

Article

Green Energy and Water Resource Management: A Case Study of Fishery and Solar Power Symbiosis in Taiwan

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Abstract: Renewable energy development is a key pathway for mitigating climate change. The Taiwan government has been actively developing low carbon green energy with solar photovoltaic technology and wind power as their primary development projects. Cigu Taiwan provides an ideal research site to examine tradeoffs between ecological conservation, marine fisheries, and green power development, and the factors affect commitments to ecological conservation in the face of these tradeoffs. This research investigates the fishery and electricity symbiosis project in Cigu through a novel combination of the theory of planned behavior and the contingent valuation method to analyze the factors influencing the local residents' behavioral intentions to safeguard ecological achievements in ecologically fragile areas through conservation trust funds. Analysis of survey responses from a convenience sample of 715 residents and resource users in the Cigu area reports that attitudes (ATT), subjective norms (SN), perceived behavioral control (PBC), environmental concern (EC), and environmental risk (ER) significantly influence the behavioral intention to pay eco-compensation fees; the local residents' willingness to pay for the conservation trust funds was NTD 621.4/year (USD 21.9/year), and decreased to NTD 545.9/year (USD 19.2/year) after the implementation of fishery and electricity symbiosis. The discussion section argues that the drivers of ATT, SN, PBC, EC, and ER can be used by policy makers to direct local residents' intentions and behavior toward conserving ecological achievements in fragile eco-environmental areas through payments for ecosystem services. Thus, this strategy can improve the sustainability of ecological and environmental restoration programs.

Keywords: ecosystem services; climate change and adaptation; renewable energy targets; greenhouse gases; environmental risk; Taiwan



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1. Introduction

The Fifth Assessment Report [1] issued by the Intergovernmental Panel on Climate Change of the United Nations predicts that global warming will raise the global mean temperature by 4.8 °C and produce a global sea level rise of 82 cm by the end of the 21st century. Climate change not only poses threats to ecological environments such as loss of coastal wetlands [2], decline of coral reefs [3], reduction in tropical rain forests, land desertification, reduction in biodiversity, and fragile ecological chains [4], but also threatens stable social and economic development [5]. The United Nations unanimously adopted the Paris Agreement at the 21st meeting of the Conference of the Parties (COP21) in 2015 [6] with the aspiration to regulate national greenhouse gas emissions according to the development of each country so that the nature, ecology, and environment of the planet could develop continuously and sustainably.

Balancing efforts to reduce greenhouse gas (GHG) emissions with ecological conservation has proven exceedingly difficult in practice, as production of alternative energy

resources can impose negative impacts on the natural environments where they are produced [7]. Thus, efforts to mitigate the consequences of climate change can threaten the natural environments that can benefit from reduced carbon production. These trade-offs are particularly challenging because ERs associated with implementing alternative energy projects in environmentally sensitive areas may affect residents and users' willingness to pay for improvement of ecosystem services. Although not a party to the United Nations Framework Convention on Climate Change, Taiwan is particularly sensitive and vulnerable to the impact of global climate change [8], not only on the residential safety of coastal areas, but also on the marine fisheries resources, agricultural production, freshwater resources, land use, and environmental and social justice [9].

Renewable energy is one of the most prominent means of mitigating climate change [10] and has become the primary focus of energy policies in many countries, such as the European Commission proposing a new renewable energy sources (RES) target in energy consumption by 2030 [11], the German government supporting its low-carbon energy transition [12], and the government of South Korea turning to nuclear power as an essential electricity generation option for the supply of reliable power whilst reducing greenhouse-gas emissions and mitigating air pollution [13]. The fishery and electricity symbiosis is designed to develop green energy facilities without affecting the original fishery production, optimize the environment for aquaculture production, reduce the labor cost of aquaculture, promote industrial upgrading, and increase the income of aquaculture farmers from wholesale power supply to create a win-win situation for both the fishery and electricity industries [14]. However, Cigu, Taiwan, where the fishery and electricity symbiosis project is located, is an ecologically sensitive and nationally protected wetland that is home to many rare terrestrial and marine resources with species such as black-faced spoonbills, peregrine falcons, oriental white storks, and Kishi velvet shrimps; it constitutes a complete wetland ecosystem. The fishery and electricity symbiosis project is intended to produce environmentally friendly economic development through sustainable, low carbon, and environmentally friendly green power generation. However, as the Cigu area has a large-scale aquaculture fishery, rich recreational attractions, and many precious and rare biological resources, implementing the policy may have adverse consequences for local aquaculture farmers, local residents, and tourists visiting the area; moreover, it may cause irreversible damage to the surrounding ecological environment.

Large-scale solar panel installations have been linked to extensive land degradation [15] and the loss of habitat may have direct negative impacts on wildlife [16]. Dhar et al. [17] highlighted negative effects on the environment, such as bird mortality, loss of biodiversity and habitat, and visual impacts resulting from solar development. This makes the mitigation of adverse impacts on the ecosystem and follow-up ecological maintenance salient. For these reasons, the Cigu area provides an ideal research site to examine GHG mitigation and ecological tradeoffs, and the factors affect long-term commitments to ecological conservation. Investigation of local residents' preferences for ecological conservation, aquaculture fisheries, and green power development promises to add new insights into how tradeoffs can be overcome through durable commitments and the factors influencing local residents' willingness to support ecological conservation. In addition, the study results can be used as a reference for other cases.

Sustainable ecosystem development which integrates society, ecology, economy, and institutions has gained increased public acceptance [18]. In recent years, unsustainable reclamation activities have damaged coastal ecosystems and degraded ecosystem services; as a result, management of coastal wetland ecosystem services has received increasing attention [19]. In 2007, the economics of ecosystems and biodiversity (TEEB) initiative was launched by the United Nations Environment Program [20] to highlight the importance of ecosystem services (ES) and their contribution to economic value. Costanza et al. [21] defined ES as "the goods and services provided by ecosystems that directly or indirectly contribute to human welfare." ES and biodiversity play an essential intermediary role between the overall environment and human economic systems within the process of

global environmental change [22]. However, as economic activities continue to develop, global ES are at risk of decline and degradation. For example, wetland area is gradually decreasing [23], waste management continues to be a problem for riverine and coastal areas [24], and coastal wetland ecosystems are declining [25], which will bring about serious environmental and social problems [26] and declines in human well-being [27]. The TEEB lists eco-compensation as a management approach to protect the ecological environment and improve ES. Eco-compensation uses nonmarket-based policy instruments, such as taxation, subsidies, user payments, fines, and regulation. It serves as a reward for providing good ES to compensate for positive externalities that adequately respond to ES, as a penalty for creating negative externalities, or as a price to be paid for using ES [28,29]. It is expected that such ecological compensation or rewards will be transferred to landowners or managers who practice ecosystem-friendly management to achieve the goal of no net loss of ES [30].

The development of tourism activities has increased the contradictions among ecology, economy, and society; therefore, to promote the sustainable development of the ecosystem [31], it is necessary to provide eco-compensation to local residents [32]. The contingent valuation method (CVM) has been widely used in the past to assess environmental amenities, damages, and other research topics [33] and has become one of the most important methods for identifying and examining the value of nonmarket goods. The CVM first establishes a hypothetical market where respondents are surveyed to understand their willingness to pay (WTP) for or willingness to accept (WTA) changing or protecting the nonmarket goods and offering a tool to evaluate the market. Arrow et al. [34] suggested that it is more reasonable to use WTP rather than WTA to measure the benefits of changes in environmental resources because the use of WTA may produce exaggerated compensation amounts.

Therefore, cross-disciplinary research to further reflect the WTP of environmental goods or services through respondents' awareness, attitudes (ATT), opinions, and perceptions is vital. How individuals perceive environmental issues and the impact of perceived environment are important because they can lead to differences in individual behaviors with respect to the environment [35]. Consequently, sociologists, psychologists, and economists have developed various sociopsychological approaches to explain environmental behaviors and facilitate more public activity in these issues [36]. The theory of planned behavior (TPB) is a sociopsychological approach used to explain and predict human behavior patterns in specific situations; it has been widely applied to various research topics since its development, such as pro-environmental behaviors [37], transportation alternatives [38], resource recycling [39], water conservation [40], energy conservation [41], and low carbon consumption [42]. The theory states that consumers' ATT, subjective norms (SN), and perceived behavioral control (PBC) will constitute their behavioral intentions (BI).

In addition, the change in consumption behavior derived from high environmental awareness can produce increased concern about personal responsibility for environmental protection and personal behavior toward the environment [43]. Dunlap and Van Liere [44] first proposed the new environmental paradigm scale (NEP), which was further modified by Dunlap [45], to assess the inner environmental values and environmental ethics of humans toward nature. Junior et al. [46] reported that an individual's environmental concern can affect their BI toward green products. The work of Paul et al. [47] also indicated that consumers' environmental concern (EC) has a significant influence on their purchase of green products. Implementing the fishery and electricity symbiosis program in Cigu has the potential to produce chemical contamination of aquaculture products caused by the solar panels and further threaten human health and create environmental risks (ER) to the wetland ecology. The so-called ER refers to the chance of negative impacts such as destruction to society and the natural environment caused by natural or human activities and spread by environmental media [48,49]. Therefore, the ER is also included as one of the variables in this study.

This study will be conducted in the following manner. First, we design survey instrument to measure the perception of ES and investigate local residents' evaluation of various ecosystem service functions; second, we use the CVM to construct the WTP for the conservation trust funds; finally, we use the TPB as a basis, combining EC and ER to explore local residents' perception of the fishery and electricity symbiosis, eco-compensation mechanism, and WTP.

2. Material and Methods

2.1. Research Framework

Considering TPB as the core of the theory, this study adds two constructs, namely EC and ER, to explore local residents' BI toward ecological conservation, aquaculture fisheries, and green power development. The research framework is shown in Figure 1, and the research hypotheses are derived from this conceptual model.

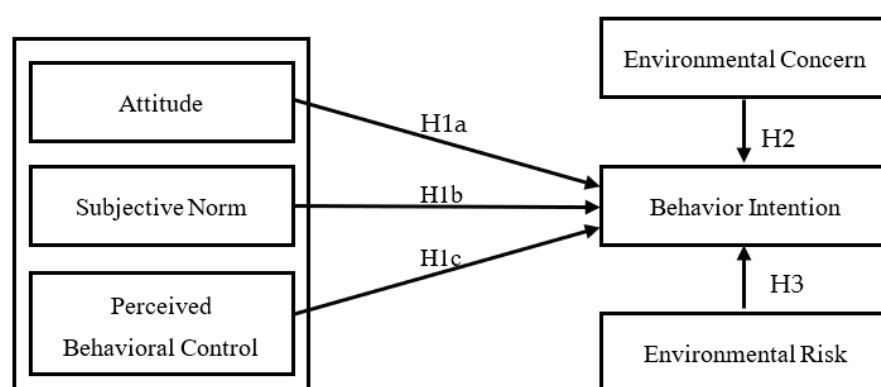


Figure 1. Conceptual model.

2.2. Research Hypotheses

The Behavior Intention (BI) reflects a person's willingness or conscious plan to engage in a behavior or thing and is a predictor of behavior [50]. López-Mosquera and Sánchez [51] reported that Subjective Norm (SN) and Perceived Behavioral Control (PBC) have significant positive relationships with WTP for park conservation. Gao et al. [52] reported that Attitude (ATT) and SN have significant positive influences on WTP for eco-compensation in wetlands. Lee and Jan [53] showed that ATT, SN, and PBC all have significant influences on tourists' intention to behave in an environmentally friendly manner. Sánchez et al. [54] reported that ATT and PBC have significant positive influences on WTP for reducing noise pollution from mass transport. Irfan et al. [55] showed that individuals' perceived costs, ATT, SN, and PBC of renewable energy have significant positive relationships with their WTP for developing renewable energy policies. Liu et al. [56] highlighted that ATT and SN have significant positive influences on tourists' civilized tourism behavior. Zhang et al. [57] showed that ATT, SN, and PBC significantly influence farmers' intentions toward climate change adaptation. Lin and Huang [58] showed that residents' ATT, SN, and PBC have significant positive influences on their ecological intentions.

Moreover, according to Yadav and Pathak [59], who used the extended model of TPB to explore Indian consumers' purchasing behavior for green products, consumers' ATT, SN, and PBC have significant influences on Behavior Intention (BI). In addition, past studies have indicated that individual ATT, SN, and PBC can influence the decision making of BI [53,57,58]. Building from and extending these findings, this study proposes the following hypotheses.

Hypotheses 1a (H1a). *ATT will have a significant positive influence on the BI toward ecological conservation and fishery and electricity symbiosis.*

Hypotheses 1b (H1b). *SN will have a significant positive influence on the BI toward ecological conservation and fishery and electricity symbiosis.*

Hypotheses 1c (H1c). *PBC will have a significant positive influence on the BI toward ecological conservation and fishery and electricity symbiosis.*

Paul et al. [47] showed that ATT, PBC, and EC have significant positive influences on consumers' BI to purchase green products. Arisal and Atalar [60] reported that Environmental Concern (EC) has a significant positive influence on consumers' intention to purchase environmentally friendly products. In addition, Dunlap [45] put forward a modified version of the NEP to assess individuals' inner environmental values and ethics toward nature to understand the antecedents for consumers to pay environmental compensation. Based on the above, individuals' EC is deduced to have a significant positive influence on their BI to pay for the improvement of ES in Cigu. Thus, the following hypothesis is proposed.

Hypotheses 2 (H2). *EC will have a significant positive influence on BI toward ecological conservation and fishery and electricity symbiosis.*

As there are many uncertainties and complexities involved in Environmental Risk (ER) [61], the likelihood and consequences of ERs can significantly affect individuals' environmental behaviors [62]. Frewer [63] emphasized the need to institutionally build public awareness of ERs to increase their sensitivity to environmental issues. Richard [64] reported that it is necessary to have the right perceptions, ATT, and coping behaviors toward ER to mitigate or reduce its potential hazards or adverse impacts on human health. Therefore, under the policy of fishery and electricity symbiosis, the public will inevitably consider its influence on the environment and individuals, which will ultimately lead to a change in their BI. Thus, the following hypothesis is proposed:

Hypotheses 3 (H3). *ER will have a significant positive influence on the BI toward ecological conservation and fishery and electricity symbiosis.*

2.3. Questionnaire Design

The description of the questionnaire design encompasses four parts. The first part is the perception of ES. In this part, we refer to the four major categories of ES functions proposed by TEBB [65,66] and adjust according to the current situation in Cigu to construct 20 types of ES functions that fit the area in order to explore local residents' perceptions of ES functions. The second part measures the participants' behavioral characteristics. In this part, we refer to the scales of Gao et al. [52], López-Mosquera and Sánchez [51], and Sánchez et al. [54] to design the questionnaire items on ATT, SN, and PBC. In terms of EC, we refer to Paul et al. [47] and Dunlap's [45] NEP and make modifications to fit the context of this study. For ER, we draw upon the insights of Robson and Toscano [48] and the United States Environmental Protection Agency (USEPA) [49]. Both components are measured by a 7-point Likert scale, asking local residents how much they agreed with each item. From "strongly disagree" to "strongly agree," participants were asked to give a score from 1 to 7.

The third section addresses the WTP for the conservation trust funds. We assume that there is an ecological conservation foundation responsible for integrating the conservation-related work of the government and nongovernmental sectors in the Cigu area. A hypothetical market is established based on the benefits and future development of the supply, regulation, support, and culture of the ES in Cigu, and the hypothetical scenarios of eco-compensation were designed to survey the respondents' WTP for each benefit. As fishery and electricity symbiosis has not been implemented in Taiwan before, it is difficult to assess the ecological compensation fees at a specific price. Therefore, we use the open-ended bidding method of WTP for this study. Respondents were asked to fill in the prices they were ready to pay for eco-compensation for the ecological conservation, aquaculture fisheries, and green power development in the Cigu area. To enhance respondents' knowledge and understanding of the ES functions in the Cigu area and to reduce the information bias of the CVM, we conducted one-on-one interviews with the onsite respondents. The fourth

part provides the respondents' basic information, including gender, age, education level, monthly income, and ecological conservation preferences.

2.4. Sample Size and Composition

In this study, convenience sampling is used to investigate the local residents who lived in Cigu, Taiwan, and the investigation period is from January 2021 to March 2021. A one-on-one interview method is adopted to reduce misunderstanding of the questionnaire and to help respondents fill out the questionnaire seamlessly. A total of 805 questionnaires were distributed, and 715 were considered to be valid after elimination of incomplete or otherwise invalid responses for a recovery rate of 88.9%. In terms of gender in the socioeconomic background of the study participants, 354 (49.5%) were male and 361 (50.5%) were female. The modal age category of the participants was 40–49 years old (37.2%), followed by 50–59 years old (22.6%). In terms of education level, high school degree accounted for the highest proportion (48.5%). The modal personal monthly income range was from NT\$ 40,001–60,000 (USD 1409–2114) (49.1%). Among the participants, 7.1% were members of environmental protection groups, and most (72%) preferred “ecological restoration” in terms of the environmental compensation preference for ecological conservation.

3. Results

3.1. Measurement Model: Reliability and Validity

The data were analyzed using Statistical Package for Social Science (SPSS) and Analysis of Moment Structure (AMOS) version 21. The research literature indicates that a Cronbach's alpha reliability coefficient greater than 0.7 is acceptable; if it is greater than 0.9, it indicates very high reliability; if it is less than 0.35, it indicates low reliability [67]. As for the construct validity, if the factor loading of each construct is higher than 0.5, it indicates that the item has construct validity [68]. Finally, the average variance extracted (AVE) and the Fornell–Larcker criterion are measured to assess discriminant validity [69]. We initially performed a confirmatory factor analysis including all latent variables (ATT, SN, PBC, EC, ER, and BI), as seen in Table 1. The correlation matrix is reported in Table 2.

Table 1. Results of the factor loading, reliability, and validity.

Question Item	Factor Loading	Cronbach's α	AVE	CR
1. Theory of planned behavior				
Attitudes (ATT)		0.873	0.735	0.917
(1) I am willing to protect the ecology in Cigu to avoid the decline of wetland area.	0.861			
(2) I am willing to protect the ecology in Cigu to avoid the decline of biodiversity.	0.871			
(3) I am willing to protect the natural landscape in Cigu.	0.867			
(4) I think the conservation of ecology has its necessity.	0.830			
(5) I do not think the development of fishery and electricity symbiosis will have any impact on the environment.	0.892			
(6) I think the development of fishery and electricity symbiosis requires a certain amount of eco-compensation.	0.647			
Subjective norms (SN)		0.924	0.769	0.943
(7) I would support fishery and electricity symbiosis because of the active promotion of the government.	0.876			
(8) I would accept the fishery and electricity symbiosis because of the general consensus in the society.	0.930			
(9) Most of the mass media reports on fishery and electricity symbiosis are positive.	0.869			
(10) I would want to support fishery and electricity symbiosis because people around me agree with it.	0.888			
(11) I would be influenced by the opinions of experts and scholars to support fishery and electricity symbiosis.	0.817			

Table 1. Cont.

Question Item	Factor Loading	Cronbach's α	AVE	CR
Perceived behavioral control (PBC)		0.897	0.656	0.920
(12) I feel that I have enough professional knowledge to choose to support fishery and electricity symbiosis.	0.779			
(13) I would support the policy of fishery and electricity symbiosis because of government subsidies.	0.788			
(14) I would be more supportive for the fishery and electricity symbiosis with the endorsement of experts and scholars.	0.793			
(15) I believe that government departments are capable of protecting the ecology in Cigu and developing fishery and electricity symbiosis.	0.861			
(16) I believe the government will use the funds exclusively for the ecological conservation and the development of fishery and electricity symbiosis in Cigu.	0.840			
(17) I have enough money, time, and opportunities to support the ecological conservation and fishery and electricity symbiosis in Cigu.	0.797			
(18) I do not think paying eco-compensation can change the status quo.	0.541			
2. Environmental concern (EC)		0.895	0.596	0.911
(1) I think the issue of ecological environment is very important.	0.810			
(2) I think we should pay more attention to the ecological environment.	0.840			
(3) I think I care a lot about the environment.	0.565			
(4) I think that protecting the environment requires major changes.	0.746			
(5) I think humans are approaching the upper limit of the number of people the earth can accommodate.	0.657			
(6) I think that humans have the right to change the natural environment to suit their needs.	0.086			
(7) I think that when humans interfere with nature, it usually results in catastrophic consequences.	0.697			
(8) I think humans seriously abuse the environment.	0.767			
(9) I think that if we learn how to exploit natural resources, we will have more of them.	0.824			
(10) I think plants and animals have equal rights as humans.	0.555			
(11) I think that the balance of nature is sufficient to cope with modern industrial nations.	0.029			
(12) I think the earth has very limited space and resources.	0.708			
(13) I think that if the current situation continues, we will soon experience a major ecological disaster.	0.027			
3. Environmental risk (ER)		0.932	0.882	0.957
(1) I think that the addition of fishery and electricity symbiosis equipment will eventually cause harm to human health.	0.925			
(2) I think that the addition of fishery and electricity symbiosis equipment will have a negative impact on the environment.	0.957			
(3) I think that the addition of fishery and electricity symbiosis equipment will have a negative impact on wildlife.	0.935			
4. Behavioral intentions (BI)		0.920	0.787	0.937
(1) I would support the construction of fishery and electricity symbiosis because of my preference for green energy development.	0.650			
(2) I am ready to pay eco-compensation fees to conserve the ecological environment of Cigu.	0.876			
(3) I am ready to pay eco-compensation fees to subsidize the harm caused by fishery and electricity symbiosis.	0.885			
(4) I am willing to donate if there are fundraising activities related to ecological conservation and fishery and electricity symbiosis.	0.896			
(5) I am willing to share my experience of paying eco-compensation.	0.891			

Table 2. Mean, standard deviation (SD), and correlations of constructs.

Construct	Mean	SD	1	2	3	4	5
ATT	5.77	0.77					
SN	5.08	1.31	0.619 ***				
PBC	4.84	1.20	0.576 ***	0.860 ***			
EC	5.80	0.78	0.671 ***	0.442 ***	0.540 ***		
ER	5.00	1.36	0.159 ***	0.206 ***	0.388 ***	0.375 ***	
BI	5.01	1.19	0.569 ***	0.654 ***	0.705 ***	0.513 ***	0.377 ***

*** $p < 0.001$. Note: ATT = Attitude; SN = Subjective Norm; PCB = Perceived Behavioral Control; EC = Environmental Concern; ER = Environmental Risk; and BI = Behavior Intention.

3.2. Perception of Ecosystem Services

First, the survey results for perception of ES functions reveal that 88.4% of the sampled local residents think that the ES in the Cigu area can provide sources of food, regulate the climate and environment, support plant and animal habitats, and inherit culture. As for the influence of each ES, about 70% of sampled local residents think that the provisioning (77.9%), regulating (74.8%), supporting (73.9%), and cultural functions (66.8%) of the ecosystem have been reduced or decreased. In terms of environmental compensation, only 5% of the sampled local residents have heard of and fully understood the concept, while the vast majority have heard of it but only partially understood it (37.1%), or do not quite understand it (35.4%). However, about 80.6% of the local residents agreed that eco-compensation could be used to prevent or reduce harm to the ecosystem. This means that, although local residents may not fully understand the concept of eco-compensation, they still agree with the idea of compensation for the harm caused to the environment.

Second, regarding the policy of fishery and electricity symbiosis, 77.2% of the sampled local residents think that the construction of the symbiosis facilities would affect the surrounding ecosystem. This finding indicates that most respondents think fishery and electricity symbiosis will have some kind of impact on the environment.

Finally, a 7-point Likert scale is used to assess the importance of the ecosystem service functions to the local residents in the Cigu area, with the score of 1 indicating very unimportant and 7 indicating very important. The importance of each function are the following: provisioning (average score = 6.17), regulating (average score = 5.96), supporting (average score = 5.90), and cultural (average score = 5.45). These results indicate that the provisioning function of the ES is the most valued by Cigu residents.

3.3. Empirical Results Related to the Respondents' Willing to Pay

The empirical results reveal high WTP for ecosystem provisioning functions in Cigu. In descending order, respondents' average WTP for the ecosystem conservation trust fund of the ES prior to implementation of fishery and electricity symbiosis are: provisioning function (NTD 711.1/year) (USD 25.1/year), regulating function (NTD 691.1/year) (USD 24.35/year), supporting function (NTD 611.7/year) (USD 21.55/year), and cultural function (NTD 471.8/year) (USD 16.62/year); in addition, the local residents' average WTP for the ecosystem conservation trust fund of the ES in Cigu after the implementation of fishery and electricity symbiosis are listed in descending order: provisioning function (NTD 626.5/year) (USD 22.07/year), regulating function (NTD 603.4/year) (USD 21.26/year), supporting function (NTD 579.7/year) (USD 20.4/year), and cultural function (NTD 470.1/year) (USD 16.56/year).

The survey results clearly demonstrate that the implementation of fishery and electricity symbiosis will reduce the WTP for the ecosystem conservation trust fund for these four categories of ES. According to previous studies, consumers are ready to pay higher prices for environmentally friendly products [70], while information about environment-polluting products will lower the price they are ready to pay [71]. As the majority of the local residents surveyed in this study think that the implementation of fishery and electricity symbiosis will have a negative impact on the environment, and most of them prefer eco-compensation

in the form of ecological restoration rather than ecological creation by external intervention, it is inferred that the price paid by local residents for the conservation trust fund is simply for the conservation of ES, rather than the repair of damage caused by the intervention of government policy. Thus, it is reasonable that the prices for the conservation trust fund before the implementation of fishery and electricity symbiosis are higher than the prices after its implementation.

3.4. Results of Structural Equation Modeling

The proposed structural model has a good fit in terms of the maximum likelihood indices ($\chi^2 = 1186.947$, $df = 714$ GFI = 0.926, CFI = 0.917, NFI = 0.943, TLI = 0.956, AGFI = 0.913, RMSEA = 0.017). The graphic representation of the results obtained is included in Figure 2. First, H1a ($\beta = 0.875$, $p < 0.001$), H1b ($\beta = 0.593$, $p < 0.001$) and H1c ($\beta = 0.699$, $p < 0.001$) hypotheses are supported in terms of the local residents' attitudes. The study results show that the sampled local residents' ATT, SN, and PBC exert significant positive influences on their BI toward ecological conservation and fishery and electricity symbiosis in Cigu. These results conform to those of previous studies that have investigated the influence of the public's SN and PBC on the payment for environmental improvements in suburban parks [51], and the significant positive influence of the public's ATT and PBC on the payment for road noise reduction [54]. The findings lead to a conclusion that respondents' BI to pay for the maintenance of the ES will be affected by their viewpoints and ATT toward the ecological conservation and fishery and electricity symbiosis in the Cigu area, the influence of third parties (e.g., mass media, family and relatives, and experts and scholars), past experiences, and the anticipated difficulties they may face in paying for the service. Therefore, they will consider their own position, government administration, and media communication before making the final decision to pay.

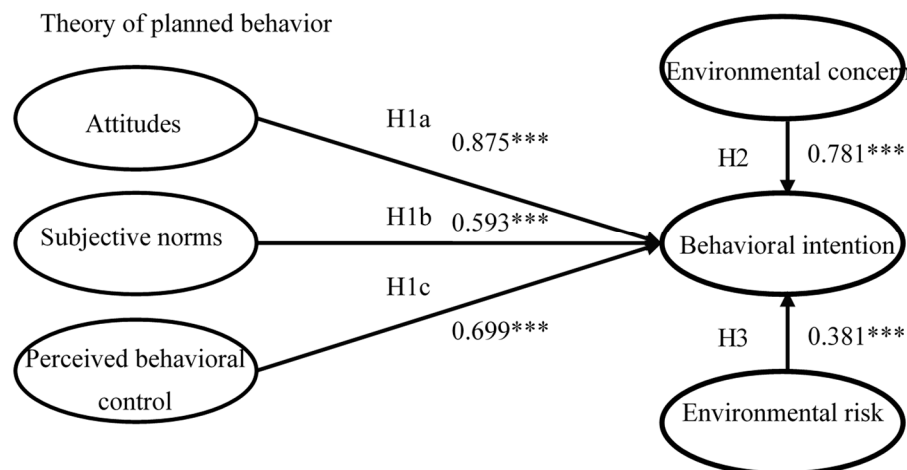


Figure 2. Path analysis of the hypothesis model. GFI = 0.926; CFI = 0.917; NFI = 0.943; TLI = 0.956; AGFI = 0.913; and RMSEA = 0.017. Note: *** $p < 0.001$; solid lines denote established hypotheses. The result of the analysis is positive indicate that there is a positive relationship between variables.

Furthermore, H2 ($\beta = 0.781$, $p < 0.001$) is confirmed. The reported effects are consistent with previous studies that have examined consumers' ATT, PBC, and EC in purchasing environmentally friendly products [47]; attitude and EC toward green brands [72]; and the significant positive influence of EC on BI to purchase environmentally friendly products [60]. These findings support the proposition that strengthening local residents' awareness of EC and making them more aware of environmental issues can effectively increase their WTP for the improvement of ES.

In addition, H3 ($\beta = 0.381$, $p < 0.001$) is also confirmed by the empirical evidence presented. The reported result is consistent with the findings of Xu et al. [62] that environmental perception and ER have significant positive influences on the BI toward

environmentally responsible behavior. This supports the conclusion that the ERs associated with the fishery and electricity symbiosis policy, such as human health hazards and negative impacts on environment and wildlife, will affect the local residents' and tourists' BI toward paying for the improvement of the ES. Thus, these issues need to be carefully assessed and effectively addressed.

With the purpose of describing a summary of the outcomes obtained by our study, Table 3 shows a description of the contrasted hypotheses and their final statistical results.

Table 3. Summary of hypothesis verification.

Hypothesis	Content	Verification
H1a	ATT has a significant positive influence on the BI toward ecological conservation and fishery and electricity symbiosis.	Supported
H1b	SN has a significant positive influence on the BI toward ecological conservation and fishery and electricity symbiosis.	Supported
H1c	PCB has a significant positive influence on the BI toward ecological conservation and fishery and electricity symbiosis.	Supported
H2	EC has a significant positive influence on BI toward ecological conservation and fishery and electricity symbiosis.	Supported
H3	ER has a significant positive influence on the BI toward ecological conservation and fishery and electricity symbiosis.	Supported

Note: ATT = Attitude; SN = Subjective Norm; PCB = Perceived Behavioral Control; EC = Environmental Concern.; ER = Environmental Risk; and BI = Behavior Intention.

4. Discussion

This SEM analysis based on TPB investigates the factors influencing the nonmarket value of ES by examining EC and ER variables to explore the ATT and BI toward ecological conservation and fishery and electricity symbiosis for a sample of Cigu residents. The extended TPB model is shown to effectively explain the antecedents for BI, and the results reveal that the greatest influence on the nonmarket value of the ES comes from ATT, followed by EC, PBC, SN, and ER; and each construct has a significant positive influence on BI. The results demonstrate how our extended TPB methodology can be applied in other environmental or green contexts to explain these individual preferences to explain this conduct, and the result conforms with past research findings. The high environmental concern people have high behavioral intention [73]; individuals' behavior is connected to the relationship they have with nature [74]; and ATT, SN, and PBC can influence visitors' intention [75]. ATT, SN, and PBC have significant positive influences on respondents' BI toward paying for the improvement of ES in Cigu. This result suggests that the local residents' viewpoints toward the fishery and electricity symbiosis, mass media, family and relatives, and experts and scholars, as well as the assessment of their own capabilities, will all affect their BI to pay for the improvement of the ES. Furthermore, discussions about EC and ER indicate that environmental awareness, concern for environmental issues, and assessment of the harm associated with fishery and electricity symbiosis are important factors that affect the fee payment.

Moreover, our results conform with those of previous studies in that ATT, SN, and PBC have significant positive influence on BI [47] and regarding the impacts of EC and ER on the WTP for environmental compensation. Similarly, EC [60] and ES [62] also have significant positive influence on BI. Thus, the outcomes of this study confirm that ATT, SN, PBC, EC, and ER are all antecedents for the WTP for environmental compensation. Ecological conservation and the improvement of ES for fishery and electricity symbiosis is evaluated using CVM. The average WTP for improving the ES after the implementation of fishery and electricity symbiosis in descending order is: provisioning function (NTD 626.5/year) (USD 22.1/year), regulating function (NTD 603.4/year) (USD 21.3/year), supporting function (NTD 579.7/year) (USD 20.4/year), and cultural

function (NTD 470.1/year) (USD 16.6/year). It can be observed that local residents are ready to pay approximately NTD 569.9/year (USD 20.1/year) to maintain the precious ES in the Cigu area, which indicates a readiness to pay to preserve the rare natural resources.

According to previous studies, factors such as natural attraction [76], ecotourism [77], local environment and climate [78], and satisfaction have significant influences on local residents' willingness to revisit. We find that ES is even more relevant in this aspect. The importance of a conservation trust fund is evident from the fact that local residents are ready to pay extra for the conservation of ES. At present, electricity generation in Taiwan is predominantly fossil-based (coal, natural gas, petroleum oil, etc.), responsible for a high degree of greenhouse gas emissions and air pollutants in the region. A solar-powered renewable electricity generation in a fishery can significantly reduce pollution while providing electricity, thereby improving and protecting the aquaculture environment. Such a symbiotic system can have the potential for future clean energy development.

5. Conclusions

5.1. Conclusion

Local residents' WTP for improving the ES in Cigu among residents in this study is significantly influenced by their ATT, SN, PBC, EC, and ER. Therefore, effectively advocating the relevant green energy policies of the government and disclosing the complete assessment reports can at least partially debunk misconceptions about green power development and further influence ATT. Governments can improve citizens' SN and PBC through holding related campaigns, endorsement by experts and scholars, and administrative practices. According to the current situation, there is no relevant policy for environmental protection after the fisheries and solar power symbiosis is implemented in the Cigu area, so it is urgent for local government to actively implement it. In terms of EC and ER, the findings of this study suggest that, through relevant advocacy activities, community gatherings, and school education, people can gain greater understanding that they are a part of a global community and should care for their surroundings, thereby raising their EC and strengthening their awareness about ERs. Although most of the sampled local residents (77.2%) think that the implementation of the fishery and electricity symbiosis policy will jeopardize the surrounding ES, they agree to balance the impact caused by the policy through eco-compensation. Therefore, this study suggests that the relevant organizations implementing the policy should establish a complete eco-compensation mechanism and ensure its effective operation and long-term maintenance to obtain a win-win situation for all stakeholders.

5.2. Research Limitations and Further Research

Given the diversity and complexity of the regional ecosystem and the incomplete understanding of fishery and electricity symbiosis, this study cannot fully account for all of the factors that affect the local residents' payment of eco-compensation. Thus, further investigation is needed to discover additional influences. In addition, the relevant research on the special ecological reserve in Taiwan is still lacking, so more research is needed to help and explore this precious natural resource. As wetland ecology is a nonmarket good, future studies can further evaluate it using the choice experiments (CE) method. As the CE method has multiple attributes and levels, it can combine different alternatives according to the important characteristics of nonmarket goods or services and, through the choice set of different scenarios, it can enable respondents to choose the appropriate alternatives according to their preferences, thereby avoiding bias in evaluation. We also hope that future research on fishery and electricity symbiosis in other settings build on this research to combine, apply, learn from, and draw upon academic work to advance environmental protection practice.

Another limitation of this study is it does not address a comparison scenario of fishery and fossil-based electricity production in Cigu. As fossil energy causes large GHG emissions that impact global climate change, which has already resulted in significantly

broad ecosystem changes, the survey responses to the fishery–fossil electricity would likely be different.

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Abbreviations

AMOS	Analysis of Moment Structure
ATT	Attitude
AVE	Average Variance Extracted
BI	Behavior Intention
CE	Choice Experiments
CVM	Contingent Valuation Method
EC	Environmental Concern
ER	Environmental Risk
ES	Ecosystem Services
GHG	Greenhouse Gas
NEP	New Environmental Paradigm
NTD	New Taiwan Dollar (1 NTD = 0.03523 USD)
PBC	Perceived Behavioral Control
RES	Renewable Energy Sources
SN	Subjective Norm
SPSS	Statistical Package for Social Science
TEEB	The Economics of Ecosystems and Biodiversity
TPB	Theory of Planned Behavior
USEPA	United States Environmental Protection Agency
WTA	Willingness to Accept
WTP	Willing to Pay

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