Behavioral Factors Underlying Households' Intention Toward Solar Photovoltaic Adoption

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Abstract

This study developed a conceptual framework based on the Unified Theory of Acceptance model and Use of Technology2 (UTAUT2) to understand the behavioral factors underlying intention to adopt solar photovoltaic (PV). The present study extends the framework to include personal norms to explain the intention to adopt solar PV. The present study aims to investigate the behavioral factors underlying the intention to adopt solar PV by Indonesian households. An empirical survey involving 413 Indonesian households from all 34 provinces in Indonesia was carried out in 2019. Based on binary logistic regression, out of the 12 factors being investigated, it was found that personal norms, age, performance expectance, price value, and facilitating condition (i.e., accessible infrastructure and service) have statistically significant influences on the intention to adopt the solar PV. The model has a classification accuracy of 74% and can explain the 27% of the intention variance. The findings imply that in addition to financial benefits and affordability, facilitating conditions in terms of the availability of supply, installation, and maintenance services play a motivating role in adopting solar PV. Further, personal norms are also a significant factor toward the intention to adopt solar PV. Potential interventions to drive up the intention to adopt solar PV are also discussed.

Keywords
Residential photovoltaic, UTAUT2, Intention, facilitating condition, Technical support.

1. Introduction

Electricity consumption is an indicator of a country's economic development. Population growth followed by increased economic activity demanded an increase in electricity supply. More than 70% of global energy needs depend on fossil, resulting in global climate change (Abbasi and Abbasi, 2012). The fulfillment of electricity needs should consider the depletion of fossil resources and commitments to reduce greenhouse gas emissions. Through its National Energy Policy (Kebijakan Energi Nasional, KEN) formulated in 2014, the Indonesian government targets 23% renewable energy in the national energy mix by 2025 and 31% in 2050. The effort is a commitment to the Paris Agreement to reduce greenhouse gases. However, by the end of 2020, the renewable mix has only reached 11.5% or half of the targeted value (MEMR, 2020). There are only four years left to get the target of 23%. Therefore, efforts are needed to accelerate the transition to renewable energy.

Indonesia is an archipelago country with a strategic geographical location, crossed by the equator. The sun shines for 11.8 -12.4 hours with an average Global Horizontal Irradiance (GHI) of 4.73 to 5.77 kWh/m^2/day, promising potential solar energy of 207,898 Mega Watt (MW) through photovoltaics (PV) technology (Setyawati, 2020). The household sector is the largest national energy user (Setiawan and Yuliania, 2018). The use of PV in this sector is effective for increasing the renewable energy mix. In Indonesia, the solar home system (SHS) program from 1997 to 2003 failed due to ineffective financing, a lack of domestic PV industry and service companies for sales and maintenance, subsidized fossil energy, expansion of the electricity grid, and misunderstanding of household characteristics (Sovacool, 2018). In 2017 the Indonesian government promoted the Rooftop Photovoltaic Solar System (RPV) through the National Movement for One Million Solar Roofs (GNSSA). GNSSA appeals to use the rooftop as a power plant through the rooftop PV application. In that year, State-owned Electricity Company (PLN), an electricity provider and distributor in Indonesia, recorded 351 customers using RPV. At the end of 2018, through the Ministry of Energy and Mineral Resources (MEMR), the Indonesian government issued Ministerial Regulation No. 49/2018 regarding the RPV. One of the policies in the regulation is that PLN customers who use RPV can export excess electricity produced by their PV systems to the PLN electricity network, and a purchase price is set at 65% of the PLN tariff. The RPV policy influences the interest in rooftop PV. In October 2020, there were 2,566 PLN customers using RPV (MEMR, 2020). However, of this number, 93% of customers are concentrated in Java Island, where the PV solar industry and service companies for sales and maintenance are located. Remote access to PV service providers is a barrier to adoption outside Java. The adoption rate in other islands is still low, including several provinces, potential markets with high purchasing power, showing that PV adoption is due to affordability and other factors. The Ministry of Energy and Mineral Resources (MEMR) recorded that until mid-2020, total rooftop PV capacity in Indonesia has only contributed 11.5MW from the target of electricity production from solar power of 6.4 GW by 2025 (MEMR, 2020). The right policies are needed to accelerate the adoption of PV systems. Therefore, the present study aims at investigating the behavioral factors underlying the intention to adopt solar PV by Indonesian households.

Increasing the adoption of PV systems is challenging, especially since PV systems are a new technology for Indonesians. Moreover, adopting new technology is carried out when relative advantage is expected, whether financial gain or social prestige (Korcaj et al., 2015). Relative advantage is related to the perception that innovation has benefits or seems better than existing technologies (Roger, 2003). PV technology replaces fossil fuel electricity, reducing greenhouse gas emissions and other types of pollutants. As "green" energy, the motivation for its use can be explained by pro-environmental behavior as the personal norms of the decision-maker. The adoption of new technologies is influenced by perceptions of the technological attribute and external factors such as social interaction, advertising, word of mouth, or peer effects (Kowalska-Pyzalska, 2018). Graf-Vlachy et al. (2018) stated the importance of studying the social influence on adopting RPV. In addition, the conditions of supporting facilities often influence innovation adoption decisions (Yang and Forney, 2013). Understanding the relationship between the two is necessary for the industry to provide adequate infrastructure to support PV technology adoption.

Several studies have investigated the influence of relative advantages, social influence, and personal norms on adoption. Therefore, this study tries to understand their role in influencing the adoption of RPV in Indonesian households. The study also assessed facilitating conditions for behavioral intentions associated with solar PV systems, a factor that has not been widely discussed in existing studies. This study contributes to understanding underlying factors that significantly influence PV adoption, which can then be used as a basis to determine interventions to accelerate PV adoption in Indonesia.

The remainder of this paper is presented as follows. An overview of the literature is provided in Section 2, and Section 3 describes the materials and methods. The data is presented in Section 4, followed by results and discussion in Section 5, and a conclusion in Section 6.

2. Literature Review

Diffusion of Innovation (DoI) from Roger (2003) is a commonly used framework to study innovation adoption and diffusion. Relative advantage, compatibility, complexity, trialability, and observability are Rogers's five perceived components of innovations. Theory Reasoned Action (TRA), developed by Fishbein and Ajzen (1975), states that user behavior is influenced by attitude and social norms. Departing from that, Davis (1985) developed the Technology Acceptance Model (TAM). Based on TAM, the use of technology was studied by behavioral intentions, attitudes, perceived ease of use, and perceived usefulness. Davis (1985) defines perceived usefulness as "the degree to which a person believes that using a particular system will improve his or her job performance." In contrast, perceived ease of use is defined as "the degree to which a person believes that using a particular system will be effort-free."

Furthermore, Davis adds one more aspect as a determinant of intention, namely subjective norms; this theory is TAM2. The development of TRA is also done by adding a perceived behavioral control construct (Ajzen, 1991). This theory is known as the Theory of Planned Behavior (TPB). Other theories were developed using various constructs in identifying the behavioral factors of innovation adoption.

Venkatesh et al. (2003) synthesize eight existing technology acceptance models, namely TRA, TPB, TAM, Combined TPB-TAM (Taylor and Todd, 1995a; Taylor and Todd, 1995b), Motivational Model-MM (Davis et al.,1992), Model of Personal Computer Utilization-MPCU (Thompson et al., 1991), Innovation Diffusion Theory – IDT (Roger, 2003), and Social Cognition Theory – SCT (Bandura, 1986). By integrating the eight elements of the model, Venkatesh et al. (2003) propose and validates the Unified Theory of Acceptance and Use of Technology (UTAUT). Combining these models gives UTAUT seven constructs. Four direct determinants of intention to use technology are performance expectations, effort expectations, social influence, and facilitation conditions. In contrast, behavioral intentions and facilitation conditions determine technology use. Table 1. shows the description of four constructs of the UTAUT.

Tabel 1. Description of UTAUT variables and models derived from them

Construct	Description	Root of construct
Performance Expectance	The degree to which an individual believes that using the system will help him or her attain job performance gains (Venkatesh et al., 2013).	Perceived usefulness (TAM/TAM2 & C-TAM-TPB) Extrinsic Motivation (MM) Relative advantage (IDT) Job fit (MPCU) Output expectations (SCT)
Effort expectance	The degree of ease associated with the use of the system (Venkatesh et al., 2013).	Perceived ease of use (TAM/TAM2) Complexity (MCPU) Ease of use (IDT)
Social Influence	The degree to which an individual perceives that important other believe he or she should use the new systems (Venkatesh et al., 2013).	Subjective norms (TRA, TAM2, TPB, C-TAM-TPB) Social Factors (MPCU) Image (IDT)
Facilitating Condition	Customers' perception of the resources and support available to perform a behavior (Venkatesh et al., 2013).	Perceived behavioral control (TPB, C-TAM-TPB) Facilitating conditions (MPCU) Compatibility (IDT)

UTAUT2 is an extension of UTAUT to study the acceptance and use of technology in the context of consumers by adding three constructs, namely hedonic motivation, price values, and habits (Venkatesh et al., 2013). Hedonic is defined as the pleasure obtained from the use of technology. Pricing is derived from the costs incurred to use the technology associated with purchasing devices and services. The last construct, habit, is defined as the degree to which people tend to perform behaviors automatically due to learning which is measured as the extent to which individuals believe that behavior is automatic (Limayem et al. 2007). The addition of hedonic motivational constructions (pleasure), price value, and habits become significant refinement as it extends the model to consumer usage contexts (Aggarwal et al., 2019).

UTAUT provides a valuable tool for identifying factors that might influence technology adoption (Williams et al., 2011). UTAUT has been widely used to investigate the market acceptance of various innovations in information technology (Kasim 2015, Lescevica et al. 2013, Slade et al. 2015). Although this model was developed to analyze the adoption of information systems, in several studies, the construction of UTAUT and UTAUT2 has been shown to explain decision-making about the transition to renewable energy. (Khorasanizadeh et al. 2016)used a modified UTAUT to investigate the factors that might play an essential role in successfully adopting light-emitting diode-based lighting in Malaysia. Lau et al. (2021) used the UTAUT2 framework to examine knowledge, price value, social influences, and facilitating conditions toward behavioral intentions of solar PV systems in Malaysia. Aggarwal et al. (2019) built a quantitative approach to identify factors and their relative impact on the purchase intention of domestic RPV buyers in India by modifying the theoretical framework of acceptance and use of integrated technology 2 (UTAUT2), which was modified through the addition of awareness/knowledge factors. Recently, Apfel and Herbes (2021) added aspects of knowledge, communication channels, and entrepreneurial orientation to the UTAUT2 framework to examine what factors drive the adoption of renewable energy technologies by small and medium enterprises (SMEs) in Senegal.

The use of traditional behavioral models (such as TPB, TRA) develops models of consumer behavior but does not undertake a comprehensive exploration of potential factors. The unified theory of acceptance and use of technology 2 (UTAUT2) has proven to provide a breakthrough in the predictability of adopting the Solar Water Heater System in Libya (Saleh et al. 2014). The use of the UTAUT2 model also makes it possible to empirically verify a very suitable model for end-user purchase intentions for rooftop solar in the Indian context (Aggarwal et al. 2021) UTAUT2 behavioral models typically provide significantly improved fit over traditional behavioral models because they investigate more factors outside of subjective norms (social influence beliefs).
Several studies have looked at the role of environmental motives in pursuing sustainable environmental innovation. Noppers et al. (2014) found that perceived environmental attributes are the main drivers of adopting sustainable innovations. Jansson et al. (2011) used Value Believe Norm (VBN) to examine the factors influencing willingness to

buy an environmentally friendly car. The results suggest that personal norms have the most substantial direct effect. Personal norms have been shown to influence behavioral intention to use environmentally friendly behavior (Jager, 2006; Jager et al., 2000; Jager, 2006; Labay and Kinnear, 1981). Personal norms play an important role in paper consumption in Indonesia (Sopha, 2013). Based on the Norm Activation Model (NAM) framework, personal norms are intrinsic factors that reflect feelings of individual moral obligation that encourage pro-environmental behavior (Zhang et al., 2019). Using a PV system is an altruistic behavior, where a person switches from fossil energy sources for environmental sustainability. Intention to do altruistic behavior occurs because of intrinsic motivation from personal norms. So the influence of personal norms on behavioral intentions to adopt PV systems is essential to investigate.

The influence of socio-demographic aspects on PV adoption intentions is an exciting study. Rai and Robinson (2015) prove the influence of race, family composition, education, and retirement status on attitudes of PV adopters. The type of occupation and the amount of income proved to significantly affect PV adoption in San Diego, California (Letchford et al., 2014). These results align with Sigrin et al.(2015), which stated that PV adopters in California tend to have more income, higher education, and larger house size. However, Chernyakhovskiy (2015) found that demographic factors had no significant effect on PV adoption in the United States. A study in Uttar Pradesh analyzed the determinants of awareness and willingness to pay for a solar home system (Urpelainen and Yoon, 2015). The study underscores the role of household heads' income, education level, and age in predicting household awareness of the home solar system. Education, income, and age are demographic determinants that significantly affect the intention to adopt PV.

Some of the literature on PV adoption in Indonesia focuses on economic factors. Sovacoll (2018) investigated the Solar Home System (SHS) program in Indonesia and found the program's failure due to the unaffordability of PV prices and the lack of support from the government. Similar results were reported by Outhred and Retnanestri (2015) and Burke et al. (2019). Based on these findings, Al Irsyad et al. (2019) investigated the effects of various financial policies on the intention to use RPV, and Setyawati (2020) focused on public perceptions of RPV policies. Both researchers investigated the influence of economic, technical, environmental, and socio-demographic factors on using RPV. According to our literature review, there has been no systematic research with a diffusion theory approach to studying the behavioral intentions of using renewable energy, especially PV technology in Indonesia.

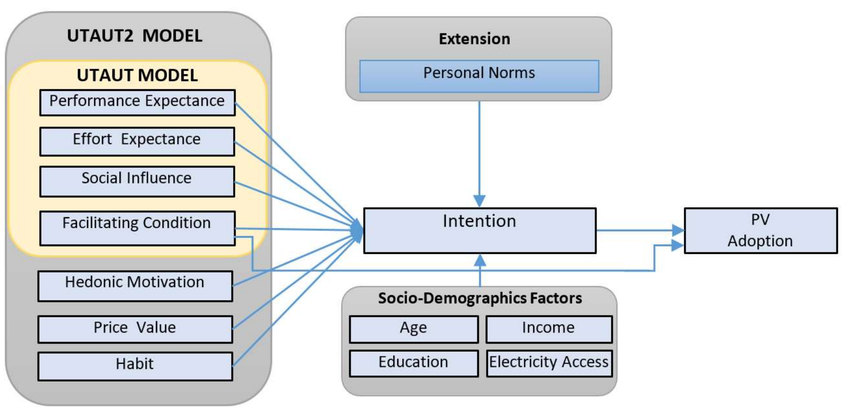

Figure 1. Extended UTAUT2 Framework

State of the art shows that UTAUT2 components have a relationship with the intent to use the RPV system (Aggarwal et al., 2019, Apfel 2021, Lau et al., 2020). Several studies have also found the influence of personal norms (Jager 2006, Zhang and Vorobeychik, 2019) and socio-demographic (Rai and Robinson 2015, Letchford et al. 2014, Sigrin et al.2015, Chernyakhovskiy 2015, Urpelainen and Yoon, 2015) on the intention to adopt PV. So this study investigates PV adoption using the extended UTAUT2 framework, including personal norms and socio-demographic. The predictors for all aspects are presented in Figure 1.

Because of the constraints in observing actual buying behavior, we concentrate on behavioral intention: purchase intention. Knowing the intention is valuable because the stronger the intention shows the magnitude of the tendency of the user behavior (Ajzen, 2012). This study is expected to identify important factors for the transition to renewable energy sources in Indonesia.

3. Methods

This study used the extended UTAUT2 framework to classify non-PV adopter households based on their intention to use PV. It categorized them into the intender group and the non-adopter group households by binomial logistic regression because of its ability to statistically compare two discrete categories (Hosmer et al., 2013). The dependent variable in this study is worth one for households that intend to adopt PV and zero for those that do not. The output of this analysis informs the critical factors in PV adoption decisions. The resulting model is a function of the independent variables obtained from the survey in numeric and categorical data. The coefficients of the logistic regression model are interpreted as the probability of adoption occurring for responses to specific survey questions when other factors and variables are controlled.

Data collection was carried out on Indonesian households using a questionnaire compiled based on the extended UTAUT2 framework. Questionnaires were prepared to obtain socio-demographic data and information about the effect of predictors on PV adoption intentions. Age, income, education, place of residence, and access to electricity are socio-demographic data collected. Factors that influence adoption intentions were asked based on the construct in the UTAUT 2 model and personal norm. Two questions were asked for each construct referring to previous research. Table 2 presents the operationalization of each construct in this study. Before distribution, a pilot project for filling out the questionnaires was conducted to test and refine the questionnaire. Distribution of questionnaires through social media to reach a wide area to get responses at the national level. It is assumed that only homeowners will install roof PV. Therefore non-homeowners responses were excluded in the data processing. The Chi^2 test was carried out to ensure no difference between the sample distribution and the regional distribution of Indonesian households. Binary logistic regression was used to analyze the effect of the independent variable in table 1 on the intention to adopt RPV. Non-adopter households were classified into "intender" and "non-adopter" groups based on the answers to questions during the survey. Respondents who stated that they would use PV in the next three years were included in the intender group and vice versa. Multicollinearity testing was carried out as a prerequisite for applying binary logistic regression by setting the rules for Variance Inflation Factors (VIF) < 10 and tolerance values > 0.1. Hosmer-Lemeshow fit test was used as a test of the fit of the formed logistic regression model. Analysis of the formed logistic regression equation was carried out to identify the effect of the independent variable on the intention to adopt RPV.

Tabel 2. Model Construct

Construct	Operationalization in this research	Sources
Performance Expectance	Save natural resources Reduces electricity bill	Korcaj et al. (2015) Khorasanizadeh et al. (2016)
Effort Expectance	Ease of use. Ease of installation	Khorasanizadeh et al. (2016), Aggarwal et al.(2019) Aggarwal et al. (2019)
Hedonic Motivation	Interesting Keeping up with technology	Khorasanizadeh et al. (2016), Aggarwal et al. (2019) Aggarwal et al. (2019)
Price Value	Installation Cost Return of Investment	Vasseur and Kemp (2015) Lau et al. (2021)
Habit	Technical knowledge Enough information	Vasseur and Kemp (2015) Khorasanizadeh et al. (2016)
Facilitating Condition	After-sales service for maintenance Availability of PV industries and supporting facilities	Lau et al. (2021) Khorasanizadeh et al. (2016)
Personal Norms	Responsible for protecting the environment. Moral obligation to reduce the use of fossil fuel energy.	Wolske (2020) Wolske (2020)
Social Influence	Number of people who recommend using RPV PV installed by neighbors	Khorasanizadeh et al. (2016), Aggarwal et al. (2019) Aggarwal et al. (2019)

4. Data

Data collection through a survey of Indonesian households was conducted from November to December 2020. The pilot study was carried out with ten households. Once refined, the questionnaire was distributed through social media to obtain information representative of responses at the national level. Only responses from homeowners and those with decision-making authority within the household were selected as respondents. Participants with missing scores on the predictive variables were also excluded, leaving 413 responses for analysis. The final analysis was based on 413 responses, 46 from RPV adopters and 367 non-adopters. Here, adopters refer to homeowners who confirm the adoption and use of PV in their homes. Non-adopting households were classified into intentional and nonuser groups based on the answers to questions during the survey. Respondents who stated that they would use PV in the next three years were included in the intention group and vice versa.

The sample distribution is compared with households in 34 provinces based on the Central Statistical Agency (BPS,2017). The test results showed that it was not significant (Chi^2 = 20.46; df = 33; p = 0.958), proving that the sample composition represents the regional distribution of Indonesian households. Empirical research has identified factors that influence the intention to use RPV in non-adopter households.

5. Results and Discussion

Tables 3 and 4 present the profile of the adopter and non-adopter. The Chi^2 test in both tables represents the assumption that adopters have a distribution that is not different from non-adopters. Table 3 reports the results for socio-demographics and social interaction. The adopter sample was dominated by respondents who had high school and university education; conversely, the sample of non-adopters was dominated by those with university and postgraduate education. The non-adopter sample represents all regions, while the non-adopter sample is only in the Java and Kalimantan regions. Most PV adopters are households without access to electricity, and PLN customers 1300 VA to 3300 VA categories. Meanwhile, non-adopter respondents were dominated by electricity customers with 1300VA and 2200VA. More than 80% of the sample of non-adopters received recommendations of less than five people, while adopters received more recommendations than that.

Table 3. Profiles of respondents based on categorical independent variables.

Variables	Adopter (N = 46)	Non Adopter (N= 367)	Chi^2 test		
			Chi^2	*df*	*p*
Education			24,784	3	< 0,001
1 = Elementary school	1 (2.2%)	1 (0.3%)			
2 = High school	14 (30,4%)	25 (6,8%)			
3 = University	20 (43.5%)	117(48,2%)			
4 = Postgraduate	11 (23.9%)	164 (44.7%)			
Region			19,304	5	0,002
1 = Java	29 (63%)	274 (74.7%)			
2 = Sumatra & surrounding islands	4 (8,7%)	36 (9.8%)			
3 = Kalimantan & surrounding islands	10 (21,7%)	14(3.8%)			
4 = Sulawesi & surrounding islands	0 (0%)	19 (5.2%)			
5 = Bali & Nusa Tenggara	1 (2.2%)	12 (3.3%)			
6 = Maluku, Papua & surrounding islands	2 (4.3%)	12 (3.3%)			
Electricity Access			40,487	5	<0,001
1 = No electricity	10 (21,7%)	2 (0,5%)			
2 = PLN < 1300 W	2 (4,3%)	20 (5.4%)			
3 = PLN 1300W	16 (34,8%)	214 (58,3%)			
4 = PLN 2200W	10 (21,7%)	91 (24,8%)			
5 = PLN 3300 W	8 (17,4%)	37 (10,1%)			
6 = PLN 5500 W or more	0 (0,0%)	3 (0,8%)			
Number of people who recommend using			24,410	4	<0,001
RPV	6 (13,0%)	106 (28,9%)			
1 = 0	29 (63,0%)	245 (66,8%)			
2 = 1–5 peers	5 (10,9%)	9 (2,5%)			
3= 6–10 peers	3 (6,5%)	6 (1,6%)			
4 = 11–15 peers	3 (6,5%)	1 (0,3%)			
5 = more than 15 peers					

Table 4. shows no significant difference between the age of the sample of non-adopter and the sample of an adopter. However, the adopter sample has a higher income level than the non-adopter sample in the income variable. Significant differences appear in three perceptual variables towards the PV system: effort expectance, habit, and facilitating conditions. For all variables, the VIF value is not more than 2.28, and the tolerance value is not less than 0.438, indicating the absence of multicollinearity. The fitness model and its predictability are tested. The results are presented in Table 5.

Table 4. Profiles of respondents based on continuous independent variables.

Sample variables	Adopter		Non Adopter		Significance test	
	Mean	SE	Mean	SE	ANOVA	Mann Whitney test
Age	39,26	1.119	39,91	0,435	F = 0,251 ; p = 0,617	
Income	14,44	2,71	9,73	0,51	F = 7.380 ; p = 0,007	
Personal Norms	4,23	0,07	4,28	0,03		Z = -0,721 ; p = 0,471
Hedonic Motivation	3,41	0,17	3,21	0,05		Z = -1,414 ; p = 0,157
Performance expectance	2,79	0,13	3,8	0,04		Z = -0,018 ; p = 0,985
Price value	3,58	0,15	3,49	0,05		Z = -0,764 ; p = 0,445
Effort expectance	3,63	0,16	3,18	0,04		Z = -3,563 ; p < 0,001
Habit	4,04	0,12	3,71	0,04		Z = -2,935 ; p = 0,003
Facilitating Condition	2,85	0,25	1,39	0,06		Z = -6,837 ; p < 0,001

The Hosmer-Lemeshow fit test result of 0.552 indicates that the predictor provides a much better fit than the null model without a predictor. Pseudo R^2 shows that the model can explain the 0.277 variability of the dependent variable. Empirical data support the model, so it can be used to predict respondents' intentions towards RPV. The absence of multiple collinearities strengthens the evidence that the factors included in the analysis are relevant explanatory factors for intention to adopt RPV.

Tabel 5. Model fit test

Test Group	Value
Goodness of Fit Hosmer- Lemeshow test Omnibus Test of Model Coefficients	 Chi^2= 6.859, *df* = 8, *p* = 0,552 Chi^2= 80,561 *df* = 13, *Sig* = 0,000
Classification accuracy	0,741
Pseudo R Square Cox and Snell Nagelkerke	 0,199 0,277

Table 6. shows the results of binary logistic regressions analysis. When applying the p criterion. 0.05 of the statistical significance, performance expectance, personal norms, price value, facilitating condition, and age was significant for the intention to use RPV.

Tabel 6. Logistic regression model for a comparison of intenders and non-adopter

Predictors	Coefficient	*p-value*	Odds ratio
Age	0,047	0,008**	1,048
Income	0,008	$0,537^{ns}$	1,008
Education	0,111	$0,601^{ns}$	1,118
Electricity access	0,170	$0,313^{ns}$	1,186
Performance Expectance	0,358	0,000***	1,430
Effort expectance	0,155	$0,147^{ns}$	1,168
Hedonic Motivation	0,027	$0,722^{ns}$	1,027
Price value	-0,259	0,002**	0,772
Habits	0,013	$0,909^{ns}$	1,013
Social Influence	0,409	$0,074^{ms}$	1,505
Facilitating Condition	0,162	0,017*	1,176
Personal Norms	0,286	0,008**	1,331

Note : *** $p < 0.001$, ** $p < 0.01$, * $p < 0,05$, m.s $p < 0.1$: marginal significant, n.s ; not significant

Next, this section will discuss the factors that might motivate non-adopter respondents to use the RPV and the possible interventions proposed from these results. Table 6 shows that when applying a $p < 0.05$ criterion for statistical significance, five variables significantly affect RPV adoption intentions, and one reaches marginal significance. The performance expectance has an odd value of 1.430, meaning that people who have the perception that RPV will provide financial and environmental benefits are 1.430 times more likely to use RPV than those who do not. Thus, the motivational factors of a respondent perceiving financial and environmental benefits had the most significant positive influences in the model. At the same time, the price value is reported as the factor with the most significant adverse effect. Households who stated that the overall cost was unaffordable were likely to use RPV 0.772 times than those who did not.

In the socio-demographic factors, age was statistically significant on RPV adoption intentions. Older respondents have higher intentions towards PV adoption. This fact may be associated with the perception of older respondents about the affordability of PV prices to household income. Although income is insignificant in the logistic regression analysis, table 5 shows a significant difference in income between adopter and non-adopter groups. Based on age group, there is a substantial difference in household income between respondents aged 40 and over and under 40. Figure 2 shaw among respondents under 40 years, 63% have a monthly payment of less than or equal to IDR.5,000,000, and only 37% of the respondents earn more than that. The opposite condition is for respondents with the age group 40 years and over. Figure 2 shows households with an income more than IDR.5.000.000 account for 68%, and only 32% of households with an income below that. This difference in distribution is due to an increase in economic level due to a rise in career path or business success with age. Older respondents find PV more affordable because they have a higher income level and a more established economy.

Figure 2. Household income comparison

Statistically, the personal norms is proven to have a significant effect on the intention to use RPV. This result is also in line with the statement that in carrying out pro-environmental behavior, people are motivated by the domain of morality in the individual's mind and are guided by an evaluation of what is right or wrong according to oneself or others (Lindenberg and Steg, 2007). Several studies provide evidence that environmental motives and value orientation are essential drivers of RPV adoption. For example, RPV adoption in Austria reported that helping the environment and responsibility towards the next generation were the primary motivations for buying solar power (Haas et al., 1999). Likewise, with the results of research in the Netherlands (Jager, 2006).

Meanwhile, research in Wisconsin shows environmental concern is why most of the users of solar power (Schelly, 2014). Chernyakhovskiy et al. (2015) also found that pro-environmental attitudes affect the demand for solar PV in the US apart from financial aspects. In Indonesia, 43% of 225 respondents stated a sense of responsibility to support clean energy and the environment due to their intention to use RPV (Setyawati, 2020).

The social influence shows a significant effect on intention. Social influence occurs due to interactions, both visual and verbal interactions. For example, visual interaction occurs when viewing the RPV on a neighbor's rooftop, generating awareness thereby increasing intention. Verbal interaction happens through communication.

Peer effect occurs when potential adopters exchange information with potential adopters about relative advantages, thereby expanding knowledge about the degree to which innovation is better than existing technology (Roger, 2003). New adopters are influenced in part by what they see and hear from their peers. Respondents with 1-5 peers significantly intended to use the RPV than respondents without recommendations. However, households with suggestions of more than 20 were not significant compared to households without recommendations. Based on people's normal reaction to the advice of a product, the first several recommendations may not be enough to attract one's attention. However, when exposed to too many recommendations and no new information is delivered, individuals may be no longer sensitive to the recommendations (Zhao et al., 2011). PV system adopters can act as "advisors" to their peers and neighbors concerning installing the PV system and the administrative procedures involved, increasing the innovation's observation and trialability and stimulating further diffusion (Karakaya et al., 2015).

The price value is implied to be a barrier to the intention to use RPV because households with perceptions of unaffordable capital costs and long-term returns on investment are unlikely to intend to use RPV. These results align with previous studies' findings, stating that the high PV technology price is a barrier to Indonesian consumers' purchasing decisions (Outhred and Retnanestri, 2015). The problem can be related to respondents' assumptions about affordability. The total PV installation costs in the residential rooftop PV market decreased by between 47% and 80% from 2010 and 2019, depending on the market (IRENA, 2019). The cost of PV in Indonesia is IDR 17.000.000 per KWh (Setyawati, 2020) and is estimated to decrease in the following years. It is necessary to convey accurate information about RPV cost so that there is no misperception from non-adopter households. The role of the PV industry as an agent of change is needed to carry out this mission. Government support is also required to reduce the burden of initial installation costs, including providing an interest-free loan scheme for equipment procurement or subsidizing the initial cost of a PV system. This support is compensation for households that are willing to switch to renewable energy sources.

Financial benefits as performance expectance of RPV are a significant factor for the intention to adopt PV. Households with high perceptions of electricity cost savings generated by PV technology have more intention to use it. These results are consistent with the findings from Setyawati (2020). Based on a survey of PLN customers, 48% of 973 respondents stated that saving electricity costs was why they were interested in using RPV, and 71% of respondents said they were interested in using RPV, but they are waiting for other policies. These findings indicate that the current RPV policy is less attractive and does not provide financial benefits for RPV users. They noted that the scheme was not pleasing to potential customers, as it took eight years to achieve a return on investment. It is necessary to increase the perception of financial benefits for non-adopters to increase intention. It is essential to review the applied financial policies to increase intention. Furthermore, financial measures are not sufficient; they should be combined with other measures such as norms and efficacy (by providing sufficient support as discussed below) to influence the adoption (KlÖckner et al., 2013).

Technical infrastructure support (as a proxy of facilitating conditions) significantly affects the intention to adopt a PV system. As a new technology, the adoption of PV requires easy access to the installation, operation, and maintenance services. The local solar company acts as a provider of information services for PV installation. Its existence has a strong influence on the PV adoption decision-making process makes local solar companies agents of change in the diffusion of PV technology (Karakaya et al., 2015). In Indonesia, currently, solar companies are centralized on Java Island. This condition has hampered the development of PV adoption outside Java. In line with Joshi's findings, the absence of a local solar company service hinders PV adoption in rural areas of India. Environmental innovations such as PV technology require a high level of knowledge about their operation and financing (Karakaya et al., 2015). Local solar companies have an essential role in providing information to increase the relative advantage and reduce the complexity perceived by potential adopters.

6. Conclusion

This paper has successfully identified factors that influence the intention to use RPV in Indonesian households. Statistically, the performance expectance has the most significant positive influence in the model, followed by social influence factors, personal norms, facilitating conditions, and age from the socio-demographic aspect. While the price value significantly becomes an obstacle to the intention to adopt PV. These results are essential for efforts to accelerate the diffusion of RPV in Indonesia. Financial and non-financial policies are needed in the right segment to promote PV technology. For households still ignorant of environmental issues, education must increase environmental awareness to have a sense of responsibility to take pro-environmental actions, including using renewable energy. The role of solar power companies is needed as service providers not only in Java. The existence of solar companies becomes an agent of change to increase the perception of relative advantage and reduce the complexity of potential adopters to stimulate PV diffusion. In addition, with proper supply chain management, the solar industry minimizes the cost of PV systems to make them more affordable. He or she cultivated peer effect by disseminating information through formal social networks involving the role of a highly motivated adopter. Information and communication in the network can increase the understanding of non-adopters who, at first, are not interested or do not know about the PV system. The current net metering policy needs to be reviewed so that rates are more attractive to potential adopters. Financial support is still needed to increase the affordability of the initial cost of the PV system, such as a loan interest subsidy mechanism or a down payment subsidy for the procurement of a PV system. In-depth research is needed to predict the impact of various policy alternatives to obtain an effective policy.

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Acknowledgments

The authors are grateful to the Ministry of Education and Culture (KEMENDIKBUD), for funding support for this research through the Doctoral Dissertation Research (PDD) grant program.

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