

**FACTORS FAVORING SOLAR WATER HEATING SYSTEM (SWHS)
USAGE AMONG MALAYSIAN LANDED PROPERTY OWNERS
IN MALAYSIA**

BY

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ABSTRAK

Pemanasan global akibat kesan karbon telah mencapai tahap yang membimbangkan dan keutamaan haruslah diberikan untuk memelihara alam sekitar dengan menggunakan sumber alam semulajadi dan tenaga solar. Penggunaan sistem pemanasan air solar (SWHS) adalah salah satu sumbangan ke arah mengurangkan kesan karbon. Walaupun Malaysia mempunyai kadar sinaran matahari sebanyak 4000-5000 Whr/m² selama 4-8 jam sehari, penggunaan SWHS tidak digunakan secara meluas berbanding dengan negara seperti China, Turki, Brazil, negara-negara Kesatuan Eropah seperti Jerman dan Sepanyol.

Thesis ini mengkaji perlakuan pembelian SWHS di kalangan kediaman Malaysia dengan pengetahuan & pangalaman terhadap SWHS sebagai pembolehubah pengantara. Hasil kajian menunjukkan bahawa subsidi kerajaan, perspektif terhadap keperluan penyelenggaraan dan pengetahuan & pengalaman di SWHS memainkan peranan penting dalam mempengaruhi pembelian SWHS. Dengan pendedahan yang minimum ke atas SWHS, rakyat Malaysia tidak menyedari faedah kos jangka masa panjang dan implikasi dari melindungi alam sekitar.

ABSTRACT

Global warming resulting from carbon footprints is at an alarming stage and high importance has to be given to preserve the environment by using the earth natural resources and solar energy. The usage of solar water heating system (SWHS) is one of the contributions toward carbon footprint reduction. Malaysia has an approximate of 4000-5000 Whr/m² of solar radiation with a *daily* sunshine duration ranging from 4-8 hours *but the usage* of SWHS is not as widely used as countries like China, Turkey, Brazil, European Union countries such as Germany and Spain.

The present article examines the SWHS purchase plan behaviour among Malaysian residential areas with knowledge on SWHS as a mediating variable. The findings of the study reveal that government subsidies, perceived maintenance and exposure & experience views on SWHS play a significant role in affecting SWHS purchase plan. With a minimal exposure on SWHS, Malaysians do not realize the benefits of long term cost benefits and the implications on protecting the environment.

Chapter 1 INTRODUCTION

1.1 Introduction

This chapter introduces the motivation behind the study of Solar Water Heating System (SWHS) among Malaysian landed property owners, the problem statement and the research question of this study. It also gives an overall picture on what is Solar Water Heating System and its functions.

1.2 Background of study

The shrinking of Mount Kilimanjaro's ice field by 80% since 1912, the melting of 2000 glaciers in Himalaya since 1950s, the total wipe off of several glaciers in European Alps and the shrinking of permanent sea-cover as large as the size of Netherlands in the Arctic Ocean every year ; these are the signs of global warming due to greenhouse effect ; the most terrifying phenomena in the 21st century. By end of 2006, scientist revealed that the planet's average temperature increased every 1 degree centigrade yearly for the past 5 years. The increasing level of acidity detected in sea water due to evaporation which disturbs the marine food chain in long term is another evident to the global warming impact. It is even more disturbing to discover that the rainfall has decreased dramatically over the last decade which results in draught in Western Australia and the deep south of America. The worst is yet to reveal when the populations increase and the shortages of drinking water supply due to greenhouse effect could lead to epidemic proportions. Not to mentioned that the basic food supplies will eventually be interrupted due to the water supply for agriculture purposes. Should this global warming worsen in the coming years, it will definitely change our lives

and the future generation would never be able to enjoy the fruits which we used to have (Global Warming and Glaciers).

Malaysia itself contributes about 208,267 thousands of metric tonnes (0.69% of the world CO₂ emission) on 2008, ranking 26th of the highest CO₂ emission in the world mainly contributed by natural gas, liquid petroleum gas, kerosene and electricity (Millennium Development Goals Indicator). In fact, we ranked 30th with 93.8 billion of kilowatt hour (kWh) electricity usage in the world (Index Mundi). Electricity are mainly generated by oil and coal which composes of complex molecules with higher carbon ratio, nitrogen and sulphur contents that emits higher ratio of carbon emissions and also releases ash particles to the environment which eventually contributes to pollution (Natural gas.org). Therefore it is important to bring out the awareness to the society to help to at least preserve the current environment if not able to reverse on the damage done on mother nature. One of the main contributions to reduce CO₂ emissions is by using an alternative method to generate household energy which eventually reduces the level of green house gasses generation.

The best alternative available is to use the existing solar energy from the sun which is the Solar Photovoltaic Panel which converts solar energy to electricity. However, Solar PV initial installation price is very pricey with approximately RM54K for terrace house, RM102K for semi-detach house and RM224K for bungalow owners (Haris, 2011). With Malaysian average annual income of RM43K in 2007, not everyone would be able to afford to purchase the Solar PV for electricity generation (The Edge Malaysia, 2008). Therefore, it is more feasible for Malaysian to play a part in helping the environment by installing Solar Water Heating System, a system which converts solar energy to heat up the water with the installation price from as low as RM3950 (Ali, Sopian, Ghoul, Othman, Zaharim, & Razali, 2009). In fact, water heater usage takes up to 14% of the household electricity (Aun, 2004).

However, the usage of Solar Water Heating System (SWHS) are yet to be popular among Malaysians landed property owners as compared to other countries like China, Turkey, Brazil, European Union countries such as Germany, Spain. Therefore, a research is carried out to understand what favours the usage of Solar Water Heating system among Malaysian landed property owners.

1.3 Problem statement

Malaysia has equivalent favourable solar energy with other Solar Water Heating System country users with average monthly daily solar radiation of 4000-5000 Whr/m² and sunshine duration ranging from 4-8 hr (K.Sopian, Othman, B.Yatim, & Shamsudin, 2000). However, the usage of Solar Water Heating System is not as widely used as countries like China, Turkey, Brazil, European Union countries such as Germany, Spain. Therefore, a study is carried out among Malaysian to understand the gap of not fully utilizing the natural solar energy resource by using SWHS, hence generating the research title as the following :

“ Factors Favouring Solar Water Heating System (SWHS) Usage Among Malaysian Landed Property Owners”

The study is typically carried out on three groups of Malaysian namely non-SWHS users, existing SWHS users and discontinued SWHS users.

1.4 Research objectives

This studies intends to accomplish the main objectives as below :

1. To determine if Malaysian residence's concerns influences the exposure and experience views on SWHS
2. To determine if the exposure and experience views on SWHS influences the purchase plan on SWHS
3. To determine if Malaysian residence's concerns with mediating exposure and experience views on SWHS influences the purchase plan on SWHS

1.5 Research questions

To achieve the above objectives, the study will answer the following research questions :

- a) What is the relationship between environment concern with mediating exposure and experience views on SWHS towards SWHS purchasing plan
- b) What is the relationship between perceived cost with mediating exposure and experience views on SWHS towards SWHS purchasing plan
- c) What is the relationship between perceived maintenance with mediating exposure and experience views on SWHS towards SWHS purchasing plan
- d) What is the relationship between government subsidies with mediating exposure and experience views on SWHS towards SWHS purchasing plan
- e) What is the relationship between potential health hazard concerns with mediating exposure and experience views on SWHS towards SWHS purchasing plan

- f) What is the relationship between solar panel aesthetics on rooftop with mediating exposure and experience views on SWHS towards SWHS purchasing plan
- g) What is the relationship between exposure and experience views on SWHS towards SWHS purchasing plan

1.6 Significance of study

With the level and importance of education stressed in this era, everyone should be aware of the global warming stage and its' responsibility to help to sustain the current condition if not able to improve it. Small efforts such as recycling can, paper, plastic bottles and reduction in usage of plastic bags in major supermarket are doable as it does not cost much, however items such as Solar Water Heating System (SWHS) requires a larger sum of initial cost about RM3950 and not everyone could afford it especially citizens with existing car and house commitment. That is the reason despite the awareness on global warming caused by electricity generated by coal and oil, not all Malaysians are willing to pay such amount to replace the existing water heater using electricity to Solar Water Heating System. This research is to determine which factor would motivate Malaysians to consider the switching to Solar Water Heating System usage to the extent of government's subsidies to reduce the initial cost burden, understand the perceived cost, maintenance, potential health hazards, income (which Malaysia is aiming to go for high income country) and also the environment concern supporter .

1.7 Definition of Solar Water Heating System (SWHS)

Solar Water Heating System in Figure 1.7.1, as its name indicates converts the sun radiation to heat up water for domestic purposes instead of conventional electric water heater. To capture maximum heat from the sun, solar collectors are mounted on the roof facing the sun. There are generally two types of SWHS which are active where a pump is used to transport heated fluid from the solar collectors to the reservoir and passive systems where the water is circulated through the natural process of convection without and pump needed. There are advantages using both passive and active systems. Active systems are more efficient as the pump is only activated when the collector temperature is higher than the reservoir temperature, hence enable the system to retain its heat during night and cloudy days. The only drawback from this system apart from the higher cost is the pump still needs power which means it's not zero carbon footprint unless the pump uses solar photovoltaic energy to power it. Passive systems in other hand are cheaper and more reliable but it is not robust to temperature change, hence it is not suitable for cold places where the temperature drops below zero degrees centigrade. For such cases freezing water will causes parts of the solar collector to burst as water expands in volume. Another issue faced will be the reverse effect of the water temperature when the collector is colder than the water in the reservoir. Hence, passive systems are more suitable for countries with warmer climates (Solar Water Heater).

Figure 1.7.1 : *Solar Water Heating System on rooftop*



Chapter 2 LITERATURE REVIEW

2.1 Introduction

The chapter reviews the relevant literatures and articles regarding the factors favouring Solar Water Heating System usage to develop the theoretical framework. The hypothesis are generated from the theoretical framework based on the several relevant studies/references.

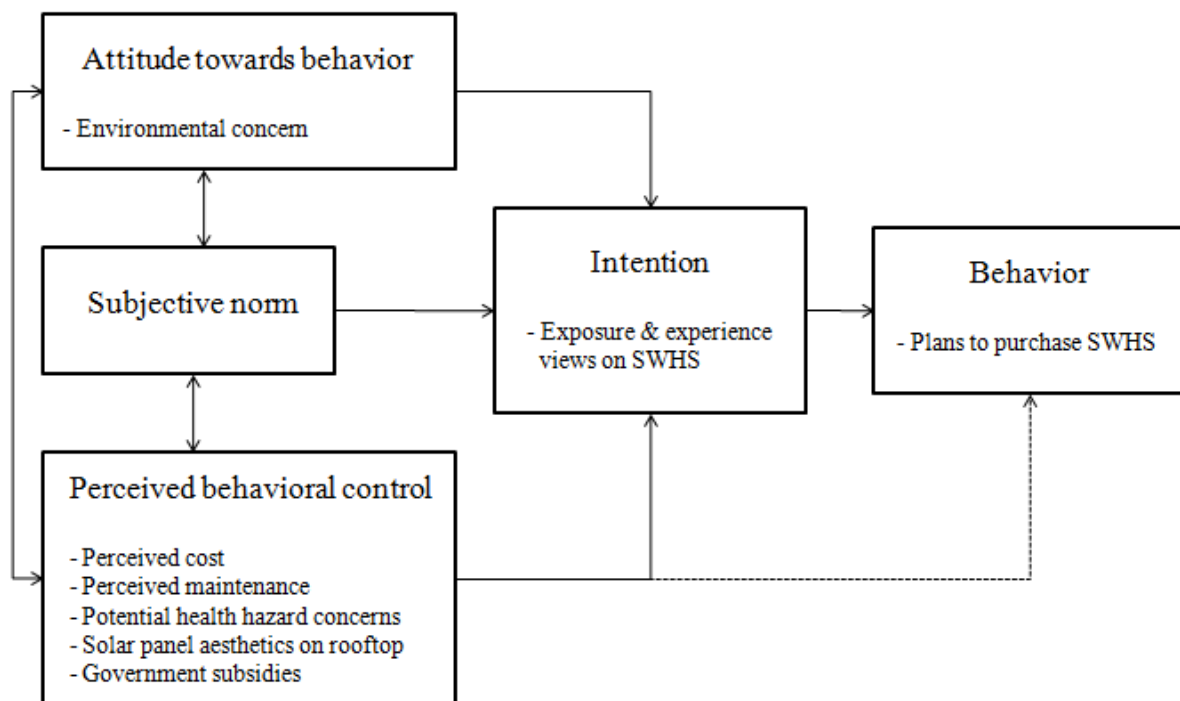
2.2 Theory of Planned Behavior (TBP)

Theory of planned behaviour by Icek Azjen (Azjen I. , 1991) is an extension of theory of reason action used to predict the intention in particular tendencies. The intentions are affected by three variables which are attitude toward the behaviour, subjective norm due to social influence and perceived behavioural control as shown in Figure 2.2.1. The first variable on attitude towards behaviour refers to an individual's assessment on a particular behaviour in regardless of the whether it is positively or negatively valued. This can be determined through the whole set of behavioural beliefs which links the behaviour to any outcomes and attributes. The more positively a person evaluates the belief and outcome of the behaviour will achieve the outcomes, the more likely the person will perform the behaviour. In the theoretical framework, environmental concern fits into this variable as individuals with self-efficacy (Bandura, 1986) beliefs that they could make a difference to the environment, in this case reducing the carbon footprint through reduction of electricity usage (lesser coal are burnt) by installing SWHS in their residential area.

The second variable on subjective norms refers to individual's perception on social normative beliefs whether a particular behaviour performed is right or wrong which determines which behaviour should or should not be carried out. This are usually influenced by the individuals close person especially parents, spouse, peers and in some cases doctors, advisors and etc. This variable however is not applicable in this study.

The third variable on perceived behavioural control refers to an individual perceived ease and difficulty in performing a behaviour, determined by a total set of accessible control beliefs (Ajzen, 1988). In this research, perceived cost, perceived maintenance, potential health hazard concerns, solar panel aesthetics on rooftop and government subsidies fall into this category as these sets of control belief will determine the individual intention to purchase SWHS in the residential area.

Figure 2.2.1 : *Theory of Planned Behavior*



The intention, in this case exposure and experience views on SWHS, is affected by the three variables reflects the indication of individual’s readiness to carry out certain behaviour whereas behaviour refers to the response based on the provided situation. The behaviour in this study refers to the plan to purchase SWHS in the residential area. Overall, the model believes that it is able to predict one’s behaviour (plans to purchase SWHS) through the intention (exposure and experience views on SWHS) and perceived behavioural control and attitude towards the behaviour.

2.3 Environmental concern

With the increase of number of environmental concerns over the past few years from the third annual survey of National Geographic Society and international polling firm, GlobeScan, more consumers are moving towards energy efficiencies enhancement in their home (UNEP, 2010). The 'environmental concerns' in this context refer to the level of individual's concern to the environment/ surroundings which leads to conscious actions of recycling or purchasing green products (Chan, 1996). These group member favours collectivism as its' emphasises on environmental concerns/issues for the well-being of human mankind (Kim & Sejung Marina, 2005) and are highly driven by their core values/principles/beliefs embedded with the altruistic value (Schultz, 2000). The motivation behind these believes are due to self-efficacy in social cognitive theory (Bandura, 1986) where these individuals belief that their contribution could make a difference to the environment. Surprisingly though despite the higher cost for green products, environmental concern consumers are willing to pay more to address the environmental issues (Tsen, Grace, Haslinda, & Merlyn Rita, 2001) (Laroche, J, & G, 2001). Therefore, it all narrows down to the social acceptance towards renewable energy (Wustenhagen et al, 2007) with one of the dimension (market acceptance) focusing on individual acceptance towards renewable energy through consumption and investment behaviour. In a recent study conducted by Pei Zhai (Zhai, 2010), environmental concern consumer thinks that Solar PV installation benefits the environment regardless of adopters or non-adopters. Therefore, this research will determine if environmental concern Malaysians influences the plan to purchase SWHS in their residential area.

H1 : Environmental concern influences plans to purchase SWHS

2.4 Perceived cost

Different people look at cost differently depending on their financial background, education exposure, peers and etc. When one purchased an item, how valuable a cost is does not solely depends on the money but also on each individuals perception, in terms of how much benefit it obtained. A good example will be in Scotland where approximately 2/3 are interested in purchasing renewable energies such as solar panel but was actually held back by the price. (Cost of green energy puts Scots off home upgrades, 2011). In other words, they perceived cost on the solar panel is high compared to the benefits obtained. From the analysis by Pei Zhai on environment, policy and social analysis of photovoltaic technologies, non-solar panel adopters have optimistic attitude towards the perceived cost where benefit is more than the cost with the actual payback time is 21 years compared to sola panel lifespan of 25 years (Zhai, 2010). In a case study carried out in Canada, majority respondents do find solar PV technology costly but are still willing to purchase it (Beckstead, 2008). This evaluation shows that people has positive perception on solar PV technology but are still pull back by the financial cost to a certain extend (Faiers & Neame, 2006). In a study carried out in China, approximately 23% respondents do not install solar PV at home due to high perceived cost (Xueliang, 2011). Therefore, perceived cost on Solar Water Heating System purchase will be analyzed.

H2 : Perceived cost influences plans to purchase SWHS

2.5 Perceived maintenance

Almost all usable items needs maintenance such as car needs periodical servicing, air conditional needs cleaning and so to solar water heating system which requires periodical maintenance by checking the collector shading, glazing and seal, collector soiling, fluid leaks at pipe connections and wiring connections as well as the storage tanks for cracks, leaks, rust or other signs of corrosion (Solar Water Heating System Maintenance and Repair, 2011). The only question is to what extend an individual find the maintenance troublesome which it is why this is called perceived maintenance. According to a survey done in Arizona, solar panel adopters put high score (5.42 out of 7) for maintenance affecting their purchase compared to non-solar adopters which puts only 4.38 (Zhai, 2010). In Canada on the school based solar PV projects, maintenance and facilities personal often resist installation of new technology due to more maintenance responsibility, which means that maintenance really play a big role in purchasing solar PV panels for the school (Beckstead, 2008). Hence, a study is conducted to understand how the perceive maintenance affects the purchase of SWHS among Malaysian residential area.

H3 : Perceived maintenance influences plans to purchase SWHS

2.6 Government subsidies

Subsidies had always been applied in various industries as a behaviour change encouragement method to targeted audiences in order to achieve certain goals/objective (Hutton & Frank, 1991). Subsidies are classified as consequence strategy which acts as a stimuli that follow the absence or presence of a behaviour and are designed to reduce or increase the frequency of a certain behavior (Winett & John H., 1984). In fact, according to

the new research funded by the Economic and Social Research Council (ESRC), “Being a green consumer is hard work”. This study highlights the need for more government subsidies to encourage more consumers to go green towards achieving a more sustainable society (ScienceDaily, 2007). Government encouragement for energy conservation incentive can come in terms of financial incentives (Gordon H.G & J.R.Brent, 1985) such as grants, loans, subsidies and tax incentives such as credits, deductions, rebates, exemptions and etc. Several countries government has already been practicing such incentives, for example US department of energy issue a residential renewable energy tax credits for consumer who install the solar energy systems. They are entitle to receive a 30% tax credit for any of the solar energy systems installed at residential area before Dec 31,2016 (US Department Of Energy). Malaysia is also moving towards the energy conservation nation with the new feed-in-tariff scheduled to be introduce in early 2011 by the Energy, Green Technology and Water Minister Datuk Seri Peter Chin. Under the new feed-in-tariff system, the national utility companies such as Tenaga Nasional Berhad, Sarawak Electricity Supply Corporation and Sabah Electricity Board had to buy power generated from renewable energy sources such as solar panels from residential and commercial area (New Straits Times, 2010). In fact, in a survey done on solar PV programs implementers in Asia and Pacific region, the lack of government support reflects the limited success of the solar PV programs (Urmee & Harries, 2009). In Kiemen country, the tremendous sales on SWHS increase due to the hybrid subsidy programs (Ken-Chin Chang, 2011). However, there is one study carried out in Arizona stating that there are still other social barriers to solar energy despite the government subsidies provided (Zhai, 2010). Therefore this research will see the effect of government subsidies to SWHS purchase among Malaysians.

H4 : Government subsidies influences plans to purchase SWHS

2.7 Potential health hazards concerns

It is very important to look into potential health hazard concern on any products before it is purchased. For an example, people used to paint their house using lead paints but due to the health hazard concerns, everyone switch to lead-free paint. For solar water heating system, the potential health hazard can be due to the Legionella bacteria growth in water storage area causing pneumonia. Users normally adjust the temperature of the heated water to suit their own comfort temperature but setting the temperature to low will expose the user to this bacteria. Legionella bacteria start to grow at 60 degree C in the tank and it is estimated that 25% of the water in the tank are contaminate with the bacteria. Further lowering down the temperature to 49 degree C will even put the household at a higher risk of contracting pneumonia apart from losing the 20% hot water supply. The organism is transmitted through contaminated water droplets from whirlpool baths, showers and even air conditioning system. In Québec, approximately 100 people are hospitalized yearly for pneumonia infection due to contaminated residential water heaters. Therefore, it is advisable to keep the water temperature higher than 60 degree C to prevent Legionella bacteria infection. (Alter, 2009). Previous research on health crisis shows that lower perception of quality results in product's deflated marginal utility which leads to the downward trend on the demand curve (Mazzocchi, 2006). In a separate study on health hazard awareness effect on the purchased product, people put a higher weight on health hazard concern compared to the taste upon purchasing the food (Heiman & Lowengart, 2008). Another issue will be the pump used to transport heated up liquid from the solar thermal collectors mounted on the rooftop to the storage tank. This small pump especially running on DC electricity might impose some health issue to those who are electrically sensitive (Eriksen, 2009). Therefore we would like to investigate the social acceptance on SWHS with the potential health hazard concerns.

H5 : Potential health hazard concerns influences plans to purchase SWHS

2.9 Solar panel aesthetics on rooftop

Believe it or not, homeowners do frowned at the large, unsightly, glaring solar panels on their rooftop. At times when birds release their droppings or perch on the solar panels, it creates a mess down the solar panel resulting in unpleasant sight & reduction of the efficiency of the solar panels. In fact, some homeowners find solar panels as ugly as the TV aerials or satellite dishes. In a research on customers' attitude towards solar power system, aesthetics considerations had been identified as a barrier for solar PV installation (Faiers & Neame, 2006). However, for school based solar panel projects, aesthetics does not play an important role in affecting the purchase of solar panel (Beckstead, 2008). Another survey conducted in Arizona, solar panel aesthetic on rooftop carries lesser weight in affecting the purchase as compared to other factors (Zhai, 2010). Hence, social acceptance on solar panel aesthetic will be tested on how it affects the purchase of SWHS.

H6 : Solar panel aesthetics on rooftop influences plans to purchase SWHS

2.10 Exposure and experience views on SWHS

Consumers usually purchase products based on the exposure and similar past experience of using the product. During the process of produce purchase decision, product knowledge / exposure plays a vital role which affects information search and processing behavior (Pillai & Hofacker, 2007). According to Brucks, customer product knowledge can be measured using three category which are subjective product knowledge, objective product knowledge

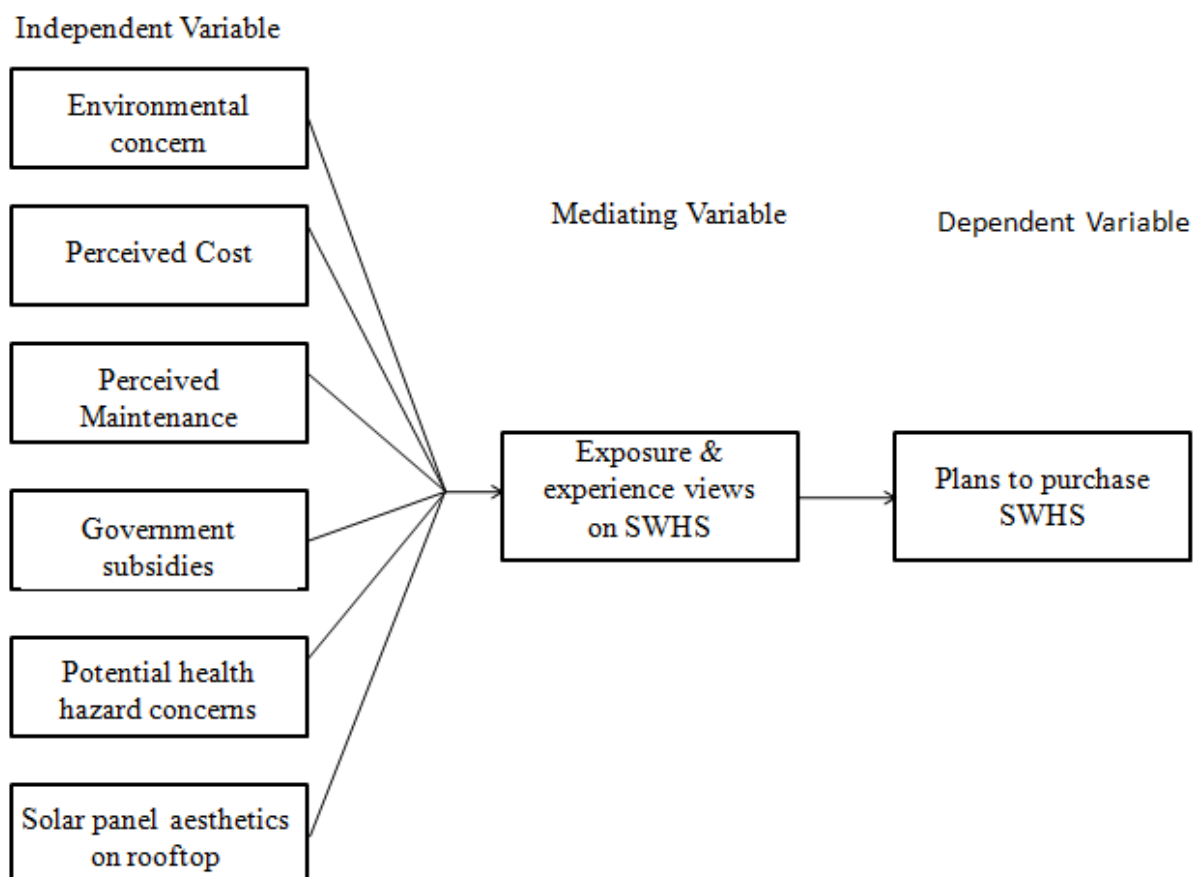
and experience based knowledge. He elaborated that product-related experience has important impact on judgement of subjective product knowledge compared to product classification information which was stored in memory has lesser impact on the judgement of objective product knowledge. (Brucks, 1985). Solomon in other hand concluded that customer made purchase decision based on memory and choices were made upon learning about the information. It was also pointed out that different types of decision making styles will generate different information for the next decision making (Solomon, 2007). In a study carried out in Canada, despite the lower knowledge on solar panel, they are still positive towards the use of solar PV technology to generate electricity (Beckstead, 2008), which is in line with another literature stating that positive attitudes towards a product might not necessarily requires high level of knowledge (Diamantopoulos et al, 2003). Hence, social acceptance on SWHS is tested based on consumers exposure and experience views of SWHS.

H7 : Exposure and experience views on SWHS mediates the relationship between the intention and plans to purchase SWHS

2.11 Conceptual framework and hypothesis development

It is very important that each and every individual play its' role to help to reduce carbon footprint. Therefore a conceptual framework is formed to understand what actually triggers Malaysian to purchase the SWHS in their residential area. From the framework, the dependent variable assigned would be the plan to purchase SWHS in Malaysian residential area and the independent variables identified in the earlier literature review are environment concern, perceived cost, perceived maintenance, government subsidies potential health hazard concerns and solar panel aesthetics on rooftop. The mediating variable representing the intention in TPB model would be exposure and experience views on SWHS.

Figure 2.11.1 : *Theoretical framework of plans to purchase SWHS*



Hence, hypothesis from the theoretical framework is generated as shown in Table 2.11.1.

Table 2.11.1 : *Hypothesis generated from theoretical framework of SWHS purchase plans*

Hypothesis	Statement	Authors
H1	Environmental concern influences plans to purchase SWHS	Chan, (1996); Kim and Sejung Marina, (2005); Schultz, (2000); Bandura, (1986); Tsen, Grace, Haslinda, and Merlyn Rita, (2001); Laroche, (2001); Wustenhagen et al., (2007)
H2	Perceived cost influences plans to purchase SWHS	Beckstead, (2008); Faiers and Neame, (2006); Xueliang, (2011)
H3	Perceived maintenance influences plans to purchase SWHS	Beckstead, (2008)
H4	Government subsidies influences plans to purchase SWHS	Hutton and Frank, (1991); Winett and John, (1984); Gordon and Brent, (1985); Urmee and Harries, (2009); Ken-Chin Chang, (2011)
H5	Potential health hazard concerns influences plans to purchase SWHS	Alter, (2009); Mazzocchi, (2006); Heiman and Lowengart, (2008); Eriksen, (2009)
H6	Solar panel aesthetics on rooftop influences plans to purchase SWHS	Faiers and Neame, (2006); Beckstead, (2008)
H7	Exposure and experience views on SWHS mediates the relationship between the intention and plans to purchase SWHS	Pillai and Hofacker, (2007); Brucks, (1985); Solomon, (2007); Beckstead, (2008); Diamantopoulos et al., (2003)

Chapter 3 RESEARCH METHODOLOGY

3.1 Introduction

This study seeks to understand to what extent the social acceptance on all independent variables and mediating variable towards dependent variable as stated in the theoretical framework in Figure 2.11.1. Therefore, this chapter elaborates further on the methodological details of this research which includes the research designs, instruments, measurements, data collection method and etc.

3.2 Research design

This particular session introduces and discusses the type of study to be taken, the population, sampling method, unit of analysis as well as sample size. The study settings carried out will be non-contrived settings where no artificial environment is needed to be simulated. Since this research is only intended to be done in one-shot, therefore it is cross-sectional studies.

3.3 Type of study

Since this research's objective is to test the five independent variable and mediating variable identified in the earlier literature towards the SWHS purchase plan (dependent variable), hypothesis testing is used. This quantitative method will assist in explaining the variance in the dependent variable to predict the outcome of the research. The research question identifies which independent and mediating variable significantly influence the purchase of SWHS in residential area. Type of investigation carried out will be correlational studies as it intended to test the relationship of among independent, mediating and dependent Variable.

3.4 Population

The population for this study will be focusing on Malaysians since the usage of renewable energy such as SWHS is still low compared to other countries such as Germany, Brazil, China and etc. Three sets of questionnaire comprising of non SWHS users, existing SWHS users and discontinued SWHS was sent out to 250 respondents through e-mails within three months. The questionnaire designed for this survey consists of a mixture of adopting relevant questions from various journals and self constructed questions.

3.5 Unit of analysis

The unit of analysis is on Malaysians living on landed properties as it is more practical to install SWHS on landed properties compared to apartments and condominiums as it's costly for the long pipe connections to the solar collectors on the rooftop and also troublesome maintenance required. Each landed property units are represented by the head of family. The samples will be taken from three categories which are non-existing SWHS users, existing SWHS users and discontinued SWHS users, mainly focusing on non existing SWHS users. The feedback is also obtained from existing SWHS users and discontinued SWHS users to get an actual feedback on the benefit or issues on SWHS.

3.6 Collection of data

The method of data collection used for this research will be in terms of questionnaire consisting a combination of relevant questions adopted from previous journals and self constructed questions. The questionnaire is then distributed to public, targeting non SWHS users, SWHS users and discontinued SWHS users (per house unit). The questionnaires (e-

survey) were distributed using e-mail as part of an effort to reduce paper usage to save more trees.

3.7 Measurement of data

An ordinal / likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was used in the independent and mediating variable to determine the preferences of the individuals whereas a binary (Yes/No) are used in the dependent variable to determine if the individual plans to purchase SWHS in their residential area as shown in Table 3.7.1.

Table 3.7.1 : *Measures of Independent, Mediating and Dependent Variable in theoretical framework*

Variable	Theory of planned behavior	Theoretical framework	Measures
Independent variable	Attitude towards behavior	Environmental concern	Likert scale from strongly disagree to strongly agree (1 --> 5)
	Subjective norms	-	
	Perceived behavioral control	Perceived cost Perceived maintenance Government subsidies Potential health hazard concerns Solar panel aesthetics on rooftop	Likert scale from strongly disagree to strongly agree (1 --> 5)
Mediating variable	Intention	Exposure & experience views on SWHS	Likert scale from strongly disagree to strongly agree (1 --> 5)
Dependent variable	Behavior	Plans to purchase SWHS	Dichotomous scale (Yes/No)

3.8 Data analysis

The data collected from public will be analyzed using SPSS (Statistical Package of Social Science) version 18 to achieve the research objectives. There will be mainly three different techniques used to study the relationship on the demographics, independent variables,

mediating variable and dependent variable. For the demographic, descriptive statistics were used to study the correspondent characteristics such as age, family size, income, education, race and readiness to stay in future at the existing house in terms of years. These descriptive statistics will give a clearer picture on the sample size / population of each category with the percentage. To test the significance of seven hypothesis generated from the independent and mediating variable towards the dependent variable of plans to purchase SWHS, both binary logistic regression and discriminant analysis were used to compare the best method that provides better significance value.

Chapter 4 DATA ANALYSIS AND RESULTS

4.1 Introduction

This chapter discussed the findings from the data generated using SPSS. First of all, the demographic frequencies are generated to understand the population of the sample size for each categories. Factor analysis were then carried out to filter and reduce unnecessary data before reliability analysis was done to further test out the internal consistency. Upon finalizing the data, the hypothesis for independent and mediating variable are tested using binary regression analysis and discriminant analysis to develop suitable model for this research.

4.2 Data preparation

Proper data preparation has to be carried out before proceeding with the analysis. The data preparation are carried out in 4 steps beginning with data validation, data editing, data coding and data entry. Since this questionnaire was sent out using a web-based free software namely KwikSurveys, no double entry data were allowed which means only one respondent can response to one set of questions. The system was set to ensure all questions were answer in that particular page before proceeding to next page. This is to ensure the respondent do not overlook any questions. Should the respondent quit answering the questionnaire halfway, the respondent will be labelled as incomplete by the system and are excluded from the analysis. Therefore, the finalized respondents taken for the analysis are complete for better accuracy. Since no missing data are allowed, hence no data editing, coding and entry are needed for this case.

4.3 Respondents rate

Three sets of questionnaire comprising of non SWHS users, existing SWHS users and discontinued SWHS was sent out to 250 Malaysian respondents. Out of 250 respondents, 106 respondents are non SWHS users, 7 respondents are existing SWHS users and 1 respondent has discontinued SWHS. There were 18 incomplete questionnaires and 118 respondents do not response to the questionnaire sent out. Only non SWHS users response were used for the SPSS analysis while existing SWHS and discontinued SWHS response were used as qualitative studies. The possible explanations for incomplete responses are the lengthy questionnaire since there were a few feedbacks from the respondent that the questions are too long. For those respondents that do not response, most of them thought that the link sent out are spam as there are multiple respondents sending e-mails to confirm the authenticity of the questionnaire.

4.4 Profile of respondents

The demographics of the respondent for non SWHS users are summarized in Table 4.4.1. Most of the respondents are less than 58 years as they are more IT literate and familiar with such web-based e-survey used to conduct this survey. The highest average of family size in one household is 4 persons which consists of husband, wife and two kids, followed by 2 person and 3 person per household indicating small families. Most of the respondent are average wage earners with the annual income of RM24,001-RM42,000. The respondents mostly are highly educated based on the ~87% are graduates and above. In the question asked on readiness to stay in the future, most of them answered not applicable indicating they are either renting a house or a room. In fact it is not surprising that Malaysians are having difficulties owning a house nowadays due to the soaring property price. Another possible

reason for renting a house/room is due to respondents working outstation. These respondents are not permanent resident in one area and frequently change their residential area from time to time.

Table 4.4.1 : *Profile of correspondents*

DEMOGRAPHIC	No of respondents	Percentage (%)
Age years)		
< 30 years	51	48.1
30 - 58 years	53	50
> 58 years	2	1.9
Family size		
1	7	6.6
2	19	17.9
3	19	17.9
4	25	23.6
5	14	13.2
6	12	11.3
7	8	7.5
8	1	0.9
9	1	0.9
Income		
< RM 24,000	12	11.3
RM24,001 - RM42,000	41	38.7
RM42,001 - RM60,000	30	28.3
> RM 60,000	23	21.7
Education		
Diploma holders	13	12.3
Graduates	69	65.1
Post graduates	15	14.2
Professionals	9	8.5
Race		
Malay	14	13.2
Chinese	77	72.6
Indian	15	14.2
Readiness to stay in the future (years)		
< 4 years	14	13.2
5 - 9 years	16	15.1
10 - 14 years	12	11.3
15 - 19 years	13	12.3
> 24 years	25	23.6
Not applicable	26	24.5