FACTORS AFFECTING THE INTENTION TO USE ROOF SOLAR PANEL IN HOUSEHOLDS IN INDONESIA

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Abstract

The purpose of this study is to identify the factors that influence household intentions to use Roof Solar Panels at home. This research combines the theory of the Technology Acceptance Model (TAM) and the Diffusion of Innovation (DOI) theory. Respondents in this study were 300 households or household decision makers in Indonesia. This study has 6 hypotheses. The analysis technique of this research is Structural Equation Model (SEM) using Partial Least Square (PLS) software. In this study it was found that Perceived Ease of Use had no significant effect on Intention to Use. Meanwhile, Awareness has a positive and significant effect on Intention to Use. There is a negative and significant effect between Perceived Cost on Intention to use. There is a positive and significant influence between Relative Advantage on Intention to use. There is a positive and significant influence between Government Initiative on Intention to use. There is a positive and significant influence between Lifestyle on Intention to use.

Keywords: Solar Panel Technology, Households, TAM, Perceived Cost, Lifestyle

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1. Introduction

In the last few decades, there has been an increase in energy demand and consumption, this implies that the production of environmentally friendly renewable energy will be one of the challenges, especially for developing countries[1]. There are three generations of hydroelectric power plants, namely the first, second, and third generations. Hydropower, biomass burning, and geothermal energies are referred to as first-generation renewable-energy technologies. The second generation is a renewable technology that is developing very rapidly, consisting of solar, wind and new models of bio energy. The third generation consists of renewable energy such as concentrated solar power, ocean energy, modern geothermal energy, and integrated bio energy[2]. Energy demand in 2018 jumped 29 percent from 2017. The increase outpaced the expansion of renewable energy and led to record emissions for greenhouse gases. The global energy agency and carbon dioxide status report stated that fossil fuels contributed almost 70 percent of all that growth over the past two years. Natural gas contributes 45 percent to the increase in energy consumption. While solar and wind power plants grew by 31 percent, it was still not fast enough to meet the soaring demand for electricity.

The world's population is experiencing a rapid increase. A person's materialistic lifestyle increases the need for energy demand[3]. Excessive use of hydrocarbons and greenhouse-gas emissions from conservative energy sources indirectly increases the universal adoption of renewable-energy sources. The household sector is the main contributor to producing carbon dioxide and accounts for 70% of all emissions around the world. Therefore, the application of roof panels is very important for the household sector[4]. Adoption of the use of roof panels among households can reduce carbon dioxide (CO2) emission levels. Energy plays an important role in driving economic growth and development in many countries. Electricity is considered as an important component of a country's economy[5]. In 2014 renewable energy represented around 58.5% of net additions to global electricity capacity[6]. By 2050, the International Energy Agency (IEA) estimates that around 11% of electricity production worldwide will be provided by solar energy. Less responsive energy reception Renewable energy is not only felt by developing countries, but also felt by the industrial world[7]. It has been widely discussed that solar photovoltaic technology will become one of the main sources of energy in the future because of its long-term benefits. Due to its abundant and renewable characteristics, this solar power is renewable. Various factors influence the acceptance of renewable-energy technology, such as technology acceptance, government policies, investments, and favorable regulations. Currently, the household sector is looking for alternative energy sources that are affordable and environmentally friendly that can preserve and clean nature. Even though green energy and renewable energy have become the main topics in various studies in the world, the adoption rate is still very low.

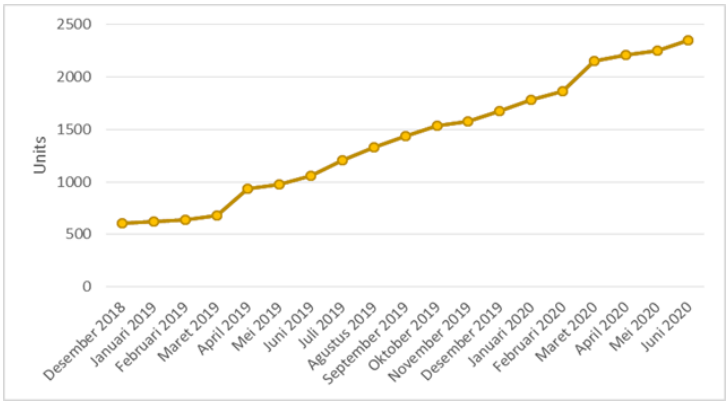

Figure 1. Number of Top PLTS Customers in Indonesia[8]

The number of PLTS users in Indonesia continues to increase. This means that Indonesia is also responding positively and taking advantage of developments in solar panel technology. The Ministry of Energy and Mineral Resources (ESDM) noted that the number of PLN customers who have installed PLTS continues to grow. In June 2020, the number of PLTS installations

reached 2,346 customers with a total capacity of 11.5 Megawatts (MW). PLN customers who have installed the Rooftop PLTS is spread across 16 provinces in Indonesia. The Ministry of Energy and Mineral Resources continues to work in a program to divert electricity subsidy funds that have been received by the community so far to be transferred to the construction of PLTS Rooftops. This step is the government's support and commitment through the Ministry of Energy and Mineral Resources to support the implementation of PLTS Roof. The household sector is the main contributor to producing carbon dioxide and accounts for 70% of all emissions around the world. Therefore, the application of roof panels is very important for the household sector[4].

In recent years, research on rooftop solar panel technology has been carried out in the household context, especially in several other developing countries such as Malaysia, Pakistan, Sri Lanka and India. Another research has explored the policy context, market perspectives, and the huge results in the acceptance and use of solar panel technology. It is important to understand the factors that influence consumer intentions to adopt new technologies such as solar rooftops. Solar panel installations in 2020 in Australia increased by 41% compared to 2019. In terms of acceptance of renewable-energy technology and resources, [9] proposes a technology acceptance model (Theory Acceptance Model) or abbreviated as TAM[9]. In the TAM model, researchers take one of the variables is Perceived Ease of Use (PEOU). PEOU refers to the extent to which individuals believe the use of new technology will be easy to use. In addition, addition, this study also uses the Diffusion of Innovation Theory (DOI).

The research[10] in Malaysia uses the independent relative advantage variables, ease of use, compatibility, trialability, observability, attitude, perceived behavioral control, subjective norm, cost, awareness, government initiative[10]. Whereas in research[11] conducted in Sri Lanka using independent variables perceived ease of use, awareness, and cost[11]. Therefore this study combines several variables from the research of the two researchers to make it complex and suitable for research in Indonesia. The independent variables that will be used by researchers are perceived ease of use, relative advantage, awareness, cost, government initiatives. In addition, this study also used the variable cost as a gap analysis, because the research conducted by [10] and [11] had different results, namely significant positive and significant negative. The difference in these results is very interesting to study in Indonesia. This study also adds new variables taken from the limitations of[11] research conducted by lifestyle variables. The research[11] in the context of solar panel adoption said that the limitations of the research were not using variable lifestyles. Therefore this study adds lifestyle variables to be explored in relation to the intention to adopt solar panels. The contribution of traders in this research is to find out what factors influence household intentions to use solar panels, and can be used as a planning strategy to ensure sustainable business growth as well as policy and decision making. The contribution of academics in this research is to be used as a reference in conducting research on solar panels in the future by adjusting existing conditions.

2. Research Method

This research is included in basic research because this research is testing, modifying, and developing theories and previous studies. The first thing that must be done in basic research is testing the initial concept or hypothesis and making deeper studies and conclusions about the observed phenomena. Based on the research objectives, this research is causal research that looks at the causal relationship between the independent variables and the dependent variable. The independent variables are perceived ease of use (PEOU), awareness, perceived cost, relative advantage, government initiative and lifestyle. While the dependent variable is the intention to use. In addition, this research is quantitative because it can be measured. All data used to support the results from this study are quantitative data.

2.1 Analysis Method

Initial data processing is to test the validity and reliability of a sample questionnaire, as many as 30 using SPSS25 software. Validity test is used to measure the legitimacy/validity of a questionnaire. A questionnaire can be said to be valid if the questions in the questionnaire are able to reveal something that will be measured by the questionnaire, namely the value of r count > r table or a significant correlation alpha <0.05. Then, reliability is a tool for measuring a questionnaire which is an indicator of the construct[12]. A questionnaire is said to be reliable or

reliable if the answers to a statement are consistent from time to time. Measurements that have high reliability are measurements that can produce reliable data. A variable is said to be reliable if the Cronbach's Alpha value has a value of > 0.7[13]. Furthermore, hypothesis testing uses a structural model that has been run on the smart-3 program and has been tested by analysis of the outer model and inner model which obtains the results on the validity and reliability of the constructed model construct. Hypothesis testing uses the results of structural model data processing by looking for the t-statistics values and p-values. The hypothesis proposed can be accepted/supported if the t-statistics ≥ 1.96 and p-value ≤ 0.05. Meanwhile, t-statistics value 0.05 then hypothesis rejected/unsupported

2.2 Hypotheses [optional]

H1. Perceived ease of use has a positive effect on intention to use
H2. Awareness has a positive effect on intention to use
H3. Perceived cost has a negative effect on intention to use
H4. Higher relative advantage has a positive intention to use
H5. Government initiatives have a positive effect on intention to use
H6. Lifestyle influences the intention to use

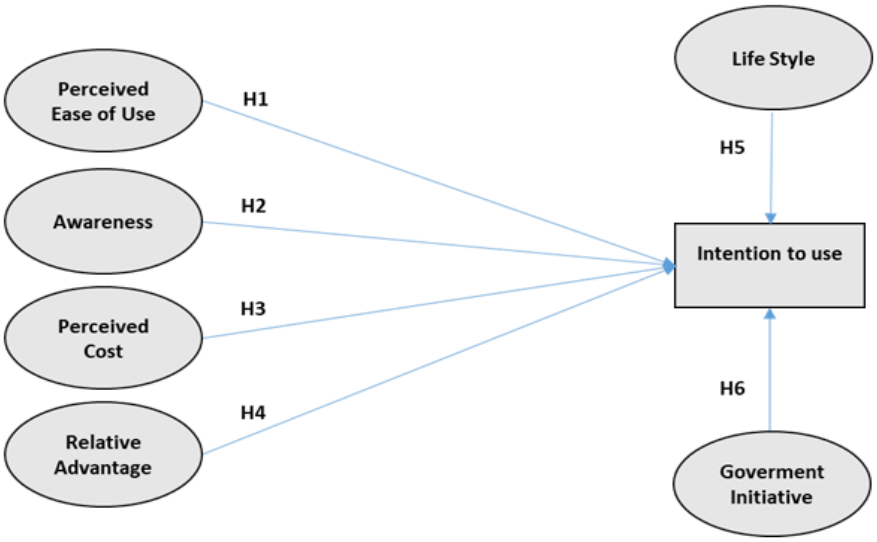

Figure 2. Research Model

3. Findings

3.1 Research Implementation

The initial data collection consisted of 30 questionnaires which were distributed to respondents according to the target population of the study. The questionnaire was made based on indicators or statement items from each of the variables perceived ease of use, awareness, perceived cost, relative advantage, government initiative, lifestyle, intention to use. Questionnaires that show valid results can explain that the statement items in the questionnaire are able to measure the variables being measured. The validity test was carried out using SPSS 25 software, using the Pearson correlation technique. Statement items are declared valid if the Pearson correlation value yields a significant value <0.05 (∝=5%). Furthermore, the Reliability Test was carried out to determine the consistency/reliability of the answers to the questionnaire when done repeatedly. Reliability test using SPSS 25 software by calculating the Cronbach's alpha value. Each statement/indicator is declared reliable if it has a Cronbach's alpha value > 0.7[14].

This research obtained 300 respondents, including 80.3% male respondents and 19.7% female respondents. There are a number of respondents with the age category of 28 by 9.0%

and 30 years by 8.7% which is the age category of the most respondents. Furthermore, 62.7% of respondents are private employees who are the most respondents. Respondents with monthly income in the range of IDR 5,000,000 – IDR 15,000,000 are 54.7% and < IDR 5,000,000 are 43.3%. Respondents with a Diploma/Strata 1 (S1) education level were 60.3%. Respondents with a number of family members ranging from 3-4 people by 54.7%. Household electricity used by respondents is 900 – 2200 watts, which is 97.7%. Electricity costs incurred per month between IDR 500,000 – IDR 1,000,000 are 79.7%. Respondents who had heard of PLTS were 100% and those who had known PLTS were 100%. In addition, 79.3% of respondents stated that they had never used a household rooftop PLTS. Respondents in this study are decision makers in the household and are interested in using a rooftop solar power plant that is equal to 100%.

Table 1. Validitas dan Reabilitas Outer Model

Variabel	Indikator	Factor Loading	Cronbach 's Alpha	Composite Reability	AVE
Perceived Ease of Use	PEOU1	0,894	0,924	0,946	0,815
	PEOU2	0,889			
	PEOU3	0,918			
	PEOU4	0,910			
Awareness	AW1	0,899	0,921	0,944	0,809
	AW2	0,912			
	AW3	0,907			
	AW4	0,880			
Perceived Cost	PC1	0,724	0,720	0,831	0,623
	PC2	0,767			
	PC3	0,869			
Relative Advantage	RA1	0,906	0,882	0,927	0,809
	RA2	0,907			
	RA3	0,885			
Government Initiave	GI1	0,927	0,938	0,960	0,889
	GI2	0,963			
	GI3	0,939			
Lifestyle	LS1	0,932	0,753	0,839	0,644
	LS2	0,859			
	LS3	0,570			
Intention to Use	IU1	0,893	0,910	0,943	0,847
	IU2	0,945			
	IU3	0,923			

Table 1 shows the values of factor loading, cronbach's alpha, composite reliability, and AVE. The factor loading value on the indicator for all indicators for each variable gets a value of > 0.7 except for the LS3 indicator which gets a value below 0.7, namely 0.570. The factor loading value recommended by Hussein (2015) is above 0.7 [15]. However, according to Chin (1998a) another reference states that a factor loading value of > 0.6 can be said to be valid and any indicator with a value below 0.4 must be removed/removed [16]. So, in this study, the LS3 indicator can still be used and not deleted/removed. In addition, the Cronbach's alpha value obtained by all indicators was > 0.6 and the composite reliability value obtained was > 0.7. This can explain that the reliability of the model has a good level

of consistency and reliability[15][16]. The AVE value obtained is also above 0.5 indicating that the model has a good level of validity.

Tabel 2. Discriminant Validity

	AW	GI	IU	LS	PC	PEOU	RA
AW	**0,900**						
GI	0,712	**0,943**					
IU	0,759	0,763	**0,921**				
LS	0,425	0,391	0,524	**0,803**			
PC	0,657	0,590	0,726	0,436	**0,789**		
PEOU	0,792	0,586	0,696	0,512	0,632	**0,903**	
RA	0,703	0,723	0,798	0,526	0,734	0,626	**0,900**

Table 2 shows that the value of discriminant validity > average cross loading/coefficients correlation, this explains that the discriminant validity of the external model is very good.

Tabel 3. Hasil Analisis Inner Model.

Konstruk	R^2	Q^2	f^2	**Keterangan**
Intention to use	0,772	0,644		
Perceived ease of use			0,013	-
Awareness			0,027	Small
Perceived cost			0,055	Small
Relative advantage			0,083	Small
Government initiative			0,130	Small
Lifestyle			0,025	Small

Note(s) : f2 : 0,02 = small ; 0,15 = medium ; 0,35 = substansial

Table 3 shows that the value of the coefficient of determination (R2) in the intention to use construct is 0.772 which means the construct variables perceived ease of use, awareness, perceived cost, relative advantage, government initiative, lifestyle can explain changes in the construct or variance value on continuance intention, namely by 77.2%. The results of the coefficient of determination (R2) in the construct of endogenous variables have shown good results where the influencing variables can explain changes in the construct/variance value of at least that is > 0.4 or more than 40%. Furthermore, the predictive relevance value (Q2) for each construct of intention to use is 0.644. This value explains that the predictive relevance value (Q2) of the endogenous construct in the study shows a value greater than 0, so the construct model has predictive relevance. In addition, the relative effect size (f2) explains that the intention to use construct has a medium level where the constructs that influence it have a small level effect. Meanwhile, the perceived ease of use variable does not have a relative effect level.

Hypothesis testing using partial least squares (PLS) is done by looking at the t-statistics and p-values. If the t-statistics value is > 1.96 and the p-value is <0.05, then there is a strong and significant influence between these variables and explains that the proposed hypothesis is supported. If the t-statistics value is < 1.96 and the p-value is > 0.05, then there is no influence between the variables and it shows that the proposed hypothesis is rejected/not supported.

The H1 hypothesis, namely "Allegedly Perceived Ease of Use (PEOU) has a positive

effect on Household Intentions (IU) to use PLTS Roofs" gets results with a t-statistics value of 1.842 <1.96 and a p-value of 0.066 > 0.05. This means that perceived ease of use (PEOU) does not have a significant positive effect on intention to use (IU) to use a rooftop solar power plant. With these results, H1 is not significant and is not supported.

The H2 hypothesis, namely "Allegedly Awareness (AW) has a positive effect on Household Intentions (IU) to Use Solar Rooftops" gets results with a t-statistics value of 2.463 > 1.96 and a p-value of 0.014 <0.05. This means that awareness (AW) has a significant positive effect on intention to use (IU) to use a rooftop solar power plant. With these results, H2 is significant and supported.

Tabel 4. Hasil Uji Hipotesis

Hipotesis		***Original Sample***	***t-statistics***	***p-value***	**Keterangan**
H1	PEOU → IU	0,096	1,842	0,066	Tidak Signifikan, Tidak terdukung
H2	AW → IU	0,154	2,463	0,014*	Signifikan, Terdukung
H3	PC → IU	0,176	3,851	***	Signifikan, Terdukung
H4	RA → IU	0,254	4,178	***	Signifikan, Terdukung
H5	GI → IU	0,274	5,735	***	Signifikan, Terdukung
H6	LS → IU	0,092	2,856	0,004**	Signifikan, Terdukung

Hypothesis H3, namely "Allegedly Perceived Cost (PC) has a negative effect on Household Intentions (IU) to Use Solar Rooftops" gets results with a t-statistics value of 3.581 > 1.96 and a p-value of 0.000 <0.05. This means that the perceived cost (PC) has a significant negative effect on the intention to use (IU) to use a rooftop solar power plant. With these results, H3 is significant and supported.

The H4 hypothesis, namely "Allegedly Relative Advantage (RA) has a positive effect on Household Intentions (IU) to use PLTS Roofs" gets results with a t-statistics value of 5.735 > 1.96 and a p-value of 0.000 <0.05. That is, the relative advantage (RA) has a significant positive effect on the intention to use (IU) to use a rooftop solar power plant. With these results, H4 is significant and supported.

The H5 hypothesis, namely "Allegedly the Government Initiative (GI) has a positive influence on Household Intentions (IU) to Use Solar Rooftops" gets results with a t-statistics value of 5.678 > 1.96 and a p-value of 0.000 <0.05. This means that the government initiative (GI) has a significant positive influence on the intention to use (IU) to use a rooftop solar power plant. With these results, H5 is significant and supported.

Hypothesis H6, namely "Allegedly Lifestyle (LS) has an influence on Household Intentions (IU) to Use Solar Rooftops" gets results with a t-statistics value of 2.856 > 1.96 and a p-value of 0.004 <0.05. That is, lifestyle (LS) has a significant positive effect on the intention to use (IU) to use a rooftop solar power plant. With these results, H6 is significant and supported.

4. Conclusion

The purpose of this study was to examine the factors that influence the intention to use rooftop solar in households in Indonesia. This study also increases knowledge and broadens horizons about PLTS renewable energy as a source of green energy for small-scale household use in urban areas. It examines the reasons for accepting or rejecting the use of alternative energy sources, namely the sun. From a managerial standpoint, these findings provide support for investment decisions for investors interested in the concept of green energy with environmental friendliness, as well as for decisions about increasing renewable energy, which can be considered for housing needs.

Research has shown five important factors that have an impact on the adoption of PV mini-grid. The results of the analysis prove that there is an influence of PLTS adoption on four variables, namely awareness, perceived cost, relative advantage, government initiative, lifestyle. Meanwhile, perceived ease of use has no effect on PLTS adoption. The biggest influence lies in the variable indicators of government initiative, relative advantage, and perceived cost indicating that households in Indonesia emphasize government support for renewable and environmentally friendly technologies, the benefits obtained in using PLTS for households, and perceived costs for households in using rooftop solar. Meanwhile, perceived ease of use in operating PLTS is not very important for households in Indonesia. Therefore, researchers recommend PLTS producers to increase profits and benefits in using PLTS and reduce the price of PLTS in accordance with economic conditions in Indonesia. As well as the government's policy on renewable energy also plays an important role, thus creating SNI-standard PLTS.

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