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Public Willingness Assessment in Utilising Solar Energy in Malaysia: A Household Perspective

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Abstract

Purpose: Climate change and environmental issues have become significant in Malaysia. Lack of awareness and correct information may also contributes to unwillingness of migrating to solar energy utilisation in Malaysia apart from financial challenges. The Malaysian government, Tenaga Nasional Berhad, and other private companies however achieved in utilising solar energy resources to help curb the mentioned issues but, there are not enough research and studies done to assess the willingness of consumers in Malaysia in utilising solar

energy for their households. This research analyses factors that influence the willingness of consumers in utilising solar energy for their household.
Design/methodology/approach: Analysis has been done on an online survey collected data of 178 respondents from three major age range in Malaysia.
Findings: This study's findings expose that the main factors identified, namely, self-effectiveness perception, concerns on environmental issues, solar energy awareness, and benefits of solar energy, may instil positive vibes on the willingness of consumers in utilising solar energy for their household, while on the other hand, the cost of implementing and installing solar energy might have a downside effect instead. In particular, indirect influence or perception on participation of neighbours instils effect that is insignificant towards the consumers of Malaysian households in utilising solar energy.
Research limitations/implications: This research impacts households' awareness and willingness towards utilising solar energy in their homes. The findings can be useful for future studies.
Practical implications: The findings of this study indicates that there are factors that can be used to influence and further improve the knowledge of the public, mainly focusing on households perspective towards renewable energy acceptance and willingness, as Malaysia has advantages of harvesting energy from the sun all year round.
Originality/value: Profiling of this study can be used as a prerequisite in finding the perception on participation of Malaysian households in utilising solar energy.
Paper type: Research paper

Keywords: Solar energy, Public willingness, Renewable energy

Introduction

Relying mainly on traditional fuels such as coal, oil, and gas hurts the economy, and contributes to environmental issues including a huge amount of total greenhouse gas emissions, global warming, carbon emissions, and unpredictable weather (Kavari, Tahani, & Mirhosseini, 2019; Raman, 2020). Malaysia needs to be careful in the excessive usage of conventional fuels as it can result in the depletion of natural resources (Irfan, Zhao, Ahmad, & Mukeshimana, 2019). Natural resources that can produce renewable energy are solar, wind, wave, and geothermal technologies. These energy technologies are sustainable; able to continuously process, replenishing, and renewing. These alternative energies bring betterment for the environment, decreasing greenhouse gas emission (Shamsuddin, 2012). Understanding whether solar technology can or should be installed in our country's households and the predicted benefits is critical for policy optimisation. Energy is essential for economic and social progress, and it has improved citizen's quality of life (Solangi, Badarudin, Kazi, Lwin, & Aman, 2013). Here in Malaysia, the government should seriously consider solar energy as one of the energy resources in order to meet the world's energy needs. Lack of research on renewable energy from the angle of social acceptance and willingness; specifically on solar energy, have been undertaken in nations that are underdeveloped (Irfan, Elavarasan, Hao, Feng, & Sailan, 2021).
The major contributions of this study and survey done can be seen from two aspects. One, to assess the acceptance factors among household towards solar energy, and secondly, to measure the relationship between acceptance factors and household willingness towards solar energy, if it were to be seriously considered, and implemented onto households in Malaysia. The results and findings from this survey would aid in spreading solar energy awareness for Malaysia to start developing and building policies or guidelines in implementing solar energy in Malaysia's households.

The remainder of this paper is organised in this manner: Section 2 explains the literature review of the survey, Section 3 elaborates on hypotheses, Section 4 on the conclusion of this study, followed by discussion and suggestions for future work.

Importance of Solar Energy

Circa 1979, an announcement was made, stating that the Supply, Utilisation, and Environmental Objectives were formed as part of the National Energy Policy and is crucial in guiding the future growth of the energy industry (Shamsuddin, 2012). The importance of solar energy relates strongly to the benefits that it offers. Due to declining of costs, favourable legislation, and worries about greenhouse gas emissions, solar power has become a more prominent source of energy in global electricity markets (Boampong & Brown, 2020). This is elaborated more in two parts below; the benefits of solar energy and the willingness of public in utilising solar energy.

Solar Energy Benefits

There are seven compelling reasons as to why humans should use solar energy and take the advantages of the solar power benefits (GreenMatch UK, n.d.). First reason stated is that solar energy brings good to the environment as it is a great way for humans to reduce carbon footprints as it represents a clean, green source of energy. The impact of energy system onto the environment is a vital factor. It is found that solar systems also have the ability to minimise pollution (Kalogirou, 2004). Second, solar energy helps to create off-grid housing. By increasing the usage of solar energy, the cost of solar panels may decrease in time. It is found that households generating electricity can be a factor in minimalising energy dependence. However, stimulation of renewable energy sources development has to be done in developing countries. Localising the production of necessary equipment for renewable energy may also reduce the total cost (Bayramov, Prokazov, Kondrashev, & Kowalik, 2021). This shows that solar energy has high potential in helping humans in securing electricity independence. Third, solar energy can use underutilised land and subsequently generate great value that provides source of power to everyone in the area. An example of this is the solar farms (comprises of solar panels) that are perfect in collecting solar energy in bulks, daily. Next, solar energy causes less electricity loss as the energy harvested becomes domestic and does not have to go through long distance transmissions via extensive networks to reach the end-consumers (households). Solar energy also helps in improving grid security. Blackouts in homes may be reduced if more and more households switch to using solar technologies as installing solar panels at home can serve as a personal power source. Other than that, in the United Kingdom (UK), solar energy creates jobs and economic growth. The UK achieved in becoming the second-largest solar employer in 2015 with 35,000 residents and also achieved in installing the continent's largest solar photovoltaic (PV) panel (GreenMatch UK, n.d.). According to studies, clean energy, such as solar energy, is related with greater job possibilities on average. It is also found that if one more state implements clean energy policies, it might result in an additional 1% green job in U.S. metropolitan areas (Yi, 2013). This can be a good example for a small country like Malaysia to look forward in increasing solar energy awareness for public acceptance in using solar energy extensively if not fully for households. Lastly, solar energy is a free source of energy from the sun. The solar energy can help households to save money but more importantly helping in saving the mother earth. The advantages can be seen long-term and the longer a household uses solar energy, the more benefits can be enjoyed while supporting the environment without even realising it.

Public Willingness in Utilising Solar Energy

With the sustainable development growing to be popular, more households are eager to contribute to environmental advantages, which leads to the willingness in paying a portion of the cost to acquire clean energy. Therefore, a survey has to be conducted to see if the Malaysian households are willing to chip in their portion and willing to pay for solar energy implementation. The survey will help in understanding the Malaysian public's willingness in adopting and installing solar energy in their households. A widely adopted concept called willingness-to-pay (WTP) is used in the analysis of the value of public goods, such as reduction in carbon emission (Adaman et al., 2011), vehicles that use new energy (O'Garra et al., 2007), bioethanol (Lim, Kim, & Yoo, 2017) and electricity services that are reliable for the public (Taale & Kyeremeh, 2016), as well as clean energy (Shin, Woo, Huh, Lee, & Jeong, 2014). WTP for green power or in this case solar energy, may differ significantly among consumers from different nations due to disparities in economic growth, environmental policies, cultural backgrounds, social customs, and other variables (Sundt & Rehdanz, 2015). According to a certain study, the perceived usefulness (PU) of renewable energy is an essential element in determining the intention to utilise renewable energy in. The second main finding, also by the same researchers, was that perceived ease of use (PEOU) has a significant impact on the desire to adopt renewable energy in Malaysia (Kardooni, Yusoff, & Kari, 2016). These findings add to our understanding of the challenges that Malaysia has in growing renewable energy including the implementation of solar energy in households.

In relation to the above discussion, framework below is adopted for this study from Irfan et al. (2021). The framework shows the influence factors of solar energy utilisation; that was expanded from the Theory of Planned Behaviour (TPB) factors, which later on will be used in the hypotheses development (Irfan et al., 2021).

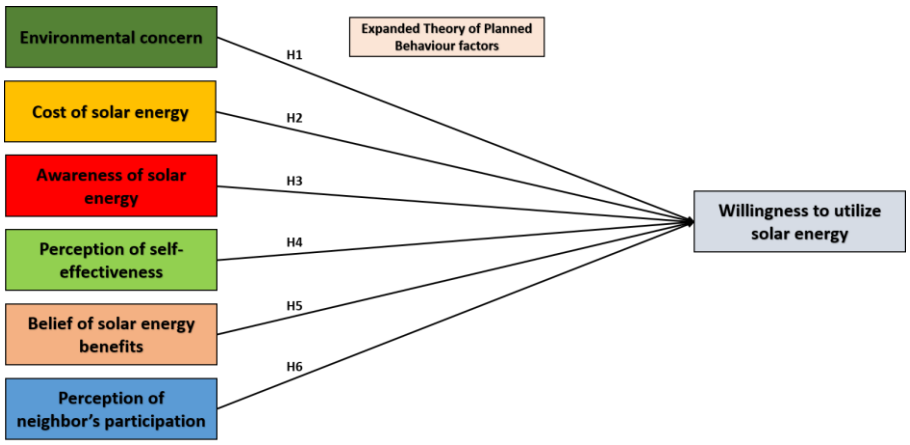

Figure 1: Influence Factors of Solar Energy Utilisation Research Framework

Hypotheses Development

A hypothesis is a statement that appears to explain observable facts and whose validity is tentatively assumed for the sake of investigation, an explanatory statement given only the degree of acceptance necessary to warrant further exploration. It's crucial to distinguish between scientific hypotheses and common sense ideas right away. Both are attempts to explain occurrences; but, the scientific hypothesis includes a combination of facts that goes beyond ordinary experience and inferences to generalisation (Feibleman, 1972).

In this section, the survey is developed by adopting six main hypotheses. The hypotheses are derived from the research framework that has been adopted from Irfan et al. (2021) research work as stated in the previous section. These hypotheses includes H1, environmental concern causes positive affects on consumers' willingness to utilise (WTU) solar energy. H2, solar energy cost that negatively affects consumers' WTU solar energy. H3, solar energy awareness may positively affects consumers' WTU solar energy. H4, self-effectiveness perception positively affects consumers' WTU solar energy. H5, trust in solar energy benefits positively affects consumers' WTU solar energy and lastly H6, neighbours' participation perception and influence positively affects consumers' WTU solar energy (Irfan et al., 2021).

Methods

In order to discover the public willingness in utilising solar energy in Malaysia, this study is developed by conducting a survey method, and data is collected from 178 public and household respondents mainly living in peninsular Malaysia. The questionnaire is developed based on the literature review and the hypotheses adopted to find a significant influence of households in Malaysia's perspective in willingness to fully utilising solar energy. Table 1 shows the survey description. The survey is conducted using a five point Likert scale, where 1 represents strongly disagree, 2 for disagree, 3 for neutral, 4 for agree, and 5 for strongly agree.

Table 1: Survey Description

Parameters	**Description**
Period of time	August and September 2021
Location	Malaysia (online)
Respondents	178
Valid responses	178

Findings

A total of 178 respondents are randomly selected from all states of Malaysia. This study is conducted through an online survey method to suit with the situation of the Covid-19 pandemic third wave in Malaysia. Sufficient information is collected through this method regardless. The survey subject is public; focusing on households, survey respondents were not limited to subjects' age. Demography of the sample is shown in Table 2, age range is included and tabled to show the inclusivity of this study. The survey has targeted and achieved in securing respondents from the Gen-Z generation (born between year 1996 – 2015), the Millennials or Gen-Y (born between year 1977 – 1995), and Gen-Z (born between year 1965 – 1976) ("Generational Breakdown: Info About All of the Generations.," 2020). The majority of the respondents are holding at least a diploma or a bachelor's degree with 77.5%.

Table 2: Demography of the Sample

Characteristics	**Categories**	**Number**	**Percentage**
Gender	Male	59	33.1%
	Female	119	66.9%
Year of Birth	1965 – 1980	37	20.8%
	1981 – 1996	29	16.3%
	1996 above	112	62.9%
Education	SPM/STPM/Certificate	14	7.9%
	Diploma/Degree	138	77.5%
	Master/PhD	26	14.6%

In order to research and find out if Malaysian households' consumers are willing to utilise solar energy, the survey is broken into six parts, accordingly to the respective hypotheses explained above. Under the factor awareness, a majority of respondents at 80.3% answer that they are strongly aware of the solar energy being an alternative power source. A 16.9% agree to that statement as well but a small percentage of 2.8% is neutral about it. 66.9% respond to strongly aware the market is accessible with solar energy-based solutions, 24.2% agree to that as well, one respondent disagree (0.6%), however 8.4% respondents feels neutral about it.
Reliability analysis test is performed to measure the data validity using SPSS packages. The results is shown below in Table 3 with Cronbach's Alpha values for all factors surpass 0.70, as per suggested by Nunnally and Bernstein (1994). It is shown that the alpha coefficient for the 15 items is 0.895, suggesting that the items have relatively high internal consistency which is considered acceptable in most social science research scenarios. This confirms that the data is valid.

Table 3: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
.895	.908	15

Table 4: Item Statistics

Factors	Mean	Std. Deviation	N
Awareness			
I am aware that solar energy is an alternative power source.	4.7753	.48135	178
I am aware that solar energy-based solutions are available in the market.	4.5730	.67040	178
Self-Effective			
I have the essential knowledge about solar energy.	4.1461	.98061	178
I have full control to utilise solar energy.	3.5562	1.08388	178
Environment Concern			
I have concerns about environmental issues.	4.5674	.67099	178
I have concerns about climate change.	4.6292	.59910	178
Solar energy utilisation would solve environmental issues.	4.4719	.69850	178
Neighbour			
Neighbour's involvement in purchasing solar energy encourages me to utilise solar energy.	3.5843	1.02851	178
Energy Benefits			
Utilisation of solar energy improve the environment.	4.5730	.59920	178
Utilisation of solar energy will strengthen energy security.	4.3258	.79937	178
New solar energy programmes will increase job opportunities.	4.4831	.71485	178
Willingness			
I am willing to utilise solar energy because I can afford it.	3.7022	1.08721	178
I am willing to utilise solar energy due to its energy-saving behavior.	4.3315	.71087	178
I am willing to spend more on solar energy compared to conventional energy.	4.0169	1.01110	178
I am willing to utilise solar energy due to its clean nature.	4.4831	.66575	178

Under the factor self-effectiveness, a small number of respondents strongly disagree (1.1%) and disagree (3.9%) to having the knowledge about solar energy. Firm percentages of 48.9% strongly agree and 23% agree in having the knowledge, but 23% feels neutral. A percentage of 34.8% are neutral about having full control to utilise solar energy, 3.9% strongly disagree, and 10.7% disagree. However, 27% agree and 23.6 strongly agree that they do have the full control in utilising solar energy in their households if desired.

Under the factor environment concern, one respondent disagree about having concerns on the environmental issues that has been going around, 8.4% remains neutral, 24.7% agree and a majority of 66.3% strongly agree that they do have concerns regarding the environmental issues. Same goes to the concerns regarding climate change, a majority of 69.1% strongly agree, 24.7% agree, however 6.2% has neutral feelings about this issue. The final question for this factor stated that solar energy utilisation would solve environmental issues, and 58.4% strongly agree and 30.9% agree with this statement, but 0.6% disagree, and 10.1% choose to be neutral about this.

Neighbours' involvement does not have a clear significant influence in purchasing and utilising solar energy among respondents. 36.5% remain neutral, 2.2% strongly disagree, 10.7% disagree, but quite a number of respondents strongly agree (23%) and agree (27.5%) that neighbours' involvement do encourage them to utilise solar energy.

Under the factor energy benefits, a big percentage strongly agree (62.9%) and agree (31.5%) that utilising solar energy can help in environment improvements. Many respondents also strongly agree (52.2%) and agree (29.2%) that utilising solar energy will help in strengthen energy security; for example: uninterrupted availability of energy sources in their daily lives. Also, a huge majority of 109 respondents (61.2%) strongly agree that programs for new solar energy can help in increasing job opportunities in Malaysia, another portion of 46 respondents (25.8%) agree as well, but 23 respondents (12.9%) choose to be neutral.

Prior analysis towards hypotheses testing is shown in Table 5 below. Factors' correlations between all the Independent Variables are tabulated as follows.

Table 5: Correlations among the Independent Variables (Pearson)

Factors		**Aware.**	**Self-Effective**	**Environ. Concern**	**Neighb.**	**Energy Benefits**
Aware.	Correlation	1	.530**	.572**	.133	.566**
	Sig. (2-tailed)		.000	.000	.078	.000
	N	178	178	178	178	178
Self-Effective	Correlation	.530**	1	.543**	.300**	.545**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	178	178	178	178	178
Environ. Concern	Correlation	.572**	.543**	1	.302**	.713**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	178	178	178	178	178
Neighb.	Correlation	.133**	.300**	.302**	1	.281**
	Sig. (2-tailed)	.078	.000	.000		.000
	N	178	178	178	178	178
Energy Benefits	Correlation	.566**	.545**	.713**	.281**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	178	178	178	178	178

Next is the factors on Malaysian households' consumers' willingness. A close call on being neutral about willingness in utilising solar energy because they can afford it (30.9%), many

however agree (29.8%), and strongly agree (28.1%) to affording solar energy utilisation. A small number of 8 respondents strongly disagree, and 12 disagree (4.5%, 6.7% respectively) in affording solar energy. For the next question under this factor, no respondents disagree on their willingness to utilising solar energy due to its energy-saving behaviour, but 14% feels neutral about it. On the other hand, 38.8% agree, and a whopping 47.2% strongly agree with the said statement. Majority respondents (41%) strongly agree that if comparing to conventional energy, they are willing to spend more on solar energy, and another 28.1% agree with this. There are 44 respondents (24.7%) state neutral about spending more, and 2.2% strongly disagree, and 3.9% disagree about this. Lastly, a significant number of respondents strongly agree (57.9%) and agree (32.6%) that there are willingness towards utilising solar energy due to its clean nature, no respondents disagree on that statement, however 9.6% feel neutral about it.

Regression analysis towards hypotheses testing is shown in Table 6 below. Table data includes R, R Squared, and Significance level.

H1 Awareness and Willingness: Table below shows that the P-value less than 0.01. This supports hypotheses 1. It can be seen that it has a weak relationship as the strength is about 36% only.

H2 Self-effectiveness and Willingness: Table stated the R value at 45%, and it shows moderate strength in supporting the hypotheses.

H3 Environment and Willingness: Table shows two models in measuring the relationship between environment concerns and willingness. Model 1 at 52%, and Model 2 at 55%. It can be seen that the strength is highly supported.

H4 Neighbour and Willingness: Table below shows that the relationship has a moderate relationship as the strength is about 47%.

H5 Energy Benefits and Willingness: Table shows the two models in measuring the relationship between energy benefits and willingness, where Model 1 is at 50%, and Model 2 at 56%. This shows that the relationship is highly supported.

Table 6: Regression

Model	TPB Expanded Factors	Variables Entered	R	R Square	Sig.
1	Awareness	I am aware that solar energy-based solutions are available in the market	.358[a]	.128	.000[b]
1	Self-Effectiveness	I have full control to utilise solar energy.	.455[a]	.207	.000[b]
1	Environment	Solar energy utilisation would solve environmental issues.	.523[a]	.273	.000[b]
2	Environment	Solar energy utilisation would solve environmental issues. I have concerns about environmental issues.	.548[b]	.301	.000[c]
1	Neighbour	Neighbor's involvement in purchasing solar energy encourages me to utilise solar energy.	.466[a]	.217	.000[b]

1	Energy Benefits	Utilisation of solar energy improve the environment.	.501[a]	.251	.000[b]
2	Energy Benefits	Utilisation of solar energy improve the environment. New solar energy programmes will increase job opportunities.	.562[b]	.316	.000[c]

Discussion and Conclusion

This study focused on the factors that influence Malaysian consumers' willingness to use solar energy in their respective households. The factors that may encourage or dissuade citizens from using solar energy have been discovered through the assessment of the survey conducted online. It is found that the cost of solar have a more negative impact to the Malaysian household consumers that positive, and that the perceptions of neighbours' engagement on solar energy for their own household has insignificant impact on the consumers' inclination to participate willingly in utilising solar energy in their household.

Theoretical Implications

These findings are about the relationship between the interest, awareness and support of household and their acceptance towards solar energy consumptions. The findings provide an understanding of household Malaysian trending in solar energy acceptance. It explains that understanding on solar energy and environment dilemma and awareness of solar energy are helpful in solving environmental issues are not sufficient to accept solar energy in their daily consumptions.

Practical and Social Implications

Since many respondents are aware of the market's solar energy-based solutions and claims that they have the necessary and important knowledge about solar energy, this is the best time for the government to draw the guidelines, policies, as well as create awareness campaigns to all Malaysians to start calculating and plan their utilisation of solar energy in their households.
Many respondents agrees that there are many benefits on adopting and utilising solar energy in their households, and there is a significant support by the public as well that utilisation of solar energy can help in getting smooth uninterrupted energy sources at home. This shows that Malaysian respondents' are highly aware of the issues and have the knowledge about solar energy utilisation. It show that it plays a big role in their investment choices and decisions as well.

Limitations and Suggestions for Future Research

This study has a potential to go further with bigger samples. A deeper understanding on public's willingness to utilising solar energy can be gained by doing so and geographical factor might play a big role in influencing the citizens. With the right support and campaigns, many Malaysians might choose the solar energy utilisation path for their betterment. The way forward for this research is to expand the study throughout the entire Malaysia especially East Malaysia.

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