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Assessing the Economic Value of The Hydropower Energy: The Role of Social Capital and Socio-economic Factors

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Abstract: A good strategy for dealing with environmental problems and improving environmental sustainability. This study examines the extent to which local communities in Yogyakarta, Kulon Progo area, Indonesia are willing to increase hydropower energy. The influence of social capital on people's willingness to get involved was studied using a logistic regression model. Based on the findings, 95% of residents are likely to make financial contributions to improve hydropower energy facilities. Increased social capital, consisting of strong interpersonal relationships, community involvement, and trust, is strongly associated with this engagement. This study adds to the literature by emphasizing the possible function of social capital in the process of adjustment to changes in renewable energy from hydropower energy in households.

Keywords: Renewable Energy; Hydropower Energy; Willingness to Pay; Contingent Valuation Method; Social Capital
JEL Classification: Q42; Q56; D91; O13; Z13; Q51

Introduction

A good strategy for dealing with environmental problems and improving environmental sustainability is to support renewable energy and environmentally friendly practices (Athayde et al, 2019). According to Chala et al. (2019), the percentage of production services in Germany and America that use renewable energy is 13.3% and 25%, respectively. The community and economy in the region benefit from the construction hydropower energy (Nautiyal & Goel, 2020). Based on the classification provided by the European Commission, hydropower energy have a power output of less than 10 MW, 2 MW, 500 kW, and 10 kW respectively (Balkhair & Rahman, 2017). Flexible technologies such as hydropower energy can provide benefits to the economy and society. In the Special Region of Yogyakarta (DIY), hydropower energy (PLTMH) are a sustainable way of utilizing nearby water resources to produce electricity. DIY PLTMH is usually less environmentally friendly but has a lower energy producing capacity if built on a small river. The growth of MHP projects, which not only provide renewable energy sources but also encourage local economic development and sustainability, relies heavily on government support and community involvement. Since receiving financial assistance in 2011, the Kalibawang River community has independently utilized hydropower energy (Fajarsari, 2014). Because Samigaluh is located on the Menoreh Peninsula, the Kalibawang River uses the Progo River airstrip in Kedungrong Hamlet, Purwoharjo Village and Samigaluh Regency. Even though the capacity of the MHP in Kedungrong Hamlet is relatively small, it can still function and be utilized by the general public as an alternative energy source to increase energy consumption and meet the community's need for energy on a global scale.

Public attitudes towards renewable energy sources have been widely discussed in the literature. A number of studies investigating various means of assessment have been conducted in recent years. Positive WTP for green energy premiums is associated with decisions made by individuals to produce renewable energy (Borchers et al., 2007; Bergmann et al., 2006; Batley et al., 2001). Additionally, WTP and socioeconomic factors including money, social standing, and education are positively correlated, based on empirical findings from assessment studies (Roe et al., 2001; Batley et al., 2001; Zarnikau, 2003). (Wiser, 2007) claims that when communal payment techniques are used compared to voluntary payment methods, the WTP for renewable energy will be higher. Likewise, there is data showing that the WTP stated based on government provisions is smaller than the WTP stated in the private provision system. The findings of this study show that WTP will increase along with public awareness of renewable energy sources and their efficiency. Although previous research refutes the “not-in-my-backyard” (NIMBY) theory, these findings highlight the importance of siting renewable energy projects (Ek, 2005). Based on similar research, (Sandhyavitri et al, 2016) shows that two socio-economic factors—number of family members and family income level—influence people's willingness to subscribe (Willingness To Connect) and their willingness to pay a certain amount for the service, or WTP (Willingness To Pay). In the CVM study (Nomura & Akai, 2004) it was found that those who anticipate using renewable energy technologies in the future are more willing to pay than others.

Studies on energy economic assessment discuss energy economic assessment methods, including cost-benefit analysis, carbon pricing, and the economic impacts of various energy policies (Nordhaus, 2007); the economic value of energy security, including risk analysis and mitigation strategies to secure energy supplies (Meeus & D'haeseleer, 2008); the economic benefits of renewable energy such as wind energy and solar energy (Tol, 2010); the economic value of carbon emissions, with a focus on assessing the economic impacts of climate change caused by human activities (Arrow et al, 2013). However, research related to small-scale water energy in Indonesia is still rarely carried out, so this research aims to carry out an economic valuation of hydropower energy. To fill this knowledge gap, this research examines village community participation. Participation in the process of utilizing PLTMH, willingness to pay, and the extent of the impact of social capital. We conducted a survey of village residents in the Kulonprogo Regency area, Yogyakarta, Indonesia, where the possibility of utilizing water energy is very high. Using a logistic regression model, we examine the impact of social capital and sociodemographic factors on citizens' willingness to pay to improve the quality of hydropower energy. This research contributes to the literature by identifying the role of social capital in improving renewable energy supply.

Research Method

Research location

The research was conducted in Purwoharjo Village, Kedungrong Hamlet, Samigaluh District, Kulon Progo Regency. The reason this location was chosen is because there is a PLTMH which still produces or distributes electricity and is managed independently by people living in the Special Region of Yogyakarta, especially in Kulon Progo Regency. Every family head in Kedungrong Hamlet uses hydropower energy at the PLTMH located in RW 025 RT 051 and RT 052, as well as RW 026 RT 053 and RT 054.

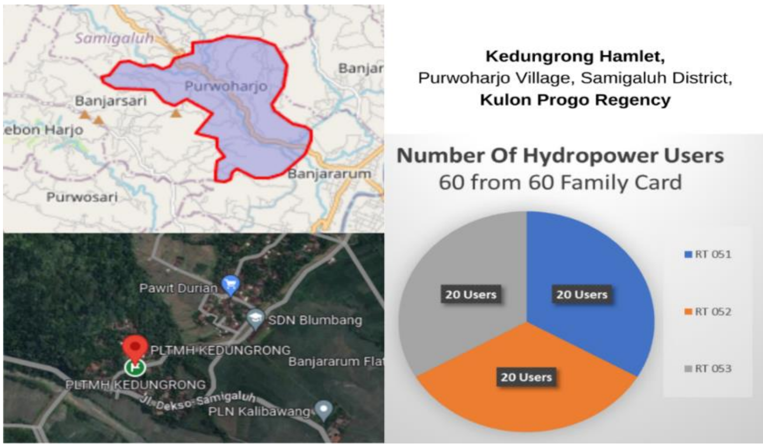

Figure 1 Map of locations of PLTMH users in Kulon Progo.

The data used in this research uses survey techniques or is obtained directly from sources, namely research subjects which can be in the form of interviews or using questionnaires distributed to Purwoharjo village residents. Primary data in this research include the respondent's willingness to pay, the respondent's age, the respondent's education level, the respondent's income level in one month, the number of respondent's family members, the respondent's ownership of the residence, the respondent's electricity bill, the respondent's knowledge regarding the use of water power, and environmental awareness.

Survey design and administration

The data used in this research uses survey techniques or is obtained directly from sources, namely research subjects which can be in the form of interviews or using questionnaires distributed to Purwoharjo village residents. Primary data in this research include the respondent's willingness to pay, the respondent's age, the respondent's education level, the respondent's income level in one month, the number of respondent's family members, the respondent's ownership of the residence, the respondent's electricity bill, the respondent's knowledge regarding the use of water power, and environmental awareness. A survey of residents at the research location was conducted to determine their willingness to pay for hydropower energy. Because all heads of families are PLTMH users, this research uses a saturated sampling technique because the entire population is

PLTMH users. A total of 60 respondents consisting of 20 people from RT 051, 20 people from RT 052, and 20 people from RT 053 Purwoharjo Hamlet were taken as samples in this study. These residents were selected from 3 RTs affected by the use of PLTMH. The survey was conducted using two-stage sampling. The mode is a face-to-face on-site survey (Le Goffe, 1995; Lee & Han, 2002; Lee, 1997; Togridou et al., 2006).

We used contingent valuation methods to determine participants' willingness to pay or willingness to accept certain changes in natural resources (Bateman et al., 2002; Cruz, 2007; Haab & McConnell, 2002; Zhongmin et al., 2003). Starting with the lowest bid of IDR 12,000 (USD 0.76), the double-bound study resulted in residents' willingness to pay IDR 15,000 (USD 0.98) for environmental conservation efforts and upgrading hydropower energy use. Of course, this estimate does not represent the willingness to pay of the entire population at the research location. More precisely, these results are indicators for determining the potential economic value for environmental conservation efforts and improving hydropower energy use from the perspective of an informed public. These estimates are then used to identify which citizens have sufficient finances and are willing to participate in adaptation. To do this, we asked participants whether they agreed or disagreed to pay (Rp. 15,000) or USD 0.98 per month for efforts to preserve the environment and upgrade hydropower energy use. The final survey questionnaire consisted of seven sections (see appendix). Part A maps the sociodemographic characteristics of the population ((i.e. family size, age, gender, housing ownership, electricity bill, social capital social capital (i.e. trust, community participation, and number of relatives outside the village)). Part B reveals the residents' knowledge (hydropower energy); Part C environmental awareness (i.e. interest in shifting electricity use to hydropower energy, support for hydropower development projects Part D perception of strategies and adaptation Part E citizens' willingness to improve quality); hydropower energy of (Rp. 15,000) or USD 0.98 per month.

Data Analysis

We used logistic regression (Wang & Elhag, 2007) to determine the relationship between social capital and citizens' willingness to improve the quality of hydropower energy. The dependent variable in this model is residents' willingness to pay for the use of MHP, where 1 means "agree" and 0 means "disagree". The independent variables in this model are sociodemographics, social capital, knowledge, and environmental awareness (Table 1).

The basic logit estimation model is as follows:

$$Log_e = \left[\frac{\{p(y=1)|x_1 \dots x_p\}}{\{1-p(y=1|x_1 \dots x_p\}}\right] = Log_e\left[\frac{\pi}{1-\pi}\right] = \alpha + \beta_1 x_1 + \dots + \beta_p x_{p^1}$$
$$= \alpha + \sum_{j=1}^{p} \beta_j x_j \quad (1)$$

where π is the conditional probability of the form P (Y = 1)

Logistics functions are as follows:

$$\langle P(Y = 1|X_1 \dots X_p) \rangle = \frac{exp\left(\alpha + \sum_{j=1}^{p} \beta_j x_j\right)}{1 + exp\left(\alpha + \sum_{j=1}^{p} \beta_j x_j\right)} \quad (2)$$

Table 2 Definition of explanatory variables.

Category	Variable
Support to improve the quality of hydropower energy.	Support to improve the quality of hydropower energy (Rp. 15,000) or USD 0.98 per month (1: yes, 0: no)
Socio-demographic characteristics	Age of head of household (years) Gender of head of household (1: male, 0: female)
Characteristics of residential ownership	Residential ownership (0: rent, 1: own)
Characteristics of social capital	Trust others (1: yes, 0: no) Household participation in society (1: yes, 0: no)
Characteristics of knowledge	Getting to know hydropower energy (0: don't know, 1: knows)
Characteristics of environmental awareness	Awareness of improving the quality of hydropower energy facilities (0: strongly disagree, 1: strongly agree)

This can also be changed to:

$$\langle P(Y = 1|X_1 \dots X_p) \rangle = \frac{1}{1 + exp\left(-\alpha - \sum_{j=1}^{p} \beta_j x_j\right)} \quad (3)$$

The possibility of not responding is:

$$P = (Y = 0|X_1 \dots X_p) = 1 - p(Y = 1|X_1 \dots X_p) = \frac{1}{1 + exp\left(-\alpha - \sum_{j=1}^{p} \beta_j x_j\right)} \quad (4)$$

Where Y = 1 (or yes) if the respondent is willing to pay (Rp. 15,000) or USD 0.98, and Y = 0 (or no) otherwise. With use predictor, equality regression logistics give possibility log-odd For support effort increase facility energy PLTMH For consumption electricity:

$$log\left[\frac{p}{1-p}\right] = b_0 + b_i x_j + \varepsilon_t \quad (5)$$

The logarithm of potential alternatives for environmental conservation and modernization of hydropower energy is represented by the above logarithmic equation, which also displays the odds ratio. Indicative parameters and statistical significance of the meaning of attitudes represent people's reactions (Gujarati, 2009).

Result and Discussion

The results showed that 95% of respondents (n = 50) were willing to pay a certain amount of money for improve the quality of hydropower energy and the remaining 5% of respondents (n = 10) were not willing. The social capital variable is significant in determining their support. Their trust in society, participation in society, and number of relatives outside the village have a positive and significant influence on their support (Table 2).

Among sociodemographic characteristics, the variables age, number of family members, and literacy level have a positive and significant influence, gender has a significant influence. As people age, they increasingly support adaptation to preserve the environment and improve hydropower energy use. The larger the number of family members, the greater their desire to participate. In addition, the more literate citizens are, the higher their willingness to participate.

Among the characteristics of residential ownership, ownership size has a positive influence on environmental conservation adaptation and increasing hydropower energy use. The greater the trust, the greater the citizens' desire to participate. Meanwhile, residents' knowledge of hydropower energy has quite a big impact. From the characteristics of environmental awareness, residents' perceptions of environmental sustainability and increasing water energy facilities for electricity use in their homes have the potential to have a positive and important impact.

Table 3 Results of the logistic regression model.

Variables	Odds ratio	Stand. error
Constant	0.250	2.587
Age	0.987**	0.039
Gender	2.657*	0.976
Residential ownership	4.639*	1.058
Trust in others	2.524*	1.071
Household participation in society	1.957*	0.984
Get to know hydropower energy	3.839*	0.854
Awareness of improving the quality of hydropower energy	0.455**	1.196
Nagelkerke R^2	0.528	
Wald	5.231	0.271

Dependent variable: Willingness to pay hydropower energy.
* significant at α = 10%
** significant at α = 5%.
***significant at α = 1%.

The same also applies if adaptation strategies are used in the process. From the analysis of individual variables, around 5% of respondents considered that preserving the environment and improving hydropower energy does not require the use of hydropower energy in their homes. Around 95% of respondents took advantage of the discovery of hydropower energy to overcome increasingly expensive electricity by using river water power.

Regarding the research focus, namely the influence of social capital on residents' willingness to pay to help preserve the environment and improve hydropower energy, this research suggests that social capital factors, measured by trust, household community involvement, and number of relatives outside. village, providing a positive and significant impact on community support. This means that people who trust other people will be more accepting of recommendations for using new technology to preserve the environment. These results are in line with research by Duffy and Wong (2000) which states that trust is needed to be able to do this in establishing interpersonal relationships and adaptation. Trust is a reflection of personal hopes, assumptions, or beliefs regarding the possibility that a person's actions in the future will be useful, good, and not detrimental to him. Lewicki and Wiethoff (2000) describe self-confidence as the willingness to act based on the words, actions, and decisions of others. A person's beliefs are determined by the development of a belief system throughout his life, experiences, rules or norms established in institutions or society, and experiences in relationships.

Community involvement in hydropower energy groups will likely increase knowledge about the importance of renewable energy in addressing climate change. These results confirm the argument of Bezabih et al (2013) that trust, as the formation of social capital in institutions, influences respondents' choice of adaptation strategies. Community participation can enrich a person's knowledge, including renewable energy technology, use of electricity, water energy, and handling climate change. hydropower energy communities typically act as mediators between the community at large and relevant government agencies. Various programs and assistance from outside the community are usually delivered through the community.

Residents who have more relatives outside the village are more willing to spend money to preserve the environment. Community knowledge about the possible impacts of climate change is increased through social capital. An individual's willingness to pay for a new hydropower renewable energy source may be positively influenced by encouragement from family members.

The results of this study are in line with previous investigations. The relationship between technology adoption in response to climate change and social capital has been examined in a number of studies. The important relationship between social capital and citizen innovation in the field of renewable energy, for example, was demonstrated by Van Rijn et al. (2012). For example, Social Media is used by New Renewable Energy (EBT), a new technology that has been successfully implemented by people with capital.

Implementing environmental management initiatives based on the interests of local communities, including their social capital, such as following local wisdom, will increase the level of success. Local communities are able to build more effective and contextual norms and successfully enforce them because of the knowledge they have accumulated from previous events, as stated by Agrawal (1996) and Ostrom (1999). Support environmental management initiatives, such as those aimed at adapting hydropower energy to new technological advances.

Conclusion

This research looks at how social capital influences people's willingness to adapt to the increase in hydropower energy, renewable energy sources. We conducted an opinion poll of people living in Yogyakarta, Kulon Progo Regency, Indonesia. As a result, 95% of local residents are willing to pay to improve the quality of hydropower energy. Residents with greater social capital—that is, those who have relatives outside the village, participate more actively in society, and have higher levels of trust in society—are more likely to support this. These findings suggest that, in countries like Indonesia where social capital is deeply embedded in society, solutions for adapting to changes in hydropower energy must include social capital strategies. The presence of social capital is also influenced by these findings. This strategy can be used in Indonesia's efforts to achieve net zero emissions by 2060; energy conservation, which limits the use of energy wisely, rationally and economically to meet current and future energy needs; setting various programs and mechanisms to encourage the implementation of energy conservation in various sectors; and public promotion of renewable hydropower energy. However, further research is still needed to ascertain how social capital influences community support for the adaptation of hydropower energy modifications in other regions in Indonesia and in other countries. The causes and effects may change depending on the social and cultural environment.

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