Solar House System Adoption among Rural Community

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Abstract. West Bandung Regency experiences inequality in access to electricity due to difficulties in the distribution process. Therefore, the purpose of this research is to determine the importance of Solar House to be done with the intention of identifying the factors that influence the adoption of SHS technology among the public. This study used a modified TAM model consisting of perceived usefulness, perceived ease of use, social factors, and resource factors. The method of data collection is through the distribution of questionnaires to 185 respondents in rural areas of West Bandung Regency. Furthermore, Partial Least Square Modeling is used as an analytical method to test hypotheses. The results reveal that social factors are the most important determinant for the adoption of SHS. From a theoretical perspective, this study broadens our understanding of the adoption of SHS technology customers in rural areas. Furthermore, from managerial applications, this research suggests a social marketing strategy that can be carried out by solar panel entrepreneurs and the government to encourage rural communities to adopt SHS technology by expanding their existing knowledge.

1. Introduction
Access to energy can improve the economic welfare of a community. This is proven by the positive relationship between the access and productivity [1]. To begin with, the electrification ratio is a reflection of people's access to electricity. According to Indonesia Ministry of Energy and Mineral Resources, Indonesia electrification ratio was 92.80% in June 2017. This rate shows that there are still some regions that have not yet gained access to electricity, especially in remote and rural areas. This inequality in access to electricity is constrained by the difficulty of the distribution process. The problems in the process of electricity distribution are caused by the funding conditions, geographical and scattered population patterns. Therefore, it is necessary to empower other energy sources available in the area to meet the electricity needs of the community.

The location that is on the equator makes Indonesia has abundant solar energy sources with the intensity of solar radiation around 4.8 kWh / m² per day [2]. This is what lies behind the development of various technologies for the utilization of solar energy sources, such as the Solar House System (SHS). In addition to increasing access to electricity and protecting the environment, SHS is recommended to be adopted because it is almost free of maintenance costs, easier to operate, and safer than other energy sources [3]. Moreover, SHS users in rural areas are also proven to feel the economic benefits of this technology [3]. Hence, up to 1995, 10,000 SHS units were installed in remote areas spread throughout
Indonesia as a form of government effort in utilizing these resources. However, inequality in access to electricity is still experienced in many rural areas on Java, even though common cases are found from outside Java. For instance, West Bandung Regency (KBB) had the lowest electrification ratio in 2014, which was 77.13%, indicated that there were still many people who had not yet got access to electricity. In fact, the solutions that were previously successfully applied to remote areas, such as Desa Ban, Karangasem Regency, Balican also could be applied in other areas, especially in Bandung [4]. This happens because Bandung has a potential that is not much different from the intensity of radiation irradiance 4.149 kWh/m²[2]. Nevertheless, as many as 65.83% of the solar panels applied in Bali have been damaged and cannot be used anymore. This is caused by no prior effort to identify how ready the community is to adopt photovoltaic solar panels and the obstacles behind their unpreparedness before installing the technology. Similar problems and the magnitude of the potential for implementing the same solution raise the need for understanding why rural KBB communities, who do not have access to electricity, cannot adopt SHS technology. Thus, a research is needed to analyze the barriers of KBB rural communities to adopt SHS and to avoid mistakes that had previously occurred in Bali. This study aims to explain the barriers to adopting SHS technology in KBB rural communities. Further, a deeper understanding of this study will benefit the community, government and technopreneur by removing these barriers and providing equal access to electricity. From a theoretical point of view, this research can develop an understanding of the obstacles to the technology acceptance model in terms of access to electricity in society. The output of this study is social marketing, which allows collaboration between several parties required in removing barriers in adopting SHS, especially for technopreneurs. Examples are forms of promotion from the technopreneur, campaigns from community groups, policy making and government education.

2. Method
Technology Acceptance Model (TAM) is a model for identifying factors which determine the user acceptance in utilizing technology by explaining someone’s steps and reasons until he determines to decide and adopt a particular technology [7, 8]. TAM suggests that someone will adopt technology if they believe that technology is useful, affordable, and easy to operate. Basically, TAM uses two main factors, namely the perception of usability and ease of use. However, some researchers have developed TAM by incorporating theories of social influence, resource factors, and demographic factors that have the potential to influence technology adoption [6].

**Hypothesis 1.** Perceived usefulness, perceived ease of use, resource factors, and social influence factors simultaneously and significantly effect on the intention to adopt SHS.

Perceived usefulness explains the extent to which a certain technology usage will increase the routine household activities effectiveness [7]. In the context of marketing, the value of technology is reflected in the costs of the product or service. Research in various industries shows that perceived usefulness aspect is a crucial aspect, which does not only affect someone's intention to adopt, but also on the behavior of the use of technology [7]. Thus, it means that if the perceived usefulness of technology is high, it can positively influence adoption behavior.

**Hypothesis 2.** Perceived usefulness individually and significantly effects on the intention to adopt SHS technology.

Perceived ease of use or self-efficacy is a concept regarding the skills and knowledge needed by technology users. Previous research has proven that this variable predicts the adoption and use of
technology [8]. It happens because someone tends to adopt technology that is easier to operate and comprehend. Moreover, when using new technology in households, users must learn to understand how the technology is operated, where the process is influenced by the availability of information about related technologies [5]. Thus, a person's initial knowledge becomes very important in determining how quickly he can learn about certain technologies. The learning process about technology, which includes the achievement and transfer of knowledge, will affect someone's willingness to adopt [9]. This happens because in the learning process, a person's mechanism for absorbing knowledge tends to be different, it depends on its characteristics, especially intelligence and motivation [9]. So, in adopting new technology, people need more encouragement that can be given by various parties. Also, consumer perceptions about the ways to operate technology play an important part in influencing whether or not they will buy technology [9]. Thus, if consumers feel that technology is difficult to operate, there is little chance that he will adopt the technology even though the price is reasonable. In this study, the process of adopting SHS is not easy with a low level of education in remote KBB communities. Therefore, knowledge and skills are important factors in adopting SHS technology.

**Hypothesis 3.** Perceived ease of use individually and significantly affects the intention to adopt SHS technology.

Resource factors are an important aspect in adopting technology because it does not only affect on the intention to adopt of a user but also influences the way users use technology. This factor is related to economic aspects, especially in terms of investment and maintenance costs. A person is considered to have resources if he is supported by sufficient funds to obtain facilities that enable technology to operate optimally. Resource factors usually do not only consist of funds, but also include existing apparatus and its compatibility with the technology that is going to be adopted. Therefore, the perceived resources are included in the TAM to appraise perceptions of the resources sufficiency which facilitate their behavior in adopting new technologies. In addition, previous research has also proven that resource factors able to influence someone's intentions and behavior in adopting technology significantly [7].

**Hypothesis 4.** Resource factors individually and significantly affect on the intention to adopt SHS technology.

Social influence is a crucial element in influencing behavior of an individual. In technology adoption, social influences from family, colleagues and friends can influence decisions to adopt a technology. This social impact will be much stronger if someone is part of a social network. It is shown by a study that the influence of social experience is a crucial determinant of the behavior of buying computer products [5]. Furthermore, the study also shows that someone who adopts certain technologies tends to encourage family and friends to adopt the identical technology, especially if its performance is satisfying. This explanation is in accordance with the crucial role of recommendations or references in influencing consumer behavior. Because technology has many similarities with each other, the findings of this previous study are presumed to appear in the case of SHS adoption by KBB communities who have not yet gained access to electricity. Past studies that integrate the influence of social factors in the TAM model also show that these factors have a strong relationship with perceived usefulness, which then influences intention and behavior to adopt technology[7].

**Hypothesis 5.** Social factors individually and significantly affect on the intention to adopt SHS technology.
Research design for this study is descriptive research to understand the causal causes of variables used. Primary and quantitative data are used in this study. The data collected are obtained directly through questionnaires distributed to 185 respondents who live in rural areas of Bandung Barat. Then, data calculation and analysis by using SPSS are conducted. Following scholars [10] recommendation, regression analysis is conducted as a method for this calculation. The purpose of regression analysis is to know the correlation between the dependent and independent variables (see Figure 1).

3. Result and Discussion

3.1 Characteristics of Respondents
Based on the table below, it results that most of the respondents are female. Also, the majority of them are ranged from 25 to 45 years old. Based on education, most of them are elementary school graduates. From respondents’ monthly income level, the most dominant one is ranged from Rp400.000-Rp800.000. In respect of decision-making process in the family, 76.2% of the respondents choose the father as someone who holds the most important role in it.

3.2 Descriptive Statistics
In this study, researchers use SPSS to compute the descriptive statistic. Mean, standard deviation, and number of items in each construct are presented in Table 1. Perceived usefulness has the highest mean (3.8351) from fifteen of total items in this study. On the other hand, social factor has the lowest mean (2.9484). Table 1 indicates that respondents have the average level of agreement toward perceived usefulness, perceived ease of use, resource factor, and intention to use.
Table 1. Descriptive Statistics

| Construct             | Mean  | Standard Deviation | Number of Items |
|-----------------------|-------|--------------------|-----------------|
| Perceived usefulness  | 3.8351| 0.51333            | 5               |
| Perceived ease of use | 3.6141| 0.59728            | 5               |
| Social factor         | 2.9484| 0.90915            | 2               |
| Resource factor       | 3.4076| 0.65047            | 2               |
| Intention to use      | 3.45  | 0.867              | 1               |

3.3 Regression Analysis

Table 2. Model Summary

| Model | R   | r²   | Adjusted r² | Std. Error of the Estimate |
|-------|-----|------|-------------|----------------------------|
| 1     | 0.555 | 0.308 | 0.293       | Supported                  |

Table 3. ANOVA

| Model         | Sum of Squares | df  | Mean square | F       | Sig.  |
|---------------|----------------|-----|-------------|---------|-------|
| Regression    | 42.343         | 4   | 19.922      | 19.922  | 0.000 |
| Residual      | 95.113         | 179 | 0.531       |         |       |
| Total         | 137.457        | 183 |             |         |       |

Table 4. Regression Analysis Result on Satisfaction

| Intention to use  | β       | t-value |
|-------------------|---------|---------|
| (Constant)        | 0.115   | 0.262   |
| Perceived usefulness | 0.444  | 4.324** |
| Perceived ease of use | 0.063  | 0.596   |
| Social factors    | 0.234   | 3.498** |
| Resource factors  | 0.241   | 2.728** |

*significant at p<0.05 **significant at p<0.01
\[ Y = 0.115 + 0.444 \text{PU} + 0.063 \text{PEU} + 0.234 \text{SF} + 0.241 \text{RF} \]

From the Table 2, it results that 29.3\% of intention to use is influenced by perceived usefulness, perceived ease of use, social factor, and resource factor. Further, Table 3 shows that the value of F (19.922) with the significant value of \( p = 0.000 \), indicates that the entire regression model fits well and H1 is supported.

Table 4 shows that three of the four hypotheses are supported. Firstly, perceived usefulness is a significant predictor of intention to use (\( \beta = 0.0306, p = 0.000 \)). Since the \( p \)-value is less than \( \alpha \), therefore H2 is supported. Conversely, H3 is not supported because Perceived ease of use is found as an insignificant predictor of attitude (\( \beta = 0.042, p = 0.552 \)). Then, the additional construct in this model, which is social factor (\( \beta = 0.245, p = 0.001 \)), is a significant predictor for intention to use. It means that H4 is supported. Lastly, H5 is also supported because resource factor is indicated as a significant predictor for intention (\( \beta = 0.181, p = 0.007 \)). This study finds that perceived usefulness affects intention to use significantly. The same result was also appeared in a previous study, who claimed that PU had the most notable impact on intention to use. Another study also mentioned that perceived usefulness defined as a structure that represents the motivation to use a certain system [11]. Similarly, it was also found that perceived usefulness was a direct predictor of users’ continuance intention [12]. These indicate that the more beneficial a technology is perceived by someone, his intention in using it will also become higher.

Another result shows that perceived ease of use is not a significant predictor of intention to use. Another result shows that perceived ease of use is not a significant determinant of intention to use. This finding is in line with past research, which is logically explained by a notion that the user will know exactly how easy a technology is used or not when they start to experience the actual usage [13]. This finding also aligns with previous research, where perceived ease of use did not become the predictor of intention to use, but perceived usefulness and public attitude did [14]. Further, it stated that perceived ease of use can only influence perceived usefulness and attitude to use.

Social factor has been revealed to be a determinant of intention to use. This is in accordance with the findings of a study that people in rural community are considered to be more connected to each other. It means that the opinion of someone who is important to them will give a certain effect to their behavior. The result is also confirmed by previous study that someone’s motives to adopt a clean energy technology also depends on other relative factors, namely social factor [15]. Also, this is also supported by previous research which found that social circle was being a factor that was able to predict intention to purchase solar panel significantly.

Lastly, resource factor is also affirmed to be a predictor of intention to use. It means that the resource to facilitate someone’s adoption toward solar panel technology should be provided first, so that the intention to use solar panel technology will appear. This finding is confirmed by the Unified Theory of Acceptance and Use of Technology (UTAUT), which states that facilitating conditions is a predictor of users’ behavioral intention [11]. Meanwhile, facilitating conditions are known as consumers’ perceptions about support and resources available to do a certain behavior [16]. Further, a study about ICT adoption among students also results that facilitating condition as a factor that predicts intention to use significantly. This study proposes a research model based on the integration of TAM, social factor, and resource factor. As a result, this study presents an empirical result regarding to solar panel technology intention to use in rural community. Besides to confirm the relevance of Technology Acceptance Model, this study can provide new research insights for advancing solar panel adoption. Moreover, it provides additional information regarding TAM application in rural community. In respect of managerial implication, this study will be very beneficial for government and solar panel companies. Government can use this finding as the foundation of strategy to boost solar panel adoption in rural.
community. In addition, it can be a program for Bandung Barat government to reach 100% electrification rate. On the other hand, the solar panel companies or the technopreneurs can make this program to be a part in their marketing strategy that can be used as their form of responsibility to the society. During this program, they can publish it to the media to build their existence. Furthermore, the success of this program will make the society who lives in a city, be more assured to adopt solar panel in their house. A highly empowered group of people is needed in order to boost people in rural community to adopt solar panel technology. Parents as the member of this group, specifically fathers as the family decision maker, will be empowered by the government and the technopreneurs. Each member will gain more knowledge about solar panel, especially about how to operate and the benefits of using it. This will happen because a collaboration of the government and the technopreneurs will facilitate every member to access resources needed in adopting this technology. Equally important, since the rural community tend to have less income, cost will become the most meaningful barrier. For this issue, the government and the technopreneurs can ease them by providing a payment system that is suitable with their income level, which is installment as an example.

4. Conclusion
This study uses the modified TAM to know barriers to adopt solar panel technology in rural community. Perceived usefulness, social factor, and resource factor are founded to be the predictors of someone’s intention to adopt solar panel technology. Overall, we use four independent variables to predict a single dependent variable, namely Intention to use. In this study, we did not use actual usage variable because there is no one who has adopted SHS technology yet in Bandung Barat rural community. As a result, future study can also conduct the same research to the actual user, so there will be a broader understanding about this model. As a limitation, this study was held in a limited area of population. The respondent is rural community of five underdeveloped villages in West Bandung Regency (KBB). Therefore, future research can apply the same research but in another area with larger population. From this, comparison can be made among these areas. In the meantime, rural community is selected to be the population in this study. For more comprehensive knowledge about solar panel technology adoption, future research can extend it to urban community. Hence, beside of gaining the most appropriate strategy to boost adoption in urban community, future research can also compare about how rural and urban community adopt the technology.

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