

Article

Extended Theory of Planned Behavior for Predicting the Willingness to Pay for Municipal Solid Waste Management in Beijing

Jiahao He ¹ , Zhefan Yu ²  and Hiroatsu Fukuda ^{1,*} 

¹ Department of Architecture, The University of Kitakyushu, Kitakyushu 808-0135, Japan; a9dbb002@eng.kitakyu-u.ac.jp

² Graduate School of Comprehensive Human Sciences, University of Tsukuba, Tsukuba 305-0821, Japan; s2036050@s.tsukuba.ac.jp

* Correspondence: fukuda@kitakyu-u.ac.jp

Abstract: Municipal solid waste (MSW) management has become a problem in China, mainly since there is no uniform standard for MSW management charges, causing conflict between local residents and the government. An intelligent garbage sorting system (IGSS) is an effective sorting approach for MSW management. To explore the predictors of local residents' willingness to pay (WTP) for the IGSS, this study applied an extended theory of planned behavior (TPB) model by adding an antecedent environmental concern (EC) prior to the main predictors of the TPB model (attitudes, subject norms, perceived behavioral control). The WTP of Beijing residents for MSW management and the determinants of WTP were analyzed. The specific amount of WTP was predicted by a contingent valuation method (CVM) in an online questionnaire, and the mean WTP was estimated to be USD 49.93 per household per year. The results showed a positive connection between EC and residents' WTP, and most of the participants were willing to pay for the IGSS for MSW management.

Keywords: theory of planned behavior (TPB); willingness to pay (WTP); municipal solid waste (MSW) management



Citation: He, J.; Yu, Z.; Fukuda, H. Extended Theory of Planned Behavior for Predicting the Willingness to Pay for Municipal Solid Waste Management in Beijing. *Sustainability* **2021**, *13*, 13902. <https://doi.org/10.3390/su132413902>

Academic Editors: Ming-Lang Tseng, Mohd Helmi Ali and Yeneneh Tamirat Negash

Received: 13 November 2021

Accepted: 6 December 2021

Published: 16 December 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

According to the World Bank's review, global municipal solid waste (MSW) generation levels are estimated to increase to approximately 2.2 billion tons per year by 2025 [1]. Consequently, the traditional waste management system has encountered difficulties in disposing of large volume of MSW [1], which has led to inadequate disposals and has become a severe problem in many developing countries. China surpassed the U.S as the world's top MSW producer in 2004. Now, China's MSW generation is growing at an annual rate of 8–9% [1]. From 2010 to 2019, MSW production in Beijing rose from 6.35 million tons per year to 10.11 million tons, averaging 27,700 tons per day, which is 1.2 kg per person per day. With a series of policies, regulations, and measures, the composition structure of MSW management technology has changed in proportion; in 2020, Beijing reached 87% of MSW recycling (43% by incineration, 45% by landfill, 12% by composting) [2]. In addition, the main problem of MSW management in China is that the MSW composition is complicated. The average water content of MSW in Beijing reaches 50.19%, and this mixed MSW makes it difficult to sort and recycle [2]. The water contained in MSW not only pollutes recyclables in MSW, but also brings difficulties and increases the cost of MSW disposal, collection, transfer, transportation, and treatment. Therefore, the pre-sorting and treatment of MSW becomes a necessary condition for incineration [2]. In this case, effective MSW management has become necessary, not only from the human health perspective, but also from the aspect of environmental concerns [3]. Effective MSW management approaches such as smart MSW sorting systems [3] have been proposed to minimize the harmful effects of inadequate

disposal in urban areas. However, in China, there is a lack of a uniform standard for MSW management charges, with local governments specifying the charges within administrative districts, one of which is levied incidentally through utility charges such as water, gas, and electricity [4]. Specifically, the payments for MSW management have normally been extracted from utilities expenses by local residents, which has become a possible cause of conflict regarding payments between residents and the local government [4]. The intelligent garbage sorting system (IGSS) is a widely used smart MSW sorting approach and is an effective way to improve urban MSW management and increase the productivity of cleaning contractors [5]. Compared with the current MSW treatment methods mainly performed in Beijing city, it can improve the efficiency of waste incineration treatment by substantially improving the efficiency of recycling and separation [5]. The MSW sorting features of IGSS are one of the most practical and economical methods and can reduce the costs of unsynchronized disposal by 80–90% [5]. In that regard, health-hazardous factors in MSW such as germs and other substrates can be substantially reduced [5]. In addition, the pre-sorting of unburnable MSW (metals, glass, etc.) can significantly reduce the costs of the second separation [5]. In this study, willingness to pay (WTP) is defined as the willingness of local residents to pay for IGSS, which is influenced by their thoughts and perceptions. Cases focusing on the WTP for IGSS have been frequently discussed in previous research and have played an important role in improving MSW management in developed countries [6,7]. In Europe, different countries have regulations on MSW separation and recycling, but there is no uniform standard for MSW management (it mainly depends on the consciousness of local residents) [8,9]. In addition, in Germany, the recycling of certain bottles can be rewarded in supermarket recycling devices (Similar to a type of IGSS), which improves the motivation of local residents for MSW separation [10]. In Japan, local residents sort MSW by different colored bags, and different levels of fees are associated with sizes and categories, which significantly increases the treatment capability of IGSS [11,12]. Compared with Europe and Japan, MSW management began late in China, with a larger amount of MSW. In this study, investigating local residents' WTP for MSW management will contribute to the development of government policies on MSW management.

Previous studies have ascertained that environment-beneficial products, services, or systems related to the IGSS are defined as having a “non-market” value [13], which cannot be assessed by market behavior, but by non-market valuation techniques [14,15]. Thus, in this study, a widely used, non-market value evaluation technique of the contingent valuation method (CVM) [16,17] was conducted to assess the WTP for the IGSS in Beijing. A standard CVM [16] was used for surveying the WTP for the IGSS by measuring subjective feedbacks using a questionnaire similar to one used in a previous study [17]. The CVM has been used in previous research for assessing the value of various environmental facilities and environmental damage, conservation and restoration of natural and historical culture, health hazard reduction, and health index improvement [17,18]. Compared to the research on environment protection, the CVM has been used as an approach to study the influence of public opinions on MSW management [18]. Based on a standard CVM, previous studies have suggested that WTP for MSW management not only comprises socioeconomic factors such as gender, age, and income, but also focused on psychosocial constructs, such as AT, which is the behavior in questions [19], and SN, a social factor that refers to the perceived social pressure of whether or not to perform the behavior [19]. PBC, which is the person's belief as to how easy or difficult performance of the behavior is likely to be [19], is a predictor of WTP [19,20]. The theory of planned behavior (TPB) model was first proposed by Ajzen [20]. It demonstrates that an individual's attitude, subjective norms, and perceived resources with regard to a specific behavior can help us better understand pro-environmental behaviors [21]. The raw TPB model has been widely used in environmental studies to analyze various behavioral intentions and behaviors, such as participation in environmental activities [22], forest protection [23], wildlife conservation [24], consumption of urban environmental goods [25], and greenhouse gas emissions [26,27].

Compared with previous studies, although some researchers have extended the TPB model for gaining a deeper understanding in the prediction of the WTP, the impact of environmental concern (EC), the personal and social awareness, and subsequent concern regarding the quality of the natural environment [27], has rarely been discussed. Thus, this study proposed to investigate the WTP for the IGSS of local residents in China, by introducing an extended TPB model that integrated the predictor of EC [27]. This study mainly aimed to evaluate and compare the following predictors and their relationships: EC, AT, SN, and PBC in the extended TPB model.

Similar works

Compared with the studies over the past five years, based on the raw TPB model for improving urban environmental products, Zahedi and Batista Foguet analyzed residents' WTP for improve urban air pollution [27], Zhang focused on protecting urban water bodies to mitigate the heat island effect [28]. Zhang used the extended TPB model with EC, in addition, Wang predicted the impact conditions of respondents' pro-environmental behavior by merging the raw TPB and NAM model [29]. Among the research for MSW management, Ma's study tends to analyze human active behavior through the TPB model [30], and Shen's study, also through the extended TPB model by attended personal moral obligation, aimed to respondents' behavioral intention [31], and the research on WTP for MSW management methods is not mentioned.

All mentioned abbreviations in this study are shown in Table 1.

Table 1. List of mentioned abbreviations.

Abbreviation	Explanation
MSW	Municipal Solid Waste
IGSS	Intelligent Garbage Sorting System
WTP	Willingness to Pay
TPB	Theory Planned Behavior
CVM	Contingent Valuation Method
EC	Environmental Concern
AT	Attitude
SN	Subjective Norm
PBC	Perceived Behavioral Control

2. Materials and Methods

2.1. Sampling Area

The investigation of this study was conducted within the following districts in Beijing: Chaoyang District, Haidian District, Fengtai District, Xicheng District, Dongcheng District, and Shijingshan District [32], which have 71% of local residents in Beijing, were defined as the sampling area.

2.2. Online Survey

We used online questionnaires in this study. Questionnaires were assigned by a third-party agency, in order to accurately recruit participants. Participants received a compensation of 100 JPY (about 1 USD).

2.3. The Design of the Survey

System of the questionnaire has over 2.6 million sample resources for quick data collection. To ensure the data is accurate and valid, the sample service provided a strict quality control mechanism. Each answer sheet was screened by automatic screening rules and manually checked by customers after submission. Those were not met the requirements were marked as invalid. The number of times a member's completed answer sheet was marked as invalid exceeds a certain percentage. In that case, the system automatically removed the member and no longer allow him/her to answer.

A pre-survey was conducted, which obtained 532 questionnaire answers and was used to determine the question direction and WTP range for the final questionnaire. The formal study began on 21 July 2021 and lasted for 14 days. The questionnaire was sent to Beijing residents randomly online, and a valid sample was eventually obtained. Many studies have shown that the method of guiding WTP has a significant impact on WTP. The payment method proposed in the questionnaire is personal and governmental share, and the frequency of payment is once a month. The first part of the questionnaire is the participants' backgrounds. The second part carried out the WTP for conserving the MSW management. The question about the WTP is: Suppose the Beijing Municipal Government needed funds to purchase IGSS for community use to improve MSW management to reduce MSW pollution. Based on your personal situation and the information above, considering your annual household income, would you be willing to pay __ yuan (CHY)? Four bid values. 10, 20, 30, over 30 yuan to purchase IGSS for your community, these four bid values above will be assigned to all respondents with a dichotomous option. The pre-survey was conducted with 532 questionnaires to pre-survey citizens in core residential areas of Beijing on their essential willingness to pay for environmental concern and MSW management. The above-average payment amounts were obtained based on the average data. In the third part, questions related to residents' behavioral characteristics are asked. This section focuses on the extended TPB model variables by questioning respondents about their AT, PBC and intentions regarding MSW and MSW management, and the key EC directions in the extended TPB model and refers to respondents' attitudinal characteristics of pro-environmental behavior regarding MSW management payments on 5-point Likert scales. (1 = strongly disagree, 5 = strongly agree). (Shown in Table 2)

Table 2. Constructs and indicators of the extended TPB model.

Predictors	Indicators	Response Scale (1–5)	References Used
Environment-concern (EC)	I care about urban environmental issues very much. I think I will reduce other expenses for urban environment improvement.	No concern–Very high concern Extremely negative–Extremely positive	[33,34]
Attitude (AT)	I think paying for MSW management is very positive. I think paying for MSW management is a responsibility. I think paying for MSW management is pro-environmental behavior	Strongly disagree–Strongly agree	[34,35]
Subjective norm (SN)	I think the people who are close to me will pay for MSW management. I think people who are close to me will support the action of paying for MSW management. I think people who are close to me will support me paying for MSW management.	Strongly disagree–Strongly agree	[34,35] [35,36]
Perceived behavioral control (PBC)	I think my payment will improve the urban environment. It is not difficult for me to pay for MSW management. I think I have time, money, and resources to contribute to the MSW management	Strongly disagree–Strongly agree	[34–37]

2.4. Data Analysis

Estimation of WTP

In this study, we used a contingent valuation method to be calculated WTP for MSW management using IGSS. A format of dichotomous selection was used to elicit WTP for residents. The average WTP was calculated according to the formula provided by Hanley [38].

$$\text{Mean WTP} = \int_0^T [1 - G_{\text{wtp}}] dW$$

G_{wtp} is the distribution function of WTP. T is the infinite value of the true payment intention, which is truncated at a specific value for estimation purposes.

In this study, structural equation modeling was used to calculate the variable factors affecting WTP. In this study, licensed AMOS 26.0 was used for processing the data. Based on the recommendations of Anderson and Gerbing [39], this study used confirmatory factor analysis (CFA) to assess the measurement quality of the extended TPB model and structural equation modeling (SEM) to verify the plausibility of the hypothesized extended TPB model. As for the results of the CFA test, the robustness of the mean squared error approximation (RMSEA) is expected to lie between 0.05 and 0.08. The comparative fit index (CFI), the normative fit index (NFI), and the goodness of fit index (GFI) should be close to 0.9 or 1. At last, the Sobel test and bootstrap method were used to calculate the indirect effects between the variables.

2.5. Theoretical Framework and Research Hypothesis

TPB (theory of planned behavior) is intended to predict and explain the behavior of individuals in specific situations. The theory of planned behavior covered six areas: (1) behaviors that are not completely controlled by individual will are influenced not only by behavioral intentions but also by actual control conditions such as personal abilities, opportunities, and resources; (2) accurate perceived behavioral control is reflective of the state of actual control conditions and therefore can be used as a proxy measure of actual control conditions to directly predict the likelihood of a behavior occurring, and the accuracy of the prediction depends on the true degree; (3) AT, SN, and PBC are the three main variables that determine behavioral intention; the more positive the AT, the greater the support of significant others, the stronger PBC, and the greater behavioral intention, and conversely; (4) an individual possesses a large number of beliefs about behavior, but only a fairly few behavioral beliefs are accessible at a certain time and context; these accessible beliefs, also known as contingent beliefs, are the cognitive and affective basis for AT, SN, and PBC; (5) personal as well as sociocultural and other factors (e.g., personality, intelligence, experience, age, gender, cultural background, etc.) indirectly influence AT, SN, and PBC by influencing behavioral beliefs and, ultimately, intentions and behaviors; (6) AT toward behavior, SN, and PBC can be completely different conceptually, but at times they may share a common basis of beliefs. Thus, they are both independent of each other and interrelated.

The structural model diagram TPB is represented in Figure 1 (for convenience, only the main part of the structural diagram is presented here).

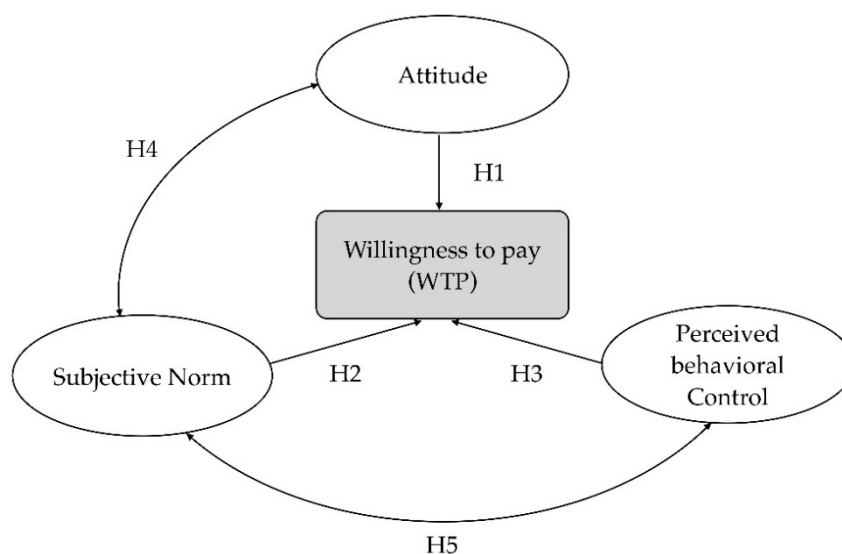


Figure 1. The raw TPB model.

The raw TPB model, a respondent is more likely to finance environmental goods if he/she has a positive AT toward behavioral options, if the respondent's family and friends support his/her behavior and if the respondent believes that he/she has the ability to participate in urban waste collection activities to mitigate urban waste management. Based on the discussion above, the following hypotheses are proposed.

Hypothesis 1 (H1). *If people have more positive AT toward using IGSS to manage MSW, people's WTP will increase.*

Hypothesis 2 (H2). *If people were more optimistic about the SN of using IGSS for MSW management, people's WTP would increase.*

Hypothesis 3 (H3). *If people were more optimistic about the PBC of using IGSS for MSW management, people's WTP would increase.*

Under the following relationships between PBC, SN, and AT, the following relationships are proposed:

Hypothesis 4 (H4). *If people have more positive SN about using IGSS for MSW management, then people have more positive AT toward this behavioral option.*

Hypothesis 5 (H5). *If people have more positive SN about using IGSS for MSW management, then people's PBC over this behavioral option will increase.*

In more than 20 years since the raw TPB was proposed, most research findings support the TPB. The results of Armitage and Conner's meta-analysis showed that behavioral AT, SN, and PBC explained 27% of the variance in behaviors and 39% of the variance in behavioral intentions, respectively, further demonstrating the good explanatory and predictive power of the TPB. While being affirmed and supported, the TPB has also been challenged by many research findings and questioned by many scholars, and these challenges and questions have contributed to the development and improvement of the TPB. Based on the raw TPB model, the extended TPB model are proposed. (Shown in Figure 2)

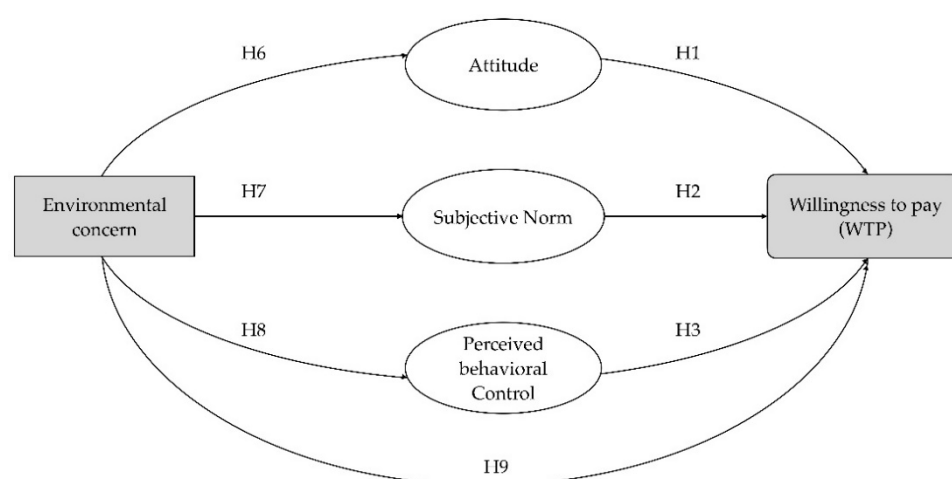


Figure 2. The Extended TPB model of WTP of MSW.

Firstly, the conceptual content of the main variables has become more prosperous, with personal subjective AT, SN, and PBC being some of the most critical components that have been influential and the possibility of mediating variables between behavioral intentions and behavior. Numerous studies have shown that the concern for the surrounding environment plays an essential role in predicting environmental issues, so we propose the

hypothesis that EC is positively correlated with people's WTP. The following assumptions were proposed:

Hypothesis 6 (H6). *EC were positively related to people's AT towards the use of IGGS for MSW management.*

Hypothesis 7 (H7). *EC were positively related to the SN of paying for IGGS for MSW management.*

Hypothesis 8 (H8). *EC were positively related to the PBC towards the use of IGGS for MSW management.*

Hypothesis 9 (H9). *If EC were more positive, people's WTP would increase.*

In addition to this, EC may influence WTP through behavioral AT, SN, and PBC. The following assumptions were proposed:

Hypothesis 10 (H10). *EC influence WTP through behavioral attitudes.*

Hypothesis 11 (H11). *EC influence WTP through SN.*

Hypothesis 12 (H12). *EC influence WTP through perceived behavior.*

3. Results

3.1. Demographic Characteristics of the Respondents in Questionnaire and WTP

The social background of the respondents included gender, age, education level, household size, and monthly income per person (Shown in Table 3). Most of the respondents were in the 18 to 55 age range (94.2%). 52.1% of the respondents were male, slightly higher than the percentage of females. As for the education level, more than 75% of respondents have a bachelor's degree or higher. More than 75% of the respondents had a monthly income of 3000–Yuan and 12% of them who earn more than 10,000 yuan a month. Regarding the family size, 73% of the families were composed of two to five family members.

Table 3. Individual demographic characteristics.

Item	Response	Frequency	Percentage
Gender	Male	162	52.1
	Female	149	47.9
Age	18–25	99	31.8
	26–35	99	31.8
	36–45	47	15.1
	46–55	48	15.4
	>55	18	5.8
Education Level	Elementary school & High school	74	23.8
	Bachelor	205	65.9
	Master's degree	32	10.3
Household Size	2 or 3	113	36.3
	4 or 5	114	36.7
	>5	84	27
Monthly income per people	1000–3000	79	25.4
	3001–5000	71	22.8
	5001–8000	60	19.3
	8001–10,000	64	20.6
	>10,001	37	11.9

The result of WTP is presented in Table 3. As the price increases, the percentage of responses agreeing to pay decreases gradually. Nearly 30% of respondents in the

pre-survey and final questionnaire refused to pay. Among those who refused to pay, the top three reasons were: payments can be diverted, unable to pay currently, and the MSW management is the responsibility of the government. Respondents who chose the option such as “I don’t have the ability to pay for the fund” and “I don’t think the MSW management worth that much” are “real zero responses” (Shown in Figure 3). The survey on social background found that respondents with higher incomes were more likely to pay. ($\beta = 0.49, p < 0.05$)

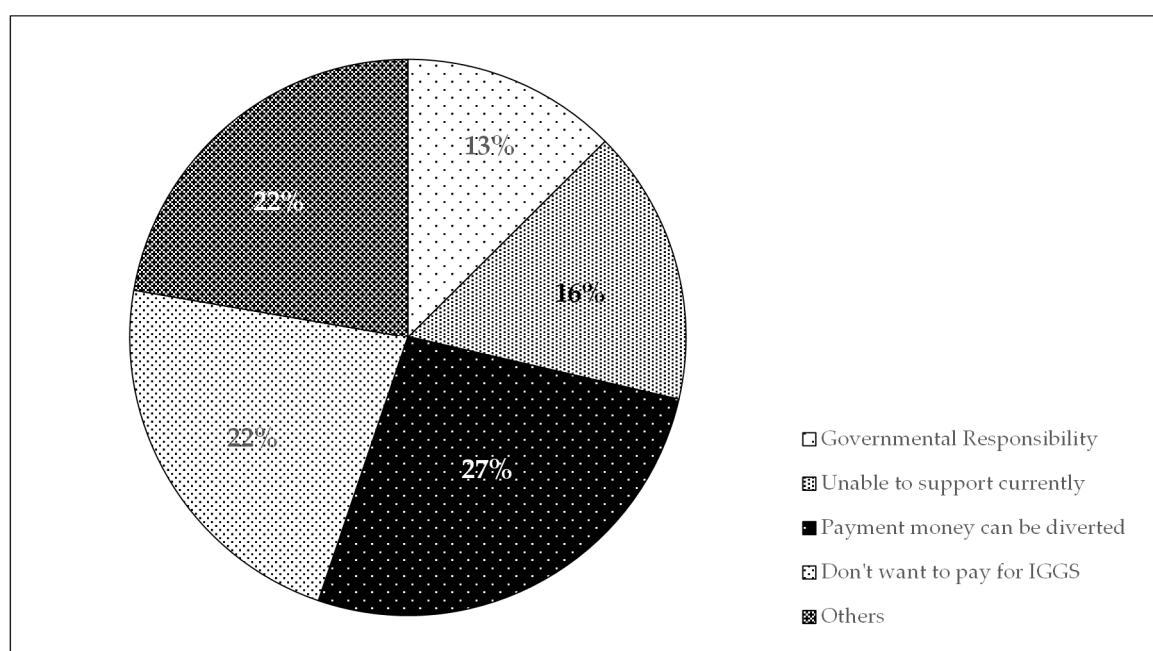


Figure 3. The motivation for the zero responses.

3.2. Measurement and Structural Model

The structural model of the raw TPB model was estimated using the maximum likelihood method. In the first step, we tested the plausibility and reliability of the measurement model by confirmatory factor analysis (CFA), then estimated the variable structure and correlations of the current model. To ensure convergence and discriminability, and measurement reliability, we conducted confirmatory factor analysis (CFA), including mainly the components of AT, SN, and PBC (Shown in Table 4). The results showed that the model data were within the plausibility interval (Chi-Square = 247.1, GFI = 0.808, CFI = 0.867, NFI = 0.804, RMSEA = 0.096). All four variable components were included and tested. The standard regression coefficients of AT, PBC, and EC in 0.01 level. The standard regression coefficient of the subject norm in the 0.05 level. All the scales achieved internal consistency.

Table 4. Distribution of responses.

WTP	10	20	30	Total
Positive	239	226	145	610
Negative	72	32	81	185
Protest zero	53	53	53	159
Total	311	311	311	933

The validity of the questionnaire data is corroborated by the fact that the AVE values in Table 5 are all higher than 0.5, according to reference [40], if the squared correlation coefficients of the different constructs are smaller than the AVE of each construct, then the discriminant validity can be confirmed.

Table 5. Reliability and CFA for the extended TPB model.

Scales	Mean (s. d.)	β	CR	AVE
Attitude			0.83	0.77
I think paying for MSW management is very positive	4.04 (1.11)	0.485		
I think paying for MSW management is a responsibility	3.96 (1.15)	0.563		
I think paying for MSW management is a pro-environmental behavior	3.96 (1.12)	0.584		
Subject Norm			0.79	0.59
I think people who are close to me will pay for MSW management	3.83 (1.20)	0.668		
I think people who are close to me will support the action of paying for MSW management	3.72 (1.24)	0.627		
I think people who are close to me will support me paying for MSW management	3.77 (1.20)	0.494		
Perceived Behavioral Control			0.87	0.74
I think my payment will improve the urban environment	3.97 (1.04)	0.466		
It is not difficult for me to pay for MSW management	3.81 (1.27)	0.485		
I think I have time, money, and resources to contribute to the MSW management.	3.67 (1.26)	0.593		
Environment-concern			0.82	0.71
I care about urban environmental issues very much	3.86(1.23)	0.475		
I think I will reduce other expenses for urban environment improvement	3.84(1.19)	0.693		

Mean (s. d): Standard deviation. β : factor loading CR (composite reliability); AVE (average variance extracted).

A discriminant validity test of the scale was performed. According to reference [40], if the squared correlation coefficients of the different constructs are smaller than the AVE of each construct, the discriminant validity can be confirmed, as is shown in Table 6, the correlations between the factors of the variables in the new extended TPB model. The high correlations between AT, SN, and PBC show profound evidence of validity. Our objective was to discover whether the TPB model, in the context of an integrated framework for understanding consumers' WTP and behavior [41] could also assess willingness towards pro-environmental behaviors that encompass "AT, SN, PBC". These are the determinants for the WTP for IGGS for MSW management in two successive questionnaires; although a 5-point scale was used in the Likert scale data statistics, it is still reliable for the applicability of the model (Chi-Square = 262.8, GFI = 0.808, CFI = 0.834, NFI = 0.787, RMSEA = 0.094), and all structural coefficients were statistically persuasive ($p < 0.01$). According to the result, AT ($\beta = 0.573$, $p < 0.01$) and PBC ($\beta = 0.692$, $p < 0.01$) affecting respondents' WTP. So, Hypothesis 1 and Hypothesis 2 can be accepted, and Hypothesis 3 was rejected.

Table 6. The scales' discriminant validity.

Title 1	1	2	3	4
1. Attitude	0.77			
2. Subjective norms	0.48 **	0.59		
3. Perceived behavioral control	0.45 **	0.50 ***	0.74	
4. Environment-concern	0.42 ***	0.42 **	0.42 ***	0.71

** $p < 0.05$, *** $p < 0.01$.

At the same time, the influence of SN on AT ($\beta = 0.762$, $p < 0.01$) and PBC ($\beta = 0.800$, $p < 0.01$) are confirmed, so Hypothesis 4 and Hypothesis 5 can be accepted. (Shown in Figure 4)

The fit measure of the extended model can be accepted (Chi-Square = 243.8, GFI = 0.838, CFI = 0.834, NFI = 0.787, RMSEA = 0.094), and most of the structural coefficients are significant ($p < 0.01$).

When the facts of PBC and EC were compared, PBC had the most significant effect on WTP ($\beta = 0.692$, $p < 0.01$) followed by the EC ($\beta = 0.594$, $p < 0.01$). Hypothesis 3

and Hypothesis 9 were validated. The positive effect relationship between EC and AT ($\beta = 0.382, p < 0.05$), SN ($\beta = 0.610, p < 0.01$), and PBC ($\beta = 0.341, p < 0.05$) can be verified, thus allowing Hypothesis 6, Hypothesis 7, and Hypothesis 8 to be accepted.

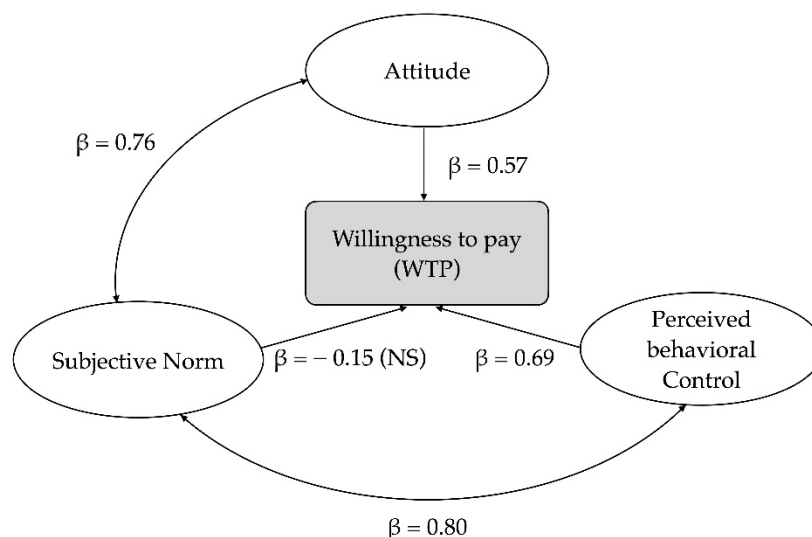


Figure 4. Raw TPB model for WTP. β represents standard regression weight.

Through previous speculations, we hypothesized the indirect effect of environment-concern on WTP for IGGS. Figure 3 shows that AT, SN, and PBC mediate between EC and WTP. However, the regression coefficients from the Sobel test for the Likert scale indicate that all indirect effects did not hold in this questionnaire. Thus, we can conclude that AT ($\beta = -0.31$), SN ($\beta = -0.36$), and PBC ($\beta = -0.12$) in this WTP for IGSS have no indirect effects. (Shown in Figure 5)

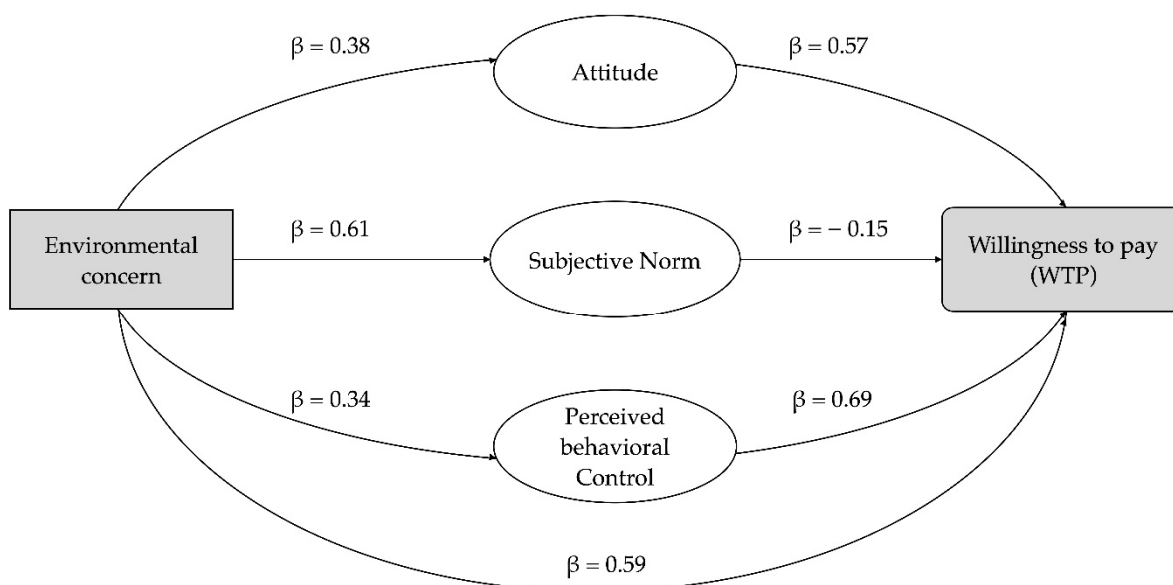


Figure 5. Extended TPB model for WTP. β represents standard regression weight.

4. Discussion

Based on Ajzen's proposed raw TPB model in 1991, we extended the raw TPB model in this study to investigate the Beijing residents' WTP for the IGSS for MSW management. In terms of MSW management charging policies around the world, on one hand, the taxes were imposed on local residents who use public facilities or enjoy public services for the dis-

posal of MSW management. In Germany, they added a refundable deposit on the recyclable bottles, which is partially refundable through the local residents' recycling behavior, as well as a system of packaging taxes and fees for the producers of the packaging [8]. On the other hand, compared with the method of garbage bag tax used in Japan [9], considering the situation in Beijing, the one of the largest cities with the largest population density, it is meaningful to study the Beijing residents' WTP for the IGSS for MSW management.

Previous studies showed increasing predictors to the raw TPB model, such as the case of EC, to improve the explanatory of raw TPB model [42,43]. In this study, we compared the raw TPB model and extended TPB model. The result has shown that the extended TPB model provides a more explanatory model for predicting WTP for IGSS and MSW management. The results of research showed that Beijing residents WTP for MSW management is significantly influenced by EC and PBC, and we found a positive relationship between EC and AT, SN, and PBC. The extended TPB model also improves the algorithm on local residents' willingness to pay for MSW management. Introducing EC variables into the raw TPB model, the new TPB model might be a psychological approach to future MSW management policies in China, such as proposing new waste recycling methods and a bag tax system. For the current Beijing government administrations, it is essential to understand what factors guide people's pro-environmental behavior, significantly to improve MSW management to mitigate environmental pollution. So, for example, PBC and EC, which is correlative information, will help improve citizens' pro-environmental behavior.

The mean WTP indicated that the residents of Beijing are willing to pay 319.2 yuan (49.43 USD) annually for IGSS to reduce the MSW of Beijing, the mean WTP, which was calculated through the CVM, if extended the mean WTP to the entire city. In the latest census, the resident population of Beijing has reached 21.893 million people, the total WTP is 6988.25 million Yuan (1082.17 million USD). The WTP for IGSS for MSW management is strong among Beijing citizens. In the two successive questionnaires (pre-survey and final survey), nearly 69.3 percent of the respondents expressed their WTP for IGSS. About 159 respondents refused to pay since they believed that "MSW management is a governmental responsibility," and, "the use of their payment money can be diverted." These refusals to pay and data were excluded when the processing data was performed. In addition, the socioeconomic characteristics of the residents also affect their WTP. Respondents with higher incomes were more likely to give WTP questions positive responses [35].

The PBC of residents was the most influencing factors in predicting local residents WTP for IGSS to MSW management. Secondly, residents' EC also influenced residents' WTP for IGSS to reduce MSW pollution. The impact of EC has been reported in numerous studies.

The conclusion is PBC, and EC determine the behavior of the respondents. EC, directly and indirectly, influences residents' WTP for MSW management using IGSS to reduce the MSW, directly and indirectly, which has also been confirmed in previous studies [44–47]. However, the impact rate of EC was not as large as PBC, which was different in previous studies by others for the extended TPB model [48,49]. However, a long time in China and the lack of unadvertised charging standard has resulted in the conflict of payment responsibility between residents and the local government. This illustrates that PBC has a significantly direct effect on the WTP for MSW management. Obviously, if Beijing residents thought they have the extra resources to contribute to the MSW management, they will respond more positively toward for environmental behavior. Therefore, it is necessary to strengthen the positive belief of those who already thought they are able to contribute to solving this issue and change the negative belief of those who thought they do not have the corresponding resource currently. It also indicates that the government administration plays a crucial role in motivating people or residents to pay. By compiling and analyzing the data, we have learned that environmental products such as IGSS if they believe they have additional resources to reduce MSW pollution. Therefore, it is necessary to enhance the positive beliefs of those who already believe they can contribute to MSW management and

alter the negative beliefs of those who believe they do not have the appropriate resources and capability to pay. Compared with the raw TPB model [50], the extended TPB model, including EC, improves the explanatory ability of the raw TPB model, which has been consistently confirmed.

Therefore, the introduction of EC helps better explain the WTP of Beijing residents for using IGSS to improve MSW management. Finally, the object of this study is the value of IGSS in terms of MSW management effects. The results of the study do not generalize to all approaches to MSW management (landfilling, composting, incineration) [51].

5. Conclusions

The raw TPB model proposed by [52,53] was adopted to anticipate Beijing residents' WTP to use IGSS to reduce MSW pollution. Based on the raw TPB model, the extended TPB model is completed by introducing the variable condition of EC [54]. This paper has presented an extended TPB model incorporating the four variables such as EC, AT, SN, and PBC to predict and explain the effect of the variables on willingness to pay. According to the test results, PBC and EC that had a significant positive effect on Beijing residents' WTP. In addition, EC about environmental issues can directly or indirectly influence people's pro-environmental behavior. As is addressed by [54,55], the improvement of WTP depends on the combined effect of PBC, EC, and AT in the extended TPB model. Determinants such as social background, residents' income and education are positively related to the WTP.

The positive effect between AT, PBC, and EC of Beijing residents on the MSW management showed the result of the relationship between the predictors assumed in our extended TPB model, which indicates that residents have a positive attitude towards the improvement of the urban environment, environmental behaviors, and concerns for the urban environment (which were certified by Hypothesis 1, Hypothesis 3, Hypothesis 9). In addition, SN is not a major condition that influences citizens' behavior in Beijing at present. Compared with Europe and Japan, the current legal regulations for MSW management in China are well established, but there is still a time lag between Beijing residents and government for understanding of MSW management regulations. It means the current publicity for MSW management in China is not effective enough (Overturned by Hypothesis 2).

Urban environmental management administration should inform residents about the harmful effects of MSW and the mitigation measures. Environmental protection administration helps promote knowledge and support for environmental protection through various means of communication, such as television, radio, and online media [55]. The increasing EC that accompanies increases people's performance of their pro-environmental behavior. EC can promote the behavior of MSW management. Meanwhile, residents' WTP varies according to their income and education background; policymakers can consider developing potential funding sources and central payment populations for MSW mitigation [56].

In the pre-survey and final questionnaire, close to 40% of the respondents refused to pay for IGSS. The main reason for the refusal to pay is that they think the environmental fund can be diverted by the environmental needs [57]. Therefore, disclosing the use of utility charges and information related to the management of the urban environment has become necessary to increasing public participation [58,59].

In the pre-survey prediction, EC were ranked the first in terms of local residents WTP. However, in the questionnaire compilation and analysis, we found that the impact of PBC on local residents' WTP is higher than residents' EC and higher than residents' AT, and we need more accurate data to verify the relationship between these predictors and local residents' WTP.

This study was conducted in Beijing, the capital of China, one of the largest cities with the largest population density. With the rapid urbanization in China, the MSW pollution issue will have the same impact on other cities. However, the WTP and acceptance of IGSS in other regions or rural areas will require further research due to the income disparity between regions. The main novelty of this study compared to similar studies on MSW management is that it predicts the WTP for IGSS (a pro-environmental product) through

an extended TPB model, providing a medium of communication between citizens and the government for a future approach to sustainable development in China.

Author Contributions: Each author contributed to the work of this article. J.H. designed the survey of this article, collected and analyzed the results and wrote all sections. Z.Y. gave advices to the design of the survey and the statistical analysis of the results. H.F. supervised the whole process of this study and the writing of this article. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: The data are available on request from the corresponding author upon reasonable request.

Acknowledgments: The authors would like to thank Kai, Xin for the mathematical support. The authors would like to thank all participants for helping to complete this study.

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

References

1. Hoornweg, D.; Bhada-Tata, P. *What a Waste: A Global Review of Solid Waste Management*; Urban Development Series; World Bank: Washington, DC, USA, 2012; p. 15.
2. Ding, Y.; Zhao, J.; Liu, J.-W.; Zhou, J.; Cheng, L.; Zhao, J.; Shao, Z.; Iris, Ç.; Pan, B.; Li, X.; et al. A review of China's municipal solid waste (MSW) and comparison with international regions: Management and technologies in treatment and resource utilization. *J. Clean. Prod.* **2021**, *293*, 126144. [\[CrossRef\]](#)
3. Mian, M.M.; Zeng, X.; Nasry, A.A.N.B.; Al-Hamadani, S.M. Municipal solid waste management in China: A comparative analysis. *J. Mater. Cycles Waste Manag.* **2017**, *19*, 1127–1135. [\[CrossRef\]](#)
4. Wang, H.T.; Nie, Y.F. Municipal solid waste characteristics and management in China. *J. Air Waste Manag. Assoc.* **2001**, *51*, 250–263. [\[CrossRef\]](#)
5. Pardini, K.; Rodrigues, J.J.; Hassan, S.A.; Kumar, N.; Furtado, V. Smart Waste Bin: A New Approach for Waste Management in Large Urban Centers. In Proceedings of the 2018 IEEE 88th Vehicular Technology Conference (VTC-Fall), Chicago, IL, USA, 27–30 August 2018; IEEE: Piscataway, NJ, USA, 2018; pp. 1–8.
6. Watson, M.; Bulkeley, H. Just waste? Municipal waste management and the politics of environmental justice. *Local Environ.* **2005**, *10*, 411–426. [\[CrossRef\]](#)
7. Kofoworola, O.F. Recovery and recycling practices in municipal solid waste management in Lagos, Nigeria. *Waste Manag.* **2007**, *27*, 1139–1143. [\[CrossRef\]](#) [\[PubMed\]](#)
8. Malinauskaitė, J.; Jouhara, H.; Czajczyńska, D.; Stanchev, P.; Katsou, E.; Rostkowski, P.; Thorne, R.; Colón, J.; Ponsá, S.; Al-Mansour, F.; et al. Municipal solid waste management and waste-to-energy in the context of a circular economy and energy recycling in Europe. *Energy* **2017**, *141*, 2013–2044. [\[CrossRef\]](#)
9. Bassi, S.A.; Christensen, T.H.; Damgaard, A. Environmental performance of household waste management in Europe—An example of 7 countries. *Waste Manag.* **2017**, *69*, 545–557. [\[CrossRef\]](#)
10. Folianto, F.; Low, Y.S.; Yeow, W.L. Smartbin: Smart waste management system. In Proceedings of the 2015 IEEE Tenth International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), Singapore, 7–9 April 2015; IEEE: Piscataway, NJ, USA, 2015; pp. 1–2.
11. Okuda, I.; Thomson, V.E. Regionalization of municipal solid waste management in Japan: Balancing the proximity principle with economic efficiency. *Environ. Manag.* **2007**, *40*, 12–19. [\[CrossRef\]](#) [\[PubMed\]](#)
12. Chifari, R.; Piano, S.L.; Matsumoto, S.; Tasaki, T. Does recyclable separation reduce the cost of municipal waste management in Japan? *Waste Manag.* **2017**, *60*, 32–41. [\[CrossRef\]](#) [\[PubMed\]](#)
13. Baker, R.; Ruting, B. Environmental policy analysis: A guide to non market valuation. *Aust. Agric. Resour. Econ. Soc.* **2014**, No. 425–2016–27204. [\[CrossRef\]](#)
14. Rogers, A.; Kragt, M.E. Non-market valuation: Usage and impacts in environmental policy and management in Australia. *Aust. J. Agric. Resour. Econ.* **2015**, *5*, 1–15. [\[CrossRef\]](#)
15. Milne, M. Accounting, Environmental Resource Values, and Non-market Valuation Techniques for Environmental Resources: A Review. *Accounting, Audit. Account. J.* **1991**, *4*, 3. [\[CrossRef\]](#)
16. Mitchell, R.C. *Using Surveys to Value Public Goods: The Contingent Valuation Method*; RFF Press: Washington, DC, USA, 2013. [\[CrossRef\]](#)
17. Carson, R.T.; Hanemann, W.M. Contingent valuation. *Handb. Environ. Econ.* **2005**, *2*, 821–936. [\[CrossRef\]](#)
18. Baranzini, A.; Faust, A.-K.; Huberman, D. Tropical forest conservation: Attitudes and preferences. *For. Policy Econ.* **2010**, *12*, 370–376. [\[CrossRef\]](#)
19. Ajzen, I.; Madden, T.J. Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control. *J. Exp. Soc. Psychol.* **1986**, *22*, 453–474. [\[CrossRef\]](#)

20. Ajzen, I. Perceived Behavioral Control, Self-Efficacy, Locus of Control, and the Theory of Planned Behavior1. *J. Appl. Soc. Psychol.* **2002**, *32*, 665–683. [CrossRef]
21. Ajzen, I. The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* **1991**, *50*, 179–211. [CrossRef]
22. Wang, H.; Mullahy, J. Willingness to pay for reducing fatal risk by improving air quality: A contingent valuation study in Chongqing, China. *Sci. Total. Environ.* **2006**, *367*, 50–57. [CrossRef] [PubMed]
23. Kim, Y.; Han, H. Intention to pay conventional-hotel prices at a green hotel—A modification of the theory of planned behavior. *J. Sustain. Tour.* **2010**, *18*, 997–1014. [CrossRef]
24. Wang, Z.; Gong, Y.; Mao, X. Exploring the value of overseas biodiversity to Chinese netizens based on willingness to pay for the African elephants' protection. *Sci. Total. Environ.* **2018**, *637–638*, 600–608. [CrossRef]
25. Na1a, S.U.; ZHANG, D.S.; Yong-jun, H.A.N. On the Ecological Restoration of City Impaired Water Bodies and the Urban Water Landscape Construction. *J. Shenyang Agric. Univ. (Soc. Sci. Ed.)* **2012**, *5*, 612–617. [CrossRef]
26. Chalak, A.; Hecht, J.; Reid, S.; Abiad, M.G. Willingness-to-pay for greenhouse gas reductions: A Bayesian investigation of distributional patterns. *Environ. Sci. Policy* **2012**, *19*, 147–157. [CrossRef]
27. Zahedi, S.; Batista-Foguet, J.M.; van Wunnik, L. Exploring the public's willingness to reduce air pollution and greenhouse gas emissions from private road transport in Catalonia. *Sci. Total. Environ.* **2019**, *646*, 850–861. [CrossRef] [PubMed]
28. Zhang, L.; Yang, X.; Fan, Y.; Zhang, J. Utilizing the theory of planned behavior to predict willingness to pay for urban heat island effect mitigation. *Build. Environ.* **2021**, *204*, 108136. [CrossRef]
29. Wang, B.; Wang, X.; Guo, D.; Zhang, B.; Wang, Z. Analysis of factors influencing residents' habitual energy-saving behaviour based on NAM and TPB models: Egoism or altruism? *Energy Policy* **2018**, *116*, 68–77. [CrossRef]
30. Ma, J.; Hipel, K.W.; Hanson, M.L.; Cai, X.; Liu, Y. An analysis of influencing factors on municipal solid waste source-separated collection behavior in Guilin, China by Using the Theory of Planned Behavior. *Sustain. Cities Soc.* **2018**, *37*, 336–343. [CrossRef]
31. Shen, L.; Si, H.; Yu, L.; Si, H. Factors Influencing Young People's Intention toward Municipal Solid Waste Sorting. *Int. J. Environ. Res. Public Health* **2019**, *16*, 1708. [CrossRef] [PubMed]
32. The People's Government of Beijing Municipal Bureau Statistics. Available online: http://tjj.beijing.gov.cn/tjsj_31433/yjdsj_31440/rk_32024/2019/index.html (accessed on 12 October 2021).
33. Wang, S.; Fan, J.; Zhao, D.; Yang, S.; Fu, Y. Predicting consumers' intention to adopt hybrid electric vehicles: Using an extended version of the theory of planned behavior model. *Transport* **2016**, *43*, 123–143. [CrossRef]
34. Fujii, S. Environmental concern, attitude toward frugality, and ease of behavior as determinants of pro-environmental behavior intentions. *J. Environ. Psychol.* **2006**, *26*, 262–268. [CrossRef]
35. Chen, M.-F.; Tung, P.-J. Developing an extended Theory of Planned Behavior model to predict consumers' intention to visit green hotels. *Int. J. Hosp. Manag.* **2014**, *36*, 221–230. [CrossRef]
36. Han, H.; Kim, Y. An investigation of green hotel customers' decision formation: Developing an extended model of the theory of planned behavior. *Int. J. Hospital. Manage* **2010**, *29*, 659–668. [CrossRef]
37. López-Mosquera, N.; Sánchez, M. Theory of Planned Behavior and the Value-Belief-Norm Theory explaining willingness to pay for a suburban park. *J. Environ. Manage* **2012**, *113*, 251–262. [CrossRef] [PubMed]
38. Hanley, N.; Shogren, J.F.; White, B. *Environmental Economics in Theory and Practice*; Macmillan International Higher Education: London, UK, 2016. [CrossRef]
39. Anderson, J.C.; Gerbing, D.W. Assumptions and Comparative Strengths of the Two-Step Approach. *Sociol. Methods Res.* **1992**, *20*, 321–333. [CrossRef]
40. Vicente-Molina, M.A.; Fernandez-Sainz, A.; Izagirre-Olaizola, J. Environmental knowledge and other variables affecting pro-environmental behaviour: Comparison of university students from emerging and advanced countries. *J. Clean. Prod.* **2013**, *61*, 130–138. [CrossRef]
41. Judith, D.G.; Linda, S. General beliefs and the theory of planned behavior: The role of environment-concerns in the TPB. *Jour-Nal Appl. Soc. Psychol.* **2007**, *37*, 1817–1836. [CrossRef]
42. Fornell, C.; Larcker, D.F. Structural Equation Models with Unobservable Variables and Measurement Error: Algebra and Statistics. *J. Mark. Res.* **1981**, *18*, 382–388. [CrossRef]
43. Shalender, K.; Sharma, N. Using extended theory of planned behavior (TPB) to predict adoption intention of electric vehicles in India. *Environment. Dev. Sustain.* **2021**, *23*, 665–681. [CrossRef]
44. Zhang, L.; Wu, Y. Market segmentation and willingness to pay for green electricity among urban residents in China: The case of Jiangsu Province. *Energy Policy* **2012**, *51*, 514–523. [CrossRef]
45. Huchting, K.; Lac, A.; LaBrie, J.W. An application of the Theory of Planned Behavior to sorority alcohol consumption. *Addict. Behav.* **2008**, *33*, 538–551. [CrossRef]
46. Zeng, C.; Niu, D.; Li, H.; Zhou, T.; Zhao, Y. Public perceptions and economic values of source-separated collection of rural solid waste: A pilot study in China. *Resour. Conserv. Recycl.* **2016**, *107*, 166–173. [CrossRef]
47. Rehfeld, K.-M.; Rennings, K.; Ziegler, A. Integrated product policy and environmental product innovations: An empirical analysis. *Ecol. Econ.* **2007**, *61*, 91–100. [CrossRef]
48. Cheng, H.; Hu, Y. Municipal solid waste (MSW) as a renewable source of energy: Current and future practices in China. *Bioresour. Technol.* **2010**, *101*, 3816–3824. [CrossRef]

-
49. Egan, K.J.; Corrigan, J.R.; Dwyer, D.F. Three reasons to use annual payments in contingent valuation surveys: Convergent validity, discount rates, and mental accounting. *J. Environ. Econ. Manag.* **2015**, *72*, 123–136. [[CrossRef](#)]
 50. Gardner, B.; Abraham, C. Going Green? Modeling the Impact of Environment-concerns and Perceptions of Transportation Alternatives on Decisions to Drive. *J. Appl. Soc. Psychol.* **2010**, *40*, 831–849. [[CrossRef](#)]
 51. Hoyos, D.; Mariel, P.; Fernández-Macho, J. The influence of cultural identity on the WTP to protect natural resources: Some empirical evidence. *Ecol. Econ.* **2009**, *68*, 2372–2381. [[CrossRef](#)]
 52. Istamto, T.; Houthuijs, D.; Lebrete, E. Willingness to pay to avoid health risks from road-traffic-related air pollution and noise across five countries. *Sci. Total. Environ.* **2014**, *497*, 420–429. [[CrossRef](#)] [[PubMed](#)]
 53. Kotchen, M.J.; Turk, Z.M.; Leiserowitz, A. Public willingness to pay for a US carbon tax and preferences for spending the revenue. *Environ. Res. Lett.* **2017**, *12*, 094012. [[CrossRef](#)]
 54. Liebe, U.; Preisendörfer, P.; Meyerhoff, J. To Pay or Not to Pay: Competing Theories to Explain Individuals' Willingness to Pay for Public Environmental Goods. *Environ. Behav.* **2011**, *43*, 106–130. [[CrossRef](#)]
 55. MacKerron, G.J.; Egerton, C.; Gaskell, C.; Parpia, A.; Mourato, S. Willingness to pay for carbon offset certification and co-benefits among (high-)flying young adults in the UK. *Energy Policy* **2009**, *37*, 1372–1381. [[CrossRef](#)]
 56. Oreg, S.; Katz-Gerro, T. Predicting proenvironmental behavior cross-nationally: Values, the theory of planned behavior, and value-belief-norm theory. *Environ. Behav.* **2006**, *20*, 462–483. [[CrossRef](#)]
 57. Spash, C.L.; Urama, K.; Burton, R.; Kenyon, W.; Shannon, P.; Hill, G. Motives behind willingness to pay for improving biodiversity in a water ecosystem: Economics, ethics and social psychology. *Ecol. Econ.* **2009**, *68*, 955–964. [[CrossRef](#)]
 58. Pouta, M.R.E. The Theory of Planned Behavior in Predicting Willingness to Pay for Abatement of Forest Regeneration. *Soc. Nat. Resour.* **2001**, *14*, 93–106. [[CrossRef](#)]
 59. Wang, B.; Ren, C.; Dong, X.; Zhang, B.; Wang, Z. Determinants shaping willingness towards on-line recycling behaviour: An empirical study of household e-waste recycling in China. *Resour. Conserv. Recycl.* **2019**, *143*, 218–225. [[CrossRef](#)]