

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 households' intention to use rooftop solar panels in their homes. This study combines the technology acceptance model (TAM) theory 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 research methodology employed In this study, we use Partial Least Squares (PLS) software to implement Structural Equation Model (SEM) analysis. The study found that perceptions of ease of use do not have a significant impact on intent to use. Research results show that awareness has a positive and significant effect on intention to use. Conversely, perceived costs negatively impact usage intent and have a significant impact. Additionally, Relative Advantage, Government Initiative, and Lifestyle all positively and significantly influence the Intention to Use. Keywords: Perceived Cost, Households, TAM, Solar Panel Technology, Lifestyle



1. Introduction

Over the past few decades, there has been a rise in energy consumption and demand. As a result, the production of renewable energy that is eco-friendly is becoming more challenging, especially for developing nations[1]. The hydroelectric power plants have been divided into three generations, namely the first, second, and third generations. The first generation of renewable energy technologies includes hydropower, biomass burning, and geothermal energies. The second generation, which is rapidly evolving, it consists of solar, wind and new bioenergy models. The third generation consists of renewable energy such as concentrated solar energy, ocean energy, advanced geothermal energy and integrated bioenergy[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 will indirectly increase the general acceptance 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. Excessive use of hydrocarbons and greenhouse gas emissions from conservative energy sources will indirectly increase the general acceptance of renewable energy sources[5]. In 2014, renewable energy accounted for about 58.5% of the net increase in global power capacity[6]. The International Energy Agency (IEA) estimates that by 2050 about 11% of the world's electricity will be supplied by solar energy. Less responsive energy reception Renewable energy is not only felt by developing countries, but also felt by the industrial world[7]. There has been extensive discussion about the potential of solar photovoltaic technology to become a major source of energy in the future, primarily due to its long-term benefits. Solar power is considered renewable, owing to its abundant and replenishable nature[8]. Various factors influence the acceptance of renewable-energy technology, such as technology acceptance, government policies, investments, and favorable regulations[9]. Currently, the household sector is looking for alternative energy sources that are affordable and environmentally friendly that can preserve and clean nature[10]. 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.

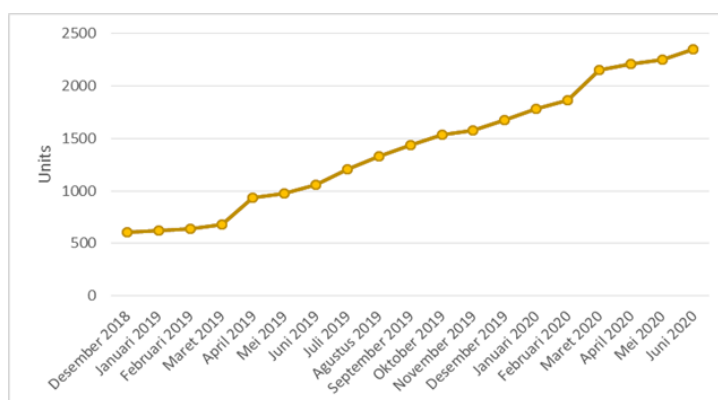


Figure 1. Number of Top PLTS Customers in Indonesia

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 Natural 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)[11]. 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[12]. The move is government support and commitment, through the Department of Energy and Natural Resources, to help implement the 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 roofs[13]. Solar panel installations in 2020 in Australia increased by 41% compared to 2019. In terms of acceptance of renewable-energy technology and resources, proposes a technology acceptance model (*Theory Acceptance Model*) or abbreviated as TAM. The TAM model includes perceived ease of use (PEOU) as one of its variables. PEOU measures how easily and easily an individual can use new technology. In addition, the study also uses diffusion theory of innovation (DOI). The Malaysian study used independent relative advantage variables, ease of use, compatibility, testability, observability, attitudes, perceived behavioral control, subjective norms, cost, awareness, and government initiative[14]. A study conducted in Sri Lanka using independent variables considered perceived ease of use, perception, and cost of equipment or supplies[15].

The aim of this study is to determine the factors that influence the intention to use solar panels on the roof of households. This study combines several variables from the research of the two researchers to make it complex and suitable for research in Indonesia[16]. Researchers will use a variety of independent variables, including perceived ease of use, relative advantage, perception, cost, and government initiatives. In addition, this study also used the variable cost as a gap analysis, because the research conducted by and had different results, namely significant positive and significant negative[17]. The difference in these results is very interesting to study in Indonesia. This study also adds new variables taken from the limitations of research conducted by lifestyle variables. The research in the context of solar panel adoption said that the limitations of the research were not using variable lifestyles[18]. Therefore this study adds lifestyle variables to be explored in relation to the intention to adopt solar panels[19]. The merchant's contribution to this study was to explore what factors influence a household's intention to use solar panels and can be used as a planning strategy to ensure business growth. sustainability 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 objective, this study is a causal study to examine the causal relationship between the independent and dependent variables[20]. Perceived independent variables are 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. The data utilized to validate the findings of this research comprise entirely of quantitative data.

2.1 Analysis Method

Initial data processing including checking the validity and reliability of a questionnaire form, up to 30 using SPSS25 software[21]. Validity tests are used to measure correctness/effectiveness questionnaire[22]. a validity test is conducted. A questionnaire is deemed valid if its questions can effectively elicit responses that correspond to what the questionnaire is designed to measure. This can be assessed by verifying whether the value of $r_{count} > r_{table}$ or a significant correlation $\alpha < 0.05$. Then, reliability as a measure of the

questionnaire is an indicator of the structure[23]. A questionnaire is said to be authoritative or reliable if the responses to the statements are consistent from time to time. A reliable measurement is one that can produce reliable data. A variable is said to be reliable if its Cronbach alpha value is > 0.7 [24]. In addition, hypothesis testing uses structural models run in the smart-3 program, analyzes and tests external and internal models, and obtains results on the validity and reliability of the constructed model constructs[25]. Hypothesis testing uses the results of structural model data processing by looking for t-statistics and p-values. A proposed hypothesis is accepted and supported if the t-statistic is greater than or equal to 1.96 and the p-value is less than or equal to 0.05. On the other hand, the t-statistic is 0.05, rejecting/not supporting the hypothesis.

2.2 Hypotheses [optional]

- H1. Perceived ease of use positively influences usage intent
- H2. Awareness has a positive effect on consumer intentions
- H3. Perceived costs negatively impact usage intent
- H4. The higher the relative advantage, the more willing you are to use
- H5. Government initiatives have a positive effect on intention to use
- H6. Lifestyle influences consumption intentions

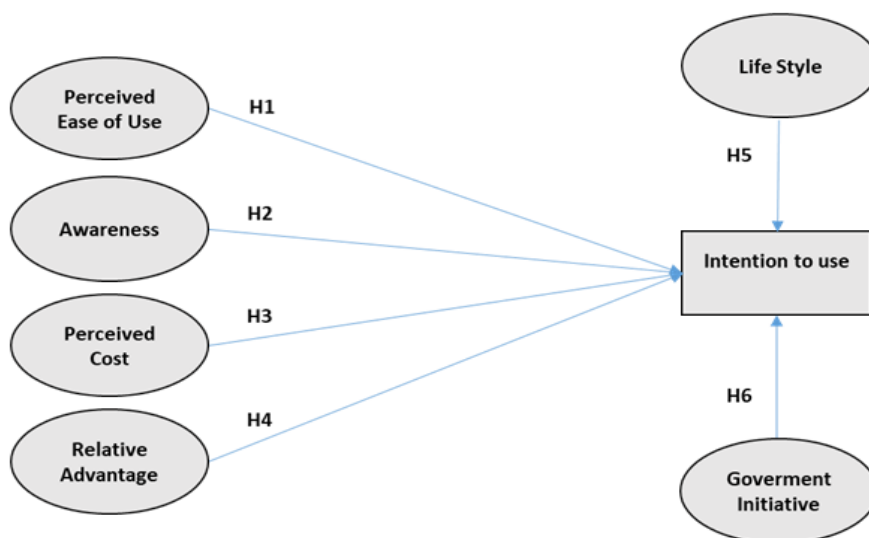


Figure 2. Research Model
Source: Bandara et al., (2020), Alam et al., (2021)

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. Questionnaires were developed based on indicators or propositional items for each variable, including perceived ease of use, perceptions, cost perceptions, relative benefits, government initiatives, lifestyle, and intent 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 ($\alpha=5\%$). Additionally, a reliability test was performed to determine the consistency/reliability of responses when the questionnaire was repeated. Reliability test using SPSS 25 software by calculating the Cronbach's alpha value. Each statement/indicator is said dependable if it has a Cronbach's

alpha value > 0.7.

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. According to the respondents, 54.7% of them have a monthly income in the range of IDR 5,000,000 to IDR 15,000,000, while 43.3% have a monthly income of less than IDR 5,000,000. 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. Validity and Reliability of External 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 Initiative	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 Factor loadings, Cronbach's alpha, combined 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. 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. 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 may explain that the model reliability has a good level of consistency and reliability. The AVE values obtained for him are also above 0.5, indicating good validity of the model.

Table 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.

Table 3. Inner Model.Result

Construct	R ²	Q ²	f ²	Statement
<i>Intention to use</i>	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 statistic, a value of 0.02 is considered small, 0.15 is medium, and 0.35 is substantial.

Table 3 shows that the value of the coefficient of determination (R²) in the intention to use construct is 0.772 That is, perceived ease of use of configuration variables, relative advantage, perceived cost, government initiative, awareness, 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, Configuration models have 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 variable of perceived ease of use does not possess a level of relative effect.

Hypothesis testing using Partial Least Squares (PLS) was performed by testing t-statistics and p-values. If the value of t statistic > 1.96 and p-value < 0.05, there is a strong and significant

influence between these variables and it is explained that the proposed hypothesis is supported. If the value of $t\text{-statistic} < 1 > 0.05$, there is no effect between the variables and this 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 $t\text{-statistics}$ value of 1.842 < 1.96 and a $p\text{-value}$ of 0.066 > 0.05 . This means that perceived ease of use (PEOU) does not have a large positive impact on intent 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 $t\text{-statistics}$ value of 2.463 > 1.96 and a $p\text{-value}$ 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.

Table 4.Hypothesis Result

Hipotesis		Original Sample	t-statistics	p-value	Statement
H1	PEOU → IU	0,096	1,842	0,066	Not Significant, Not Supported
H2	AW → IU	0,154	2,463	0,014*	Significant, Supported
H3	PC → IU	0,176	3,851	***	Significant, Supported
H4	RA → IU	0,254	4,178	***	Significant, Supported
H5	GI → IU	0,274	5,735	***	Significant, Supported
H6	LS → IU	0,092	2,856	0,004**	Significant, Supported

Hypothesis H3, namely "Allegedly Perceived Cost (PC) has a negative effect on Household Intentions (IU) to Use Solar Rooftops" Obtain results with a $t\text{-statistic}$ value of 3.581 > 1.96 and a $p\text{-value}$ of 0.000 < 0.05 . This indicates that the intention to use (IU) of a rooftop solar power plant is significantly and adversely influenced by the perceived cost (PC). 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 $t\text{-statistics}$ value of 5.735 > 1.96 and a $p\text{-value}$ of 0.000 < 0.05 . That is, the intention to use (IU) of a rooftop solar power plant is significantly and positively influenced by the relative advantage (RA). 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 $t\text{-statistics}$ value of 5.678 > 1.96 and a $p\text{-value}$ of 0.000 < 0.05 . Government initiatives (GI) therefore have a very positive impact on the intent to use (IU) of rooftop solar power plants. 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 worth $2.856 > 1.96$ and a worth of $0.004 < 0.05$. That is, lifestyle (LS) has a significant positive impact on intention to use (IU) for using solar power plants on roofs. These results make H6 important and supportive.

4. Conclusion

The purpose of this study is to investigate the factors influencing the use of solar roofs in Indonesia. This research also contributes to the knowledge and broadens the perspective on renewable energy PLTS as a green energy source for small urban residential buildings. This study examines the reasons for accepting or rejecting the use of alternative energy sources, namely solar energy. From a business perspective, these results will assist investors in making investment decisions interested in environmentally friendly green energy concepts, as well as renewable energy adoption decisions that can be factored into residential needs. Research has shown five important factors that have an impact on the adoption of PV mini-grid. The analysis findings demonstrate that PLTS has an impact of 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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