sustainability

MDPI

Article

Determining Factors Affecting Customer Intention to Use Rooftop Solar Photovoltaics in Indonesia

Dafit Bagus Maha Bekti [1], Yogi Tri Prasetyo [2,*], Anak Agung Ngurah Perwira Redi [1], Arif S. Budiman [1], I Made Putra Loka Mandala [1], Angga Ranggana Putra [3], Satria Fadil Persada [2], Reny Nadlifatin [4] and Michael Nayat Young [2]

[1] Industrial Engineering Department, BINUS Graduate Program—Master of Industrial Engineering, Bina Nusantara University, Jakarta 11480, Indonesia; dafit.bekti@binus.ac.id (D.B.M.B.); wira.redi@binus.edu (A.A.N.P.R.); arif.budiman@binus.edu (A.S.B.); made.putra@binus.ac.id (I.M.P.L.M.)
[2] School of Industrial Engineering and Engineering Management, Mapúa University, 658 Muralla St., Intramuros, Manila 1002, Philippines; satriafp@gmail.com (S.F.P.); mnyoung@mapua.edu.ph (M.N.Y.)
[3] Department of Management, Universitas Pertamina, Jakarta 12220, Indonesia; angga.rp@universitaspertamina.ac.id
[4] Department of Information System, Institut Teknologi Sepuluh Nopember, Kampus ITS Sukolilo, Surabaya 60111, Indonesia; reny@its.ac.id
* Correspondence: ytprasetyo@mapua.edu.ph; Tel.: +63-(2)8247-5000 (ext. 6202)

Abstract: Many developing countries on the equator, including Indonesia, have the potential for renewable and sustainable resources, such as solar energy. However, despite the enormous potential, the adoption level remains low. Previously, several studies discussed the potential, the feasibility, and the supporting policy of this technology, but none have been discussed from the customers' perspective on a national scale. Therefore, this study attempts to determine the factors affecting the customers' intention to use solar photovoltaics in Indonesia to develop a sustainable circular supply chain for renewable energy. This investigation was conducted based on integrating the unified theory of acceptance and use of technology 2 (UTAUT2) and the theory of planned behaviour (TPB). Furthermore, an online questionnaire was successfully distributed with a total of 208 participants. Structural equation modeling (SEM) was utilized to derive the causal relationships of the proposed hypotheses. The results indicated that price value (PV) has a positive relationship and a significant influence on attitude toward use (ATU), which leads to the behavioral intention (BI) to make the construct the most affecting factor. This is the first comprehensive study to analyze the intention to use rooftop solar panels based on the UTAUT2 and TPB framework. The successful approach to support photovoltaic use will bring less waste and strengthen the circular supply chain to support sustainable development.

Keywords: solar photovoltaic; UTAUT2; circular supply chain; sustainability development

Citation: Bekti, D.B.M.; Prasetyo, Y.T.; Redi, A.A.N.P.; Budiman, A.S.; Mandala, I.M.P.L.; Putra, A.R.; Persada, S.F.; Nadlifatin, R.; Young, M.N. Determining Factors Affecting Customer Intention to Use Rooftop Solar Photovoltaics in Indonesia. *Sustainability* **2022**, *14*, 280. https://doi.org/10.3390/su14010280

Academic Editors: Muhammad Ikram and Marcos Ferasso

Received: 12 October 2021
Accepted: 17 December 2021
Published: 28 December 2021

1. Introduction

The sustainable development of developing countries is positively affected by renewable energy usage. A common understanding is that renewable resources in energy production are inversely proportional to their loss [1]. The use of renewable energy such as solar panels is consistent with the circular supply chain concept that recognizes future scarcity challenges [2]. A circular supply chain minimizes waste, thereby supporting the seventh sustainable development goal in ensuring access to affordable, reliable, sustainable, and modern energy for all [3]. A circular supply chain enables the amount of waste production to be reduced and ensures self-sustaining production systems. Therefore, the necessity to consider a circular supply chain, which is part of the economic concept as climate change mitigation tools in sustainable development goals, has been confirmed [4].

Situated in the equator [5], Indonesia can consume daily solar energy throughout the year [6]. A photovoltaic (PV) system is an excellent alternative electricity for a country with

more than 500 GW of potential solar sources based on stable daily irradiation levels averaging 4.80 kWh/m^2. This system is considered safer, pollution-free, reliable, maintenance-free, and has a long life of approximately 20−30 years. However, considering the development of this technology in other developing countries, the number of solar sources installed in Indonesia is only 80 MW. This number is behind Thailand (2.6 GW) and the Philippines (868 MW) [6]. Until 2018, the total installed capacity of solar PV was lower than 100 MW (95 MW according to MEMR, 60 MW according to IRENA [7]. Indonesia is also known to be ranked 23 out of 42 countries based on average efficiency in energy use, or in other words, the dependence on conventional energy sources remains high [8]. Considering this number, Indonesia is far from the solar energy target of 6.5 GW by 2025 [7].

Life cycle analysis (LCA) was performed to confirm the feasibility of the photovoltaic system [5]. The Indonesian government has promoted this promising renewable energy through the rooftop photovoltaic solar systems (RPVSS) policy [9]. Furthermore, policy studies on payment instruments such as net metering, which are considered effective in increasing household roof PV adoption, have also been carried out [10]. However, assessing this technology from the customer or user perspective is necessary due to the underutilization rate, which was not discussed in the previously mentioned studies. Meanwhile, assessments of customer acceptance of rooftop photovoltaic systems have been carried out in other countries such as India [11], Pakistan [12,13], and the US [14] using the technology acceptance model.

A study in India showed that social belief is critical in determining customer purchase intention [11]. Therefore, a creative marketing program is considered to have a good impact in increasing penetration. A study in Pakistan [12] found that this technology is more likely to be adopted when it is deemed helpful in protecting the environment, is socially acceptable, and is cheaper than other alternative energy sources. Therefore, raising awareness of the benefits becomes essential. In addition, findings from developed countries such as the US [14] stated that this technology is more attractive to individuals looking for new technologies and those concerned about energy issues. Despite the interesting findings, these studies are limited in demographics and sample size as they come from only one to two cities or states. In addition, this study also provides a perspective of countries located on the equator, such as Indonesia, which have the potential for solar energy throughout the year compared to countries outside the equator such as India, Pakistan, and the USA.

Understanding the factor affecting the customers' intention to use rooftop solar PV technologies is essential to increase renewable sources and form a circular supply chain. Furthermore, gaining more information from PV users' points of view can facilitate a better understanding of the acceptance of the technology [10]. The successful usage of renewable energy will bring the best circular supply chain product without unnecessary waste. Therefore, this study aims to analyze the factors affecting the customers' intention to use rooftop solar photovoltaics based on integrating existing technology adoption models. In summary, the main contribution is an integrated model of unified theory of acceptance and use of technology 2 (UTAUT), and theory of planned behavior (TPB). The model served as a conceptual acceptance model to assess factors affecting the customers' intention to use rooftop solar photovoltaics in Indonesia. Furthermore, the questionnaire and hypotheses formulated refer to the UTAUT2 and TPB framework.

Further discussion concerning this study is designed as follows. First, the proposed conceptual framework is presented in Section 2, while Section 3 describes the details of the methodology, including the design of the questionnaire and participants. Afterwards, Section 4 presents the survey results and analysis. Section 5 provides a discussion on the survey result and managerial implications. Finally, Section 6 contains the concluding remarks obtained from this work and potential future study directions.

2. Conceptual Framework

The proposed conceptual framework of this study is based on UTAUT2 and TPB. The UTAUT2 was chosen because this model is considered to have high explanatory power

compared to other models and provides a more comprehensive framework for consumer-oriented studies [15,16]. In addition, TPB can help to examine the technology adoption from the perspective of psychological factors such as attitudes and perceived behavioral control, which can provide more systematic predictions and offer deeper insights [17]. The theoretical framework can be seen in Figure 1.

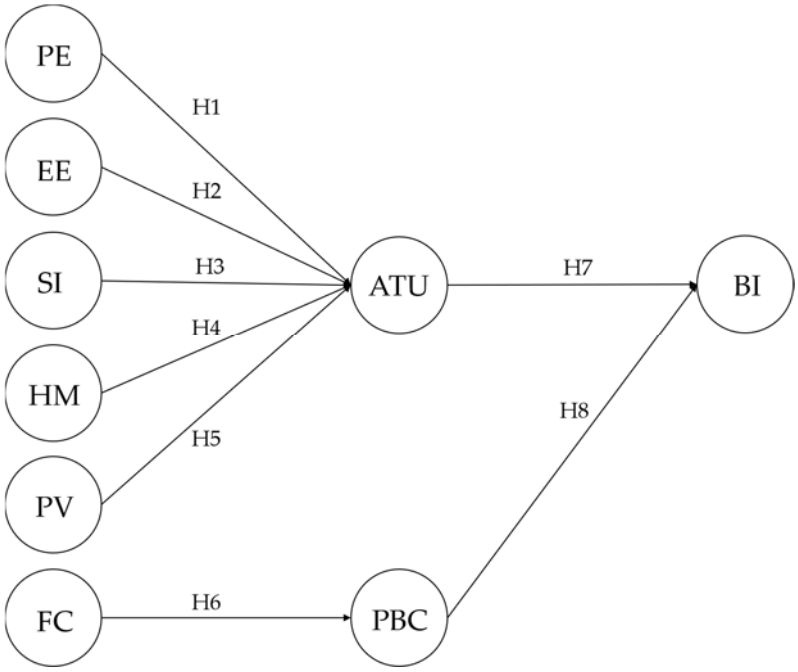

Figure 1. Theoretical Study Framework.

The UTAUT2 framework is a refinement of the UTAUT model designed by Venkatesh et al. [18] that introduces several critical constructs in the technology acceptance model, including performance expectancy (PE), effort expectancy (EE), social influences (SI), and facilitating conditions (FC). Additional constructs identified on the UTAUT2 are hedonic motivation (HC), price value (PV), and habit. Meanwhile, TPB is a model proposed by Ajzen, which states that a person's action or individual's decision in terms of adopting particular technology is influenced by an attitude (ATU), subjective norms (SN), and perceived behavioral control (PBC) [19].

Performance expectancy (PE) is related to an individual's belief in the benefits of using a particular technology towards their job performance [20]. In this study, performance expectancy refers to the belief that rooftop solar PV will be helpful in daily life. Furthermore, similar studies indicated that PE has a positive impact on behavioral intention [11]. Therefore, the following hypothesis was proposed:

Hypothesis 1 (H1). *Performance expectancy (PE) has a significant positive relationship with customer attitudes towards the use of rooftop PV.*

Effort expectancy (EE) is defined as the extent of the ease of utilizing specific technology [20]. This construct is similar to the concept of perceived ease of use in the TAM. In addition, similar studies indicated that EE has a statistically significant relationship with the customers' purchase intention [11]. Therefore, the following hypothesis was proposed:

Hypothesis 2 (H2). *Effort expectancy (EE) has a significant positive relationship with customer attitudes towards the use of rooftop PV.*

Social influence (SI) is defined as the degree to which an individual perceives that others believe they should use the new system, the solar photovoltaic application [20]. Similar

studies showed the significant influence of SI on the behavioral intention of adopting a system [11]. Therefore, the following hypothesis was proposed:

Hypothesis 3 (H3). *Social influence (SI) has a significant positive relationship with customer attitudes towards the use of rooftop PV.*

The following construct is the facilitating condition (FC), which is defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of a particular technology [20]. Therefore, the following hypothesis was proposed:

Hypothesis 4 (H4). *Facilitating condition (FC) has a significant positive relationship with customer attitudes towards the use of rooftop PV.*

Hedonic motivation (HM) is defined as the fun or pleasure derived from using rooftop solar PV. HM demonstrated an essential role in determining technology acceptance and use [21]. Therefore, the following hypothesis was proposed:

Hypothesis 5 (H5). *Hedonic motivation (HM) has a significant positive relationship with customer attitudes towards the use of rooftop PV.*

The price value (PV) construct regards a trade-off between the benefits derived and the cost incurred from using particular technology [22]. The price value shows a positive effect when the benefits of using technology are more significant than the economic cost [18]. Therefore, the following hypothesis was proposed:

Hypothesis 6 (H6). *Price value (PV) has a significant positive relationship with customer attitudes towards the use of rooftop PV.*

Habit has been defined as the extent to which people automatically perform a behavior because of learning [23], while other studies associate it with automaticity [24]. In addition, Ajzen and Fishbein [25] noted that feedback from previous experiences might influence various beliefs and, consequently, future behavioral performance [18]. Respondents who contributed to this study have no experience using solar photovoltaic technology; therefore, this construct is not included in the analysis in order to remain relevant.

Attitude toward use (ATU) is related to how the individuals respond and lead behavior to specific actions and objectives where the outcome may be positive or the opposite [26]. Therefore, the following hypothesis was proposed:

Hypothesis 7 (H7). *Attitude has a significant positive relationship with customer intention to use rooftop PV.*

Subjective norm (SN) refers to the extent to which an individual believes that influential people or certain reference groups think that the behavior should be performed or avoided [27]. This construct represents the part of TPB that reflects social influences [26]. However, several studies argued that the subjective norm component of the TPB is inadequate and rarely predicts intention.Therefore, this subjective norm construct is excluded in this model, referring to the two previous statements [27].

PBC refers to the perceived ease or difficulty of performing the behavior, and the amount of control one has over the attained the behavior's goals [28]. Therefore, the following hypothesis was proposed:

Hypothesis 8 (H8). *Perceived behavioral control (PBC] has a significant positive relationship with customer intention to use rooftop PV.*

3. Methodology

3.1. Participants

It is challenging to get the precise number on the population of people who intend to use rooftop solar photovoltaics in Indonesia. Therefore, simple random sampling was used. Then, to have a more representative respondent with the tendency to use solar photovoltaics, the survey questionnaire was deployed to target individuals living in big cities to represent the Indonesian population. As a result, the online questionnaire was successfully distributed from 29 January to 8 April 2021, with 208 participants and demographic statistics presented in Table 1. The response rate equals 54.99% based on 208 out of 379 respondents that completed the online questionnaire. The constructs and measurement items presented in Table 2.

Table 1. Descriptive statistics of respondents (N = 208).

Characteristic	Category	N	%
Gender	Male	148	71.2%
	Female	60	28.8%
Marital Status	Single	139	66.8%
	Married	69	33.2%
Age	17–25	84	40.4%
	26–35	112	53.8%
	36–45	8	3.8%
	Over 46	4	1.9%
Domicile	Jabodetabek	99	47.6%
	West java	68	32.7%
	Central java	7	3.4%
	East Java	7	3.4%
	Kalimantan	10	4.8%
	Sumatera	7	3.4%
	Sulawesi	4	1.9%
	NTT	2	1.0%
	Bali	3	1.4%
	Papua	1	0.5%
Education	SMA/SMK	5	2.4%
	D1–D3	50	24%
	S1	131	63%
	S2/S3	22	10.6%
Occupation	Student	15	7.2%
	PNS/BUMN	44	21.2%
	Private employee	133	63.9%
	Entrepreneur	7	3.4%
	Other	9	4.3%
Income	<5 million	41	19.7%
	5–15 million	126	60.6%
	>15–25 million	31	14.9%
	>25 million	10	4.8%
Information	Print media	12	5.8%
	Electronic media	28	13.5%
	Internet	126	60.6%
	Colleague	20	9.6%
	Other	22	10.6%

Table 2. Constructs and measurement items.

Construct	Items	Measures	References
Performance Expectancy (PE)	PE1	I think solar panels are environmentally friendly technology	
	PE2	I think solar panels will be beneficial in my daily life	[28]
	PE3	In my opinion, solar panels are a technology that is easy to use	[11]
	PE4	In my opinion, using solar panels will save electricity usage where I live	[28]
Effort Expectancy (EE)	EE1	Solar panels can be easily installed in my house	[11]
	EE2	Solar panels will work well with my household appliances	
	EE3	Solar panels are easy to maintain	
	EE4	It is easy for me to understand how solar panels work on household appliances in my residences	[28]
Social Influence (SI)	SI1	I always ask friends about their experiences using an item before deciding to buy	[11]
	SI2	If my friends have a good experience with solar panels, I am likely to be interested in buying one too	
	SI3	People whom I think are essential (friends, family) will think that I should use this solar panel technology	
	SI4	I will recommend solar panel technology to my friends/neighbors	[29]
Facilitating Condition (FC)	FC1	I have a sufficient/usable area to install solar panels in my residence	
	FC2	I have sufficient knowledge about solar panels	[28]
	FC3	I can quickly get help when I have trouble with the solar panel	[28]
Hedonic Motivation (HM)	HM1	I would be satisfied to be the first to use solar panels in my neighborhood	[11]
	HM2	I love trying new products before others	
	HM3	The purchase/installation of solar panels in my residence is something that makes me satisfied	[28]
	HM4	Purchasing/installing solar panels at my residence will be a pleasant experience	[28]
Price Value (PV)	PV1	Solar panels make electricity costs more affordable	
	PV2	A subsidy from the government will increase my desire to use solar panels	[11]
	PV3	I will be reluctant to use solar panel technology when it is more expensive than conventional electricity	
	PV4	I think the cost of electricity should be affordable	[11]
Attitude Toward Use (ATU)	ATU1	I am among those who care about the environment	
	ATU2	I like to use environmentally friendly technology	
	ATU3	In my opinion, using solar panels as an alternative source of electricity is a good idea	[30]
Perceived Behavioral Control (PBC)	PBC1	It is easy for me to get permission to install solar panels in my residences	
	PBC2	It is easy to find solar panel providers around my neighborhood	
	PBC3	When given the facilities, opportunities, and knowledge about solar panels, I will be more interested in using the technology	[31]
Behavioral Intention (BI)	BI1	I would love to try and use solar panel technology	
	BI2	I am interested in using solar panels when given more detailed information	

As presented in Table 1, 71.2% of participants were males, while 28.8% were females. The majority live on the island of Java, 47.6% are from Jabodetabek, 32.7% are from West Java, and 3.4% are from Central Java and East Java. Additionally, most respondents reported a 5–15 million (60.6%) and worked as private employees (63.9%).

3.2. Questionnaire

The questionnaire was developed by creating questions based on previous studies and making additional adjustments. It consisted of demographic information (gender, marital status, age, domicile, education background, occupation, monthly income, and information resources). Furthermore, it examines UTAUT2 and TPB constructs: (1) performance expectancy, (2) effort expectancy, (3) social influence, (4) hedonic motivation, (5) price value, (6) facilitating condition, (7) attitude toward use, (8) perceived behavior control, and (9) behavioral intention. Each construct measurement scale uses a Likert scale (5-points).

3.3. Structural Equation Modeling

AMOS version 23.0 was utilized for structural equation modeling (SEM) to derive the causal relationships of the proposed hypotheses construct. SEM is a statistical model that uses various models to depict relationships among observed variables, with the same fundamental goal of providing a quantitative test of a theoretical hypothesized model [32]. More specifically, various theoretical models can be tested in SEM that hypothesize how sets of variables define constructs and their relationship [33]. The rules of thumb of the minimum 0.6 for Cronbach Alpha are assumed.

Several reliable model-fit indicators [32] were used, as shown in Table 3. The expected IFI, TLI, and CFI are 0.9 or higher [34,35]; for GFI and AGFI, a value greater than 0.8 was the minimum requirement [36]. Meanwhile, the RMSEA should be less than 0.07 to indicate a good model [37].

Table 3. Model fit.

Goodness of Fit Measures	Value Obtained	Minimum Cut-Off	Suggested
IFI	0.919	>0.90	Hair [34]
TLI	0.899	>0.90	Hu and Bentler [35]
CFI	0.918	>0.90	Hair [34]
GFI	0.855	>0.80	Gefen et al. [36]
AGFI	0.806	>0.80	Gefen et al. [36]
RMSEA	0.068	<0.07	Steiger [37]
CMINDF	1.948	<2.00	Arbuckle [38]

4. Results

The results of the factor loadings, validity, and reliability of each indicator are given in Table 4. Figure 2 describes the final SEM model according to the validity and reliability test. Finally, the achieved GOF value is presented in Table 5.

Table 4. Factor loadings, validity, and reliability.

Construct	Items	Factor Loadings	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
Performance Expectancy (PE)	PE1	0.594	0.729	0.741	0.418
	PE2	0.696			
	PE3	0.686			
	PE4	0.605			
Effort Expectancy (EE)	EE1	0.745	0.835	0.835	0.559
	EE2	0.694			
	EE3	0.771			
	EE4	0.777			

Table 4. *Cont.*

Construct	Items	Factor Loadings	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
Social Influence (SI)	SI2 SI3 SI4	0.685 0.719 0.787	0.784	0.775	0.535
Facilitating Condition (FC)	FC1 FC2 FC3	0.574 0.742 0.805	0.738	0.753	0.509
Hedonic Motivation (HM)	HM1 HM2 HM3 HM4	0.674 0.620 0.917 0.778	0.826	0.839	0.571
Price Value (PV)	PV1 PV2	0.727 0.685	0.661	0.665	0.499
Attitude Toward Use (ATU)	ATU1 ATU2 ATU3	0.588 0.684 0.829	0.794	0.746	0.500
Perceived Behavioral Control (PBC)	PBC1 PBC2	0.642 0.688	0.607	0.613	0.443
Behavioral Intention (BI)	BI1 BI2	0.823 0.636	0.687	0.699	0.541

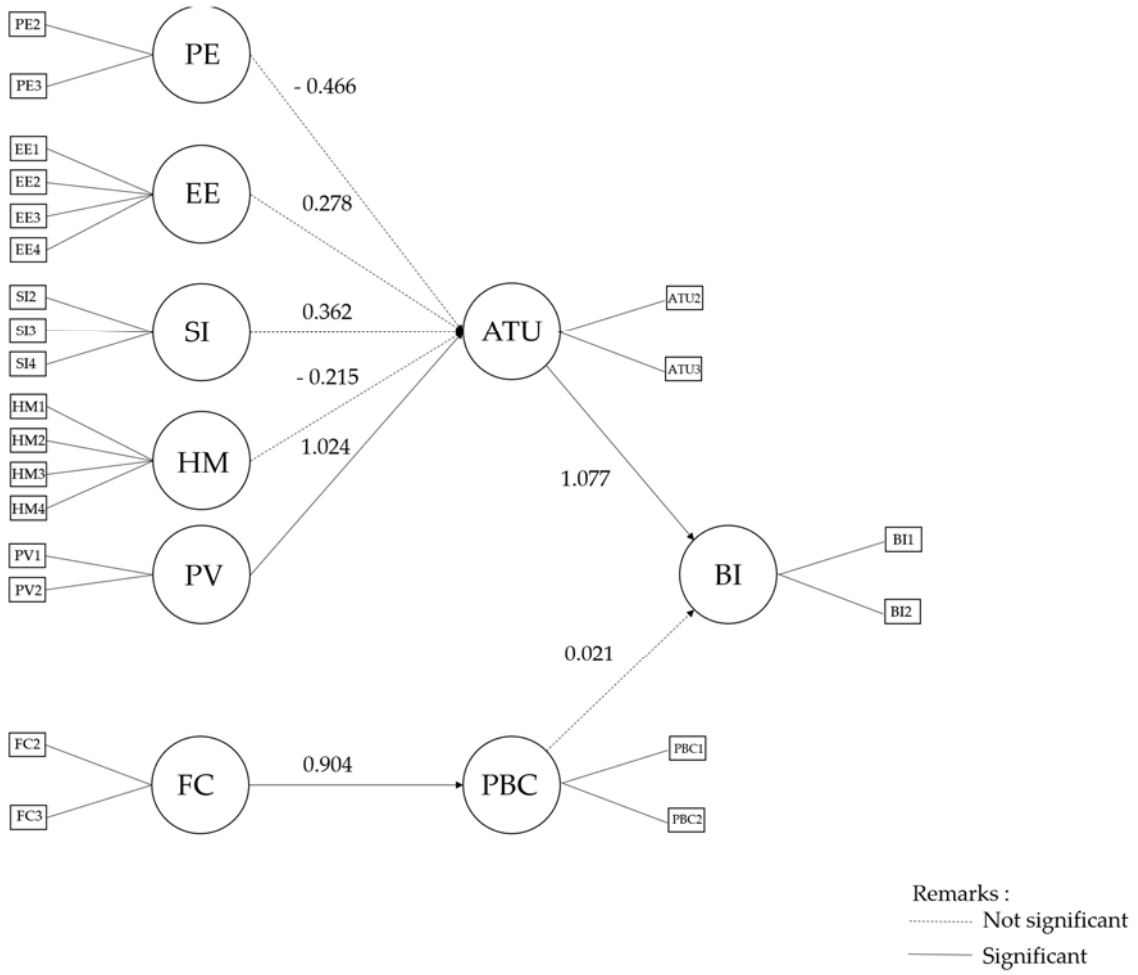

Figure 2. The final SEM model for factors affecting the customers' intention to use rooftop solar photovoltaics in Indonesia.

Table 5. Significance and loading factor values.

Parameter	Estimate	Lower	Upper	P
ATU ← PE	−0.466	−4.374	0.117	0.152
ATU ← EE	0.278	−0.108	3.305	0.231
ATU ← SI	0.362	−0.432	2.092	0.284
ATU ← HM	−0.215	−0.725	−0.009	0.094
ATU ← PV	1.024	0.634	1.677	0.014
PBC ← FC	0.904	0.801	1.002	0.007
BI ← PBC	0.021	−0.076	0.157	0.604
BI ← ATU	1.077	1.011	1.177	0.014

Table 5 show the significant value and loading factor, which shows the relationship between constructs. This value also shows the results of the hypothesis. The results showed that two constructs have a significant positive effect ($p < 0.05$), namely PV –> ATU –> BI and FC –> PBC. In addition, two constructs are known to have a positive but less significant effect, namely EE and SI. Then, PE and HM do not have a positive and significant effect.

5. Discussion

The results showed that price value (PV) had a significant positive relationship to attitude toward use (ATU), which subsequently led to the behavioral intention (BI) to use solar panels (β = 1.024, $p = 0.014$). This finding was consistent with Venkatesh et al., 2012 [18], highlighting the importance of price value in consumer decision-making concerning technology use.

Based on demographic statistics, 43.8% of the total respondents agreed that the use of rooftop solar panels would make electricity costs more affordable. Furthermore, 60.6% of respondents were considered middle to upper-class income, 49.2% expressed interest in trying to using the systems, while 51% felt that incentives from the government would significantly increase their willingness to adopt the system. From those numbers, there is the implication that the Indonesian people are already aware of the benefits of using rooftop solar panels as an alternative to conventional energy sources, having adequate financial ability, and showing good interest in this technology. In addition, it was found that incentives are still one of the attractive schemes encouraging individuals to adopt this renewable energy.

Effort expectancy (EE) and social influence (SI) are known to have a positive, but not significant, relationship to attitude toward use (ATU) towards the intention of rooftop solar panel adoption (β = 0.278, $p = 0.231$) and (β = 0.362, $p = 0.284$). The insignificant relationship of effort expectancy (EE) is consistent with Venkatesh et al., where this construct is more salient for women [20]. The majority of respondents were women (71.2%). In addition, effort expectancy (EE) was also known as the most critical construct, specifically in the early stages of the adoption process of technology [20]. This construct relates to the degree of convenience associated with the use of a system. The survey results showed that most respondents choose neutral answers to questions related to the system convenience, which indicates that respondents are not quite sure about the ease of installing rooftop solar panels. This finding explains why effort expectancy is not significant in this study. Therefore, further assessment of respondents' knowledge of this technology, specifically in the early stages of transition from conventional to renewable energy sources, is required.

Similar to effort expectancy (EE), social influence (SI) tends to be more influential on female individuals [20]. However, most respondents were male (71.2%), which explains why social influence has a less significant effect in Indonesia. It is also known to have a significant effect on something mandatory [20], while solar panels in Indonesia are still optional.

Facilitating condition (FC) has a significant positive relationship to perceived behavioral control (PBC) but less significant to behavioral intention (BI) in rooftop solar panel adoption (β = 0.904, $p = 0.604$). The survey results showed that most respondents answered neutrally

to the indicators of the two constructs related to knowledge of technical assistance, permits, and providers of rooftop solar panels. This finding of the significance of these two constructs correlates with the effort expectancy (EE) construct. However, the provision of technical assistance, permits, and information regarding the providers in the initial adoption process can increase this technology's adoption level.

Performance expectancy (PE) and hedonic motivation (HM) has not had a significant positive relationship with customer intention in adopting rooftop solar panels in Indonesia ($\beta = -0.466$, $p = 0.152$) and ($\beta = -0.215$, $p = 0.094$). Interestingly, this finding is different from Venkatesh's, which mentions performance expectancy (PE) as a determining factor [20]. This is because the benefits offered from the use of rooftop solar panels are considered not to affect the job performances or productivity of the individual. The job performance or productivity remains the same regardless of the type of energy used, either conventional or renewable energy. This explains why performance expectancy (PE) does not affect the customer's intention to adopt the technology. Among 88% of the respondents, 45.2% agreed, and 42.8% strongly agreed that rooftop solar panels would save their electricity. This number indicates that the Indonesian people are aware of the benefits of a system from an economic perspective.

Hedonic motivation (HM), according to [39], is not an appropriate construct to assess the technologies where customers are engaged in certain technology for utilitarian purposes instead of pleasure. Considering an individual's motive for using rooftop solar panels, people in Indonesia tend to benefit financially rather than via pleasure from this system. Therefore, hedonic motivation has no positive influence on the intention of rooftop solar panel adoption.

6. Managerial Implications

From a managerial perspective, this study elaborates that solar PV adoption needs to concentrate on pricing strategy to provide a better approach in the early stages of adoption. The Indonesian government has implemented two policy instruments where one of the schemes, namely net metering, is considered quite effective to promote solar energy development in the household sector. Referring to the demographic statistics of respondents, the majority of the population lives on the island of Java. They are mainly from the upper-middle class, making Java a potential market for solar panels and a suitable area to test the effectiveness of price-related policies such as net metering. Meanwhile, concerning the role of subsidies or incentives, which are still an important tool to increase adoption, West Java residents deserve to be the priority recipients of this scheme, followed by individuals or heads of families in the Greater Jakarta area. This is based on the survey results, which showed that 19% of the total respondents earn less than five million rupiahs, of which 46.3% are from West Java, and 29.2% are from Greater Jakarta.

Concerning providing a better approach in the early stages of adoption, policymakers can design a technical flow that is easily accessible for potential customers to provide a smooth adoption process. Furthermore, this technical flow or installation procedure is expected to increase the understanding of the customer during the preparation of installation, such as technical assistance, permit, service provider, and all information required about the system installment. Therefore, the help of promoting and facilitating social conditions will boost the rate of rooftop photovoltaic adoption.

The same challenges related to the price also occur in the circular supply chain, specifically in developing countries. According to a study conducted in India [2], there are several barriers to forming a circular supply chain. Inadequacy of industry stimulus for "greener" activities is one of the barriers to implementing a circular supply chain. Government incentives for industries are necessary for promoting the green/circular concepts and developing sustainable/regenerative goods. The lack of environmental laws and regulations was also considered as a constraint [2]. There is a finding of extensive regulatory barriers that severely affect trade in both remanufactured goods and core in Indonesia. Remanufacturing is con-

sidered an important variable to increase the resource efficiency of economies and enable a circular supply chain through a circular economy [40].

7. Conclusions and Future Study Directions

The sustainable circular supply chain can be projected well with renewable solar energy, including in Indonesia. Therefore, this study examined the factors affecting customers' intention to use rooftop solar photovoltaics based on the UTAUT2 and TPB framework. Structural equation modeling was utilized to depict relationships among observed variables: performance expectancy (PE), effort expectancy (EE), social influence (SI), hedonic motivation (HM), price value (PV), facilitating condition (FC), attitude toward use (ATU), perceived behavioral control (PBC), and behavioral intention (BI).

The results indicated that price value (PV) has a positive relationship and significant influence on attitude toward use (ATU), which leads to behavioral intention (BI). This construct is the most influential factor on the customer's intention to use rooftop solar panels in Indonesia. Subsidies/incentives from the government remain an attractive primary scheme for most people to adopt this technology. Effort expectancy (EE) is a potential factor to boost more comprehensive adoption of the system in Indonesia, followed by social influence (SI) and facilitating condition (FC).

The current study results showed that the model designed based on the UTAUT2 and TPB framework has good potential for analyzing customers' intention to use rooftop solar photovoltaics in Indonesia. Constructs used in the proposed model facilitate the analysis process to become more focused. This study provides a good overview of future study direction concerning what should be subsequently conducted to elevate the customers' intention to use rooftop solar photovoltaics as a renewable energy resource to form a circular supply chain towards sustainable development.

The direction of future studies should address several limitations that are available in the current study. First, related to the potential factor of effort expectancy (EE) to boost wider adoption, extending the study to the design of a procedure or techniques to provide convenience for prospective customers in the initial adoption process will be interesting. Second, this study can be developed further to access the effort expectancy (EE) construct by providing more profound questions that can better describe the customers' knowledge regarding the utilization of rooftop solar panels in the early stages of adoption. Furthermore, concerning use, variables such as education, income, and age can be modeled. Finally, due to the limitations of the sample already using the system, this study is limited to the behavioral intention to use solar PV. However, it generates an opportunity to analyze the factors that affect users from the intention to use, to the actual use of the system.

Author Contributions: Conceptualization, D.B.M.B., A.A.N.P.R., A.S.B., I.M.P.L.M., S.F.P. and Y.T.P.; methodology D.B.M.B., A.A.N.P.R. and Y.T.P.; software, D.B.M.B., A.A.N.P.R. and R.N.; validation, D.B.M.B., A.A.N.P.R. and A.R.P.; formal analysis, D.B.M.B., A.A.N.P.R. and S.F.P.; investigation, D.B.M.B. and A.A.N.P.R.; resources, D.B.M.B., A.A.N.P.R. and R.N.; data curation, D.B.M.B., A.A.N.P.R. and Y.T.P.; writing—original draft preparation, D.B.M.B., A.A.N.P.R., I.M.P.L.M. and Y.T.P.; writing—review and editing, D.B.M.B., A.A.N.P.R., A.R.P., S.F.P., Y.T.P. and M.N.Y.; visualization, D.B.M.B., A.A.N.P.R. and I.M.P.L.M.; supervision, A.A.N.P.R., A.S.B., A.R.P., S.F.P., Y.T.P. and M.N.Y.; project administration, A.A.N.P.R., A.S.B. and Y.T.P.; funding acquisition, A.A.N.P.R., Y.T.P., I.M.P.L.M., A.R.P., R.N. and M.N.Y. All authors have read and agreed to the published version of the manuscript.

Funding: This study was funded by Mapúa University's Directed Research for Innovation and Value Enhancement (DRIVE) and Bina Nusantara University.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Acknowledgments: The authors are grateful to the respondents that answered the online questionnaire.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Güney, T. Renewable energy, non-renewable energy and sustainable development. *Int. J. Sustain. Dev. World Ecol.* **2019**, *26*, 389–397. [CrossRef]
2. Mangla, S.K.; Luthra, S.; Mishra, N.; Singh, A.; Rana, N.P.; Dora, M.; Dwivedi, Y. Barriers to effective circular supply chain management in a developing country context. *Prod. Plan Control* **2018**, *29*, 551–569. [CrossRef]
3. United Nation. Affordable and Clean Energy: People around the World Lack Access to Electricity. Available online: https://www.un.org/sustainabledevelopment/wp-content/uploads/2016/08/7_Why-It-Matters-2020.pdf (accessed on 20 December 2021).
4. Durán-Romero, G.; López, A.M.; Beliaeva, T.; Ferasso, M.; Garonne, C.; Jones, P. Bridging the gap between circular economy and climate change mitigation policies through eco-innovations and Quintuple Helix Model. *Technol. Forecast. Soc. Chang.* **2020**, *160*, 120246. [CrossRef]
5. Yudha, H.M.; Dewi, T.; Risma, P.; Oktarina, Y. Life cycle analysis for the feasibility of photovoltaic system application in Indonesia. In *IOP Conference Series: Earth and Environmental Science*; IOP Publishing: Bristol, UK, 2018; p. 12005.
6. Summary, E. *Indonesia's Solar Policies*; Institute for Energy Economics and Financila Analysis: Cleveland, OH, USA, 2019; pp. 1–30.
7. Damayanti, H.; Christian, J.; Simamora, P.; Gabriella, M. Under the Same Sun: A Cross-Country Comparison of Condition and Policy Supports for Utility-Scale Solar Photovoltaic Projects Jakarta. 2019. Available online: http://iesr.or.id/pustaka/under-the-same-sun-a-cross-country-comparison-of-conditions-and-policy-supports-for-utility-scale-solar-photovoltaic-projects/# (accessed on 20 December 2021).
8. Wang, C.-N.; Dang, T.-T.; Tibo, H.; Duong, D.-H. Assessing Renewable Energy Production Capabilities Using DEA Window and Fuzzy TOPSIS Model. *Symmetry* **2021**, *13*, 334. [CrossRef]
9. Setyawati, D. Analysis of perceptions towards the rooftop photovoltaic solar system policy in Indonesia. *Energy Policy* **2020**, *144*, 111569. [CrossRef]
10. Hidayatno, A.; Setiawan, A.D.; Wikananda Supartha, I.M.; Moeis, A.O.; Rahman, I.; Widiono, E. Investigating policies on improving household rooftop photovoltaics adoption in Indonesia. *Renew. Energy* **2020**, *156*, 731–742. [CrossRef]
11. Aggarwal, A.K.; Syed, A.A.; Garg, S. Factors Driving Indian Consumer's Purchase Intention of Roof Top Solar. *Int. J. Energy Sect. Manag.* **2019**, *13*, 539–555. [CrossRef]
12. Ali, S.; Poulova, P.; Akbar, A.; Usama Javed, H.M.; Danish, M. Determining the Influencing Factors in the Adoption of Solar Photovoltaic Technology in Pakistan: Model Approach sector is worldwide. *Economies* **2020**, *8*, 108. [CrossRef]
13. Irfan, M.; Zhao, Z.-Y.; Li, H.; Rehman, A. The influence of consumers' intention factors on willingness to pay for renewable energy: A structural equation modeling approach. *Environ. Sci. Pollut. Res.* **2020**, *27*, 21747–21761. [CrossRef]
14. Wolske, K.S.; Stern, P.C.; Dietz, T. Explaining interest in adopting residential solar photovoltaic systems in the United States: Toward an integration of behavioral theories. *Energy Res. Soc. Sci.* **2017**, *25*, 134–151. [CrossRef]
15. Macedo, I.M. Predicting the acceptance and use of information and communication technology by older adults: An empirical examination of the revised UTAUT2. *Comput. Hum. Behav.* **2017**, *75*, 935–948. [CrossRef]
16. Korkmaz, H.; Fidanoglu, A.; Ozcelik, S.; Okumus, A. User acceptance of autonomous public transport systems: Extended UTAUT2 model. *J. Public Transp.* **2021**, *23*, 1–38. [CrossRef]
17. Yuen, K.F.; Huyen, D.T.K.; Wang, X.; Qi, G. Factors influencing the adoption of shared autonomous vehicles. *Int. J. Environ. Res. Public Health* **2020**, *17*, 4868. [CrossRef] [PubMed]
18. Venkates, V.; Thong, J.Y.L.; Xin, X. Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Q.* **2012**, *36*, 157–178. [CrossRef]
19. Teo, T.; Beng Lee, C. Explaining the intention to use technology among student teachers. *Campus-Wide Inf. Syst.* **2010**, *27*, 60–67. [CrossRef]
20. Venkates, V.; Morris, M.G.; Davis, G.B.; Davis, F.D. User Acceptance of Information Technology: Toward A Unified View. *MIS Q.* **2003**, *27*, 425–478. [CrossRef]
21. Brown, V. Model of Adoption of Technology in Households: A Baseline Model Test and Extension Incorporating Household Life Cycle. *MIS Q.* **2005**, *29*, 399. [CrossRef]
22. Dodds, W.B.; Monroe, K.B.; Grewal, D. Effects of Price, Brand, and Store Information on Buyers' Product Evaluations. *J. Mark Res.* **1991**, *28*, 307–319.
23. Limayem, H.C. How Habit Limits the Predictive Power of Intention: The Case of Information Systems Continuance. *MIS Q.* **2007**, *31*, 705. [CrossRef]
24. Kim, H.F.; Ghazizadeh, A.; Hikosaka, O. Dopamine Neurons Encoding Long-Term Memory of Object Value for Habitual Behavior. *Cell* **2015**, *163*, 1165–1175. [CrossRef]
25. Fishbein, M.; Ajzen, I. Theory-based Behavior Change Interventions: Comments on Hobbis and Sutton. *J. Health Psychol.* **2005**, *10*, 27–31. [CrossRef]
26. Vabø, M.; Hansen, H. Purchase intentions for domestic food: A moderated TPB-explanation. *Br. Food J.* **2016**, *118*, 2372–2387. [CrossRef]

27. Armitage, C.J.; Conner, M. Efficacy of the theory of planned behaviour: A meta-analytic review. *Br. J. Soc. Psychol.* **2001**, *40*, 471–499. [CrossRef]
28. Kapser, S.; Abdelrahman, M. Acceptance of autonomous delivery vehicles for last-mile delivery in Germany–Extending UTAUT2 with risk perceptions. *Transp. Res. Part C Emerg. Technol.* **2020**, *111*, 210–225. [CrossRef]
29. Nordhoff, S.; Louw, T.; Innamaa, S.; Lehtonen, E.; Beuster, A.; Torrao, G.; Bjorvatn, A.; Kessel, T.; Malin, F.; Happee, R.; et al. Using the UTAUT2 model to explain public acceptance of conditionally automated (L3) cars: A questionnaire study among 9118 car drivers from eight European countries. *Transp. Res. Part F Traffic Psychol. Behav.* **2020**, *74*, 280–297. [CrossRef]
30. Lu, C.; Huang, S.; Lo, P. An empirical study of on-line tax filing acceptance model: Integrating TAM and TPB. *Afr. J. Bus. Manag.* **2010**, *4*, 800–810.
31. Rahman, M.M.; Lesch, M.F.; Horrey, W.J.; Strawderman, L. Assessing the utility of TAM, TPB, and UTAUT for advanced driver assistance systems. *Accid. Anal. Prev.* **2017**, *108*, 361–373. [CrossRef]
32. Prasetyo, Y.T.; Tanto, H.; Mariyanto, M.; Hanjaya, C.; Young, M.N.; Persada, S.F.; Miraja, B.A.; Redi, A.A. Factors affecting customer satisfaction and loyalty in online food delivery service during the COVID-19 pandemic: Its relation with open innovation. *J. Open Innov. Technol. Mark Complex.* **2021**, *7*, 76. [CrossRef]
33. Kumar, K. *A Beginner's Guide to Structural Equation Modeling*, 3rd ed.; Routledge: Oxfordshire, UK, 2012; Volume 175, pp. 828–829.
34. Hair, J.F.; Anderson, R.E.; Babin, B.J.; Black, W.C. *Multivariate Data Analysis: A Global Perspective*; Pearson: Upper Saddle River, NJ, USA, 2010.
35. Hu, L.; Bentler, P.M. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Struct. Equ. Modeling Multidiscip. J.* **1999**, *6*, 1–55. [CrossRef]
36. Gefen, D.; Straub, D.; Boudreau, M.-C. Structural equation modeling and regression: Guidelines for research practice. *Commun. Assoc. Inf. Syst.* **2000**, *4*, 7. [CrossRef]
37. Steiger, J.H. Understanding the limitations of global fit assessment in structural equation modeling. *Personal. Individ. Differ.* **2007**, *42*, 893–898. [CrossRef]
38. Mardyantoro, I. Analisis Faktor-Faktor Yang Mempengaruhi Kinerja Di Sokaraja Kabupaten Banyumas. *Majalah Ilmu Ekonomika* **2016**, *11*, 46–70.
39. Tamilmani, K.; Rana, N.P.; Prakasam, N.; Dwivedi, Y.K. The battle of Brain vs. Heart: A literature review and meta-analysis of "hedonic motivation" use in UTAUT2. *Int. J. Inf. Manag.* **2019**, *46*, 222–235. [CrossRef]
40. Matsumoto, M. *Barriers for Remanufacturing Business in Southeast Asia: The Role of Governments in Circular Economy*; Sustainable Production, Life Cycle Engineering and Management: Singapore, 2021; pp. 425–439.