awareness among students, improving energy awareness and energy-use behaviour in universities is one of the non-structural energy conservation methods. According to Mat et.al. (2009), sustainability and energy management becomes concerns in universities communities since universities have a large number of population and facilities. "Behaviour" is defined as "the totality of intra and extra

organism actions and interactions of an organism with its physical and social environment (Wolman, 1973).” In term of behavioural approach, attitudes, knowledge, awareness, and skills can tremendously help in energy conservation (Vesma, 2002).

Awareness is the seed for tomorrow changes (Wong, 1997). This point had been supported by Yik *et. al* (2002) whom commented that knowledge is the key barriers for the improvement of energy efficiency in existing building. This statement is strongly supported by Choong (2009) which defined that the lack of awareness is the reason of energy inefficiency. Therefore, awareness plays an important role in changing the behaviour among students in Universities. Awareness helps to change attitudes, thus encouraging students to seek the ways for saving energy and also changes their behaviours, making sure they continue to use and maintain energy saving equipment even after it has been installed. Savings in energy consumption worth millions of dollars may be realized through public conservation campaigns that raise consumers’ awareness of the financial and environmental impact of wasteful practices (Mahmoud, 2010).

Energy awareness and energy-use behaviour helps to increase the persistence of energy-savings projects so that university can continue to reap savings year by year. The initial savings from such savings provide the seed money for higher-cost energy saving investment (Energy Technology Bulletin, 2009).

Energy awareness and energy-use behaviour among consumers is very important. Building can be designed with advance green technology features but if lack of end user energy awareness and energy-use behaviour, the building would not operate efficiently and would waste energy. Most operators do not have sense of energy management due to the lack of energy awareness and commitment indeed (Steve Anthony Lojuntion, 2009). According to Muhildeen (2008), student’ behaviour is the major contributor to large amount of energy wastage in the highest learning institution. However, Malaysian Universities is large and involving a huge numbers of students.

A Conceptual Model of Energy Awareness Development Process (CMEADP) has been proposed by Choong (2009) to raise energy awareness and improve energy-use behaviour among students and staffs in university. The initial step in Conceptual Model of Energy Awareness Development Process (CMEADP) proposed by Choong (2009) was to assess receivers' existing energy awareness and energy-use behaviour. However, the energy awareness and energy-use behaviour measurement attributes for the model is absent and has not been proposed.

Having energy awareness and energy-use behaviour is the first step beyond other energy conservation strategies. One of the most successful means of motivating employees is through awareness. However, energy awareness and energy-use behaviour among the students is abstract and has not been explored. We do not know how high the level of energy awareness and energy-use behaviour among the students in Malaysian Universities for we can only manage what we measure. Without knowing the level of energy awareness and energy-use behaviour, we cannot provide the better energy conservation program. According to Energy Technology Bulletin (2009), the way to measure an awareness program's effectiveness is to develop a set of subjective assessment criteria to gauge changes in users' energy habits.

It seems that energy awareness has a close relationship with energy-use behaviour. It is important to measure them together and reveal their relationship so that we can manage it and we can keep track on management goal.

The research questions formulated for this study are:

- i. What is the level of energy awareness among students in Malaysian University?
- ii. What is the level of energy-use behaviour among students in Malaysian University?
- iii. Are there any relationship between energy awareness and energy-use behaviour?

1.3 Research Objectives

The objectives of the research:

- i. To assess energy awareness of students in Malaysian University.
- ii. To assess energy-use behaviour of students in Malaysian University.
- iii. To determine the relationship between energy awareness and energy-use behaviour.

1.4 Scope of Study

This research is focused on the energy awareness and energy-use behaviour among the students in Malaysian Public Universities. Five research universities were selected as a sample for this research which is Universiti Teknologi Malaysia (UTM), Universiti Malaya (UM), Universiti Sains Malaysia (USM), Universiti Kebangsaan Malaysia (UKM) and Universiti Putra Malaysia (UPM). According to research done by Quacquarelli Symonds (QS) Asian University Ranking for the ranks of Universities in Asian, those selected universities were in the highest rank among all Universities in Malaysia.

1.5 Significance of Study

Recently, energy wastage is serious in university. This research is to assess energy awareness and energy-use behaviour among the students in Malaysian University. Better understanding on energy awareness and energy-use behaviour can lead them to a better success of energy management efforts. It can encourage the

students in university to conserve energy and enhance university energy efficiency. In this case, students can contribute to simple cost-cutting measures such as switching off the lights and shutting down the computer when not in use etc. Through changing students' energy-use behaviour, university will reduce the dependency on technology base and the technology cost to conserve energy.

However, to provide an appropriate energy conservation and energy awareness program, the management needs to know the level of energy awareness and the reason of students did not save energy. By doing this, it is able to provide useful information to enhance the whole energy conservation program. This research would serve as a guideline for the universities so that they can assess the level of energy awareness and energy-use behaviour among the students in Malaysian University.

Awareness is the essential foundation for any energy management program. It is the first step ahead among other efforts. However, the energy awareness and energy-use behaviour among students in Malaysian University is still unknown. One of the reasons due to the energy awareness and energy-use behaviour measurement attributes is not being implemented widely among students. Therefore, this research will contribute some value to the current academic and knowledge in the content of developing a sample of energy awareness and energy-use behaviour measurement techniques.

This research provides useful information to the facilities management professional in contributing to the successful of energy management program. In addition, this research also provides a guideline for the facilities managers to re-evaluate and improve their existing energy management program. This research will enhance the energy conservation behavioural model for facilities managers to influence the students in university to conserve energy. Through determining the relationship between energy awareness and energy-use behaviour, researcher will be able to implement the effective measures of the energy conservation.

1.6 Research Methodology

The methodology of this research consisted of four stages. In stage I, research objectives were obtained from the problem statement. Significant and scope of the study were also identified in this stage.

For the theoretical study in stage II, a series of literature review on theoretical part was carried out. The review of the structural and non-structural energy management methods, importance of measuring attributes, energy awareness and energy-use behaviour measurement were collected from literature review.

In stage III, based on literature review, energy awareness and energy-use behaviour measurement attributes questionnaire was developed. The developed questionnaire was sent to the experts for verifications. An interview was conducted with five experts in sustainable and energy management; the suggestions from the expert serve as the input to refine the questionnaire. A Pilot study was conducted in this stage as well. The purposes of conducting the pilot study is to ensure the questionnaire was understandable by the respondents, possibility response by respondent to any particular question as a whole and time spent by respondents in completing the questionnaire.

In stage IV, the developed questionnaires of the energy awareness and energy-use behaviour were distributed to the students in selected Malaysian universities to assess their energy awareness and energy-use behaviour. Collected data were analyses by using descriptive analysis including frequency analysis as well as inferential statistic, including chi-square. Some discussion and conclusion of this research was carried out by referring the results from the analyses which was carried out in previous stage. Some suggestion and recommendation for further research to be done with regard to this research topic also were carried out in this stage. The research stage flow chart is shown in Figure 1.1.

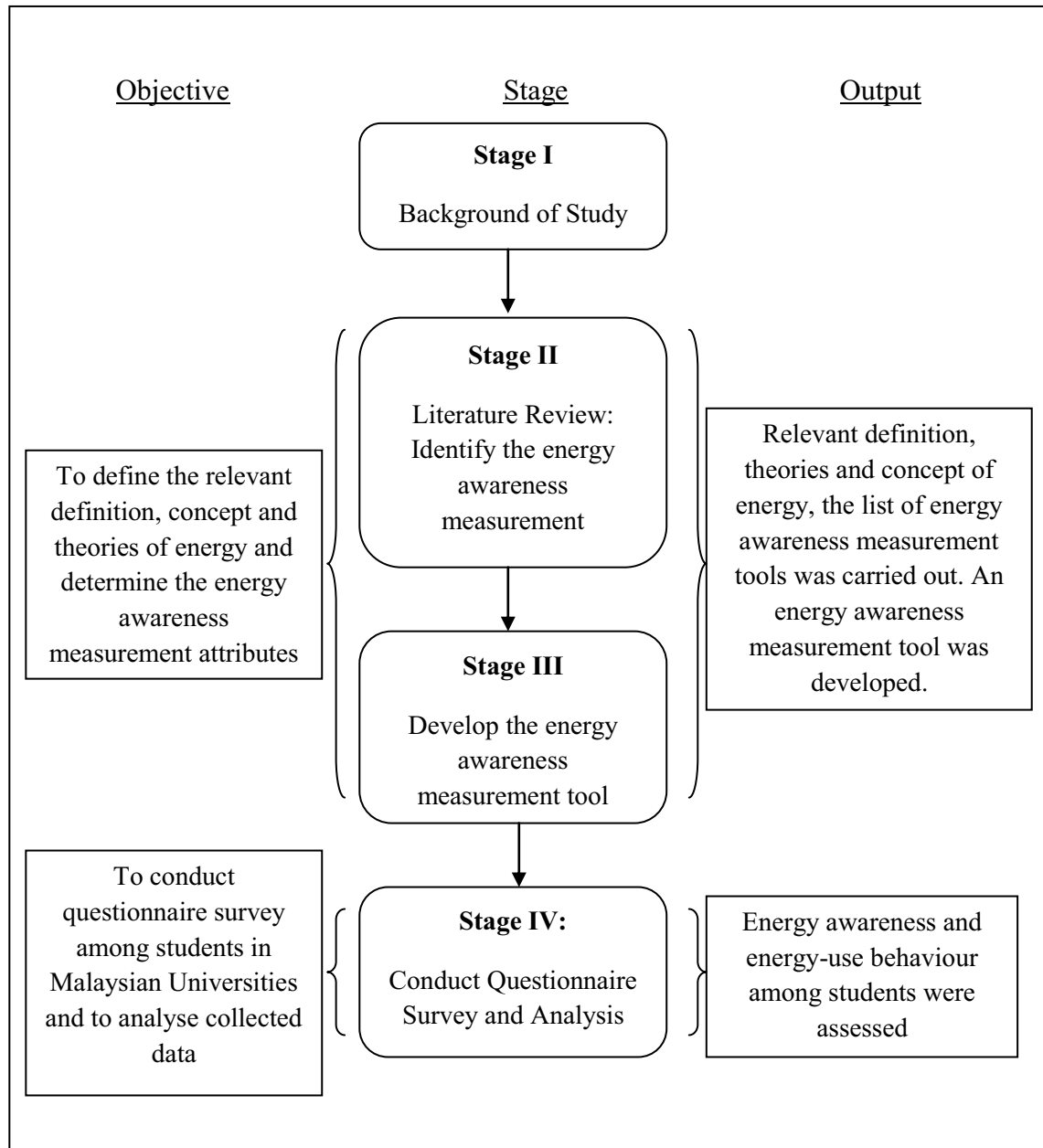


Figure 1.1 Flow Chart of Research Stage

1.7 Layout of Chapters

This research consists of seven chapters. The layouts of these chapters are as follows:

i. Chapter 1: Introduction

Chapter one covered the background of study, problem statement, research objectives, scope of study, significance of study, methodology of study, flowchart of the study, as well as the description of the layout of chapters.

ii. Chapter 2: Literature Review

Chapter two explained the theories in this study. The explanation covered the definitions, concepts and theories related to energy awareness development process, importance of measure energy awareness and energy-use behaviour. In addition, energy awareness and energy-use behaviour measurement tools were also discussed through literature review.

iii. Chapter 3: Research Methodology

Chapter three discussed the details of the research methodology to achieve the research's objectives. The research approach adopted for this research such as the questionnaire survey and review of literature for the research was explained in thoroughly. Designation of questionnaire survey also was discussed in this chapter. In addition, the methods and techniques in data collection and data analyses were illustrated in the comprehensive research flow chart.

iv. Chapter 4: Energy Awareness of Students in Malaysian University

Chapter four explained the analysis from the questionnaire survey. The purpose of this analysis is to accomplish the research objectives. This chapter also presented the findings and final outcomes that meet the objective one.

- v. Chapter 5: Energy-use Behaviour of Students in Malaysian University
Chapter five explained the analysis from the questionnaire survey. The purpose of this analysis is to assess energy-use behaviour of students in Malaysian University. This chapter also presented the findings and final outcomes that meet the objective two.

- vi. Chapter 6: Relationship between Energy Awareness and Energy-use Behaviour of Students in Malaysian University
Chapter six presented the analysis and findings from the questionnaire survey. The purpose of this analysis is to determine the energy awareness and energy-use behaviour of students in Malaysian University. This chapter also presented the findings and final outcomes that meet the objective three.

- vii. Chapter 7: Conclusion and Recommendation
This chapter summarized the results obtained for study. A conclusion of the study based on the analyses and findings which achieved in previous chapter was derived. Apart from that, suggestions for further study regarding the topic of this study were discussed in this chapter.

References

- Aaker, D. A., & Day, G. S. (1980). *Marketing Research: Private and the Public Sector Decisions*. Toronto: J Wiley.
- Abdul, M. A. R. (2004). *Low Energy Cooling Technology for Malaysian Homes*. Pulau Pinang: Penerbit Universiti Sains Malaysia.
- Al-Mofleh, A., Soib Taib, M.A. Mujeebu, Wael Slah (2009). Analysis of Sectoral Energy Conservation in Malaysia. *Energy* 34(6). 733-739.
- Bonta, D. and Snyder, S. (2008). *New Green Home Solutions : Renewable Household Energy and Sustainable Living*. Layton, Utah: Gibbs Smith.
- Bowonder, B. (1984) Energy Management Awareness Programme for Senior Executives. *The Environment* 4. 125-129.
- Bradburn, N. M., Sudman, S., & Wansink, B. (2004). *Asking Questions: The Definitive Guide to Questionnaire Design : for Market Research, Political Polls, and Social and Health Questionnaires*. San Francisco: Jossey-Bass.
- Bream, C. F. (1986). *Energy Management In Buildings – Techniques and Priorities*. In Energy Management in Buildings Conference, and Sherratt, A. F. C. (Ed.) *Energy management in buildings*. (pp. 10-32) London: Hutchinson.
- Brundtland G.H. (1987). *Our Common Future*. Oxford: Oxford University Press.
- Capehart, B. L., Turner, W. C. and Kennedy, W. J. (2008). *Guide to Energy Management : International Version*. Lilburn, GA; Boca Raton, FL: Fairmont Press ; Distributed by CRC Press/Taylor & Francis.

- Carver, R. H., & Nash, J. G. (2009). *Doing Data Analysis With SPSS version 16.0*. Belmont, CA: Brooks/Cole.
- Choong W. W. (2009). The Conceptual Model of Energy Awareness Development Process. *3rd International Conference on Energy and Environment*. 7th -8th December 2009.
- Choong, W.W., Abdul Hakim and Low, S.T. (2009). The Needs for Raising Energy Awareness and Improving Energy Use Behaviour in Malaysia Public Universities. *Malaysian Journal of Real Estate*. 4(1). 1-9.
- Cleveland, C. J. and Morris, C. (2006). *Dictionary of Energy*. Amsterdam: Elsevier.
- Corbetta, P. (2003). *Social research: Theory, Methods and Techniques*. Thousand Oaks, Calif: SAGE Publications.
- Cutler J. Cleveland & Christopher Morris (Eds.). (2006) *Dictionary of Energy* Amsterdam: Elsevier.
- Devine-Wright, P. and Clayton, S. (2010). Introduction to the Special Issue: Place, Identity and Environmental Behaviour. *Journal of Environmental Psychology*, 30(3), 267-270.
- Eastop, T. D. and Croft, D. R. (1990). *Energy Efficiency : for Engineers and Technologists*. Harlow, Essex; New York: Longman Scientific & Technical ; Wiley.
- Gardner, G. and Stern, P. C. (2002). *Environmental Problems and Human Behaviour*. Boston: Pearson.
- Gray, D. E. (2009). *Doing Research in the Real World*. London: SAGE.
- Hall, C. W. and Hinman, G. W. (1983). *Dictionary of Energy*. New York: M. Dekker.

- Hansen, S. J. (2002). *Manual for Intelligent Energy Services*. New York: Marcel Dekker.
- Henry, H.W., Symonds, F. W., Bohm, R. A., Gibbons, J. H., Moore, J. R. and Snyder, W. T. (1980). *Energy Management Theory and Practice*. Energy, Power, and Environment. New York: M. Dekker.
- Hezri A. A. and Mohd Nordin Hassan (2006). Towards Sustainable Development? The Evolution of Environmental Policy in Malaysia. *Natural Resources Forum*. 30. 37-50.
- Howell, D. C. (2008). *Fundamental Statistics for the Behavioral Sciences*. Belmont, CA: Thomson/Wadsworth.
- Implementation of an Energy Management System-Energy Management for improved energy efficiency and better profit (2006, September). *Malaysia Industrial Energy Efficiency Improvement Project (MIEEIP)*. Retrieved December 5, 2010, From <http://www.ptm.org.my>
- Kennedy, W. J., and Turner, W. C. (1984). *Energy Management*. Prentice-Hall series in energy. Englewood Cliffs, N.J.: Prentice Hall.
- Kumar, R. (2005). *Research Methodology: A Step-by-Step Guide for Beginners*. London: SAGE.
- Kunju Ahmad, R. and Gibb, A. (2004). Towards Effective Safety Performance Measurement-Evaluation of Existing Techniques and Proposals for the Future. In Rowlinson, S. (Ed.). *Construction Safety Management Systems*. (425-442). London: Spon Press
- LESTARI (1999). Sustainable Development Indicator Initiatives in Malaysia – Novel Approaches and Viable Frameworks. *Institute for Environment and Development*, Universiti Kebangsaan Malaysia.

- Lincoln, S. F. (2006). *Challenged Earth an Overview of Humanity's Stewardship of Earth*. London: Imperial College Press.
- Loozen, A and Moosdijk, C.V.D. (2001). *A Consumer Advise on Energy Efficient Use and Purchase of Household Appliances and Lighting*. In: Bertoldi, P., Ricci, A. and Almeida, A.D. *Energy Efficiency in Household Appliances and Lighting* (pp. 468-474). Berlin: Springer.
- Low, S.T. , Choong, W.W. and Abdul Hakim (2009). The Energy Knowledge and Conservation Behaviour among Community in University. *International University Social Responsibility Conference and Exhibition 2010 (IUSRCE 2010)*, October 5-6, 2010, Kuala Lumpur, Malaysia.
- Mahmoud, M. A. and Alajmi, A. F. (2010). Quantitative Assessment of Energy Conservation due to Public Awareness Campaigns using Neural Networks. *Applied Energy*, 87(1), 220-228.
- Marans, R. W. and Edelstein, J. Y. (2010). The Human Dimension of Energy Conservation and Sustainability: A Case Study of the University of Michigan's Energy Conservation Program. *International Journal of Sustainability in Higher Education*, 11(1), 6-18.
- Mat, S., Sopian, K., Ali, B., Mokhtar, M., Hashim, H. S., Rashid, A. K. A., et al. (2009). Managing Sustainable Campus in Malaysia - Organisational Approach and Measures. *Eur. J. Soc. Sci. European Journal of Social Sciences*, 8(2), 201-214.
- Mehmetoglu and Mehmet. (2010). Factors Influencing the Willingness to Behave Environmentally Friendly at Home and Holiday Settings. *Scandinavian Journal of Hospitality and Tourism*, 10(4), 430-447.
- Mohon, H.P., Kiss, M.G., Leimer, H.J. (1983). *Efficient Energy Management (Method for Improved Commercial and Industrial Productivity)*. Englewoods Cliffs, N.J.: Prentice-Hall.

- Morgan, G. A. (2007). *SPSS for introductory statistics : use and interpretation*. Mahwah N.J.: L. Erlbaum.
- Muhiedeen, M. W., Adam, N. M., Salleh, E., Tang, S. H., & Kwong, Q. J. (2008). Student Behavior that Leads to Energy Abuse at a Teaching Institution in Malaysia. Paper presented at the International Seminar in Sustainable Environment & Architecture (9th SENVAR + 2ND ISESEE 2008: Humanity and Technology), Universiti Teknologi Mara, Shah Alam.
- Muijs, D. (2004). *Doing Quantitative Research in Education with SPSS*. London: SAGE.
- Neuman, W. L. (2006). *Social Research Methods: Qualitative and Quantitative Approaches*. Boston, Mass: Pearson.
- Omer A. M. (2008). Energy, Environment and Sustainable Development. *Renewable and Sustainable Energy Reviews*. 12(9). 2265-2300.
- Ouyang, J., Gao, L., Hokao, K., Yan, Y. and Ge, J. (2009). Effects of improved consumer behavior on energy conservation in the urban residential sector of Hangzhou, China. *Journal of Asian Architecture and Building Engineering*, 8(1), 243-249.
- Rosenthal, S. (2010). Measuring Knowledge of Indoor Environmental Hazards. *Journal of Environmental Psychology*, 31(2). 137-146.
- Schools hit by power bill woes. (2007, September 13). *The Star*. Retrieved December 5, 2007, from <http://www.thestar.com.my>
- Steve Anthony Lojuntin (2009). *Green Technology in Buildings*. Kuala Lumpur. Pusat Tenaga Malaysia.
- Thakur, D. (2003). *Research Methodology in Social Sciences*. New Delhi: Deep & Deep Publications.

- Thumann, A., and Metha, D.P. (1997). *Handbook of Energy Engineering*. Lilburn, GA: Fairmont Press.
- Vesma, V. (2002). Power to the People Facilities Management. *Facilities Management*. 9(5): 26.
- Walliman, N. (2006). *Social Research Methods*. London: SAGE Publication.
- Wedge, R. (2003). *Energy Efficiency: Key to Managing Costs*. NZ Forest Industries.
- Weisberg, H. F., Krosnick, J. A., Bowen, B. D., & Weisberg, H. F. (1996). *An Introduction to Survey Research, Polling, and Data Analysis*. Thousand Oaks, Calif: Sage Publications.
- Williams, M. A. (1993). Initiating, Organizing, and Managing Energy Management Programs. In.: Turner, W.C. *Energy Management Handbook (Second Edition)* (7-20). Liburn: The Fairmont Press, Inc.
- Wolman, B.B. (1973). *Dictionary of Behavioral Science*. New York: Van Nostrand Reinhold.
- Wong, S.S. M. (1997). *Energy Conservation and Human Behaviors: The Profesional Faculties Building in the University of Calgary*. Master, University of Calgary, Calgary.
- Wong, T. Q. and Marketing Institute of, S. (1999). *Marketing Research*. Marketing Institute of Singapore. Butterworth Heinemann.
- World Commission on Environment and Development (1987). *Our Common Future*. England: Oxford University Press.
- Yamane, T. (1973). *Statistics: An Introductory Analysis*. New York: Harper & Row.

- Yan-ping, F., Yong, W. and Chang-bin, L. (2009). Energy-Efficiency Supervision Systems for Energy Management in Large Public Buildings: Necessary Choice for China. *Energy Policy*, 37(6), 2060-2065.
- Yik, F.W.H., Lee, W.L. and Ng, C.K. (2002). Building Energy Efficiency and the Remuneration of Operation and Maintenance Personnel. *Journal of Facilities*. 20(13/14):406-413.