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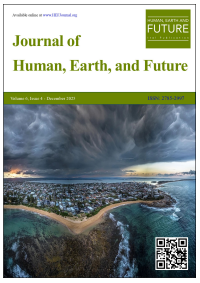

Determinants of Household Willingness to Engage in E-Waste Recycling

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Abstract

Electronic waste (e-waste) constitutes a significant environmental threat in rapidly urbanizing regions, such as Vietnam's Mekong Delta, where formal management infrastructure remains profoundly underdeveloped. This study provides crucial baseline data by assessing the Knowledge, Attitude, and Behavior (KAB) of 900 households in Can Tho City. We specifically investigated the key determinants influencing residents' willingness to hand over (WTH) used electronics and their willingness to pay (WTP) for formal recycling services. Utilizing a cross-sectional survey design, the research employed descriptive and regression analyses to model public participatory behavior. The findings reveal a critical behavioral paradox: despite critically low public knowledge of e-waste hazards, resident attitudes are highly positive, culminating in an exceptionally high WTH (93.11%). However, this strong participatory intent does not translate into financial commitment, evidenced by a low WTP (45.44%). Regression modeling confirmed that attitude is the primary, robust driver of WTH, whereas WTP is significantly influenced by both knowledge and attitude. This research highlights a pivotal gap between public behavioral readiness and the financial viability of formal e-waste schemes. The results strongly suggest that initial policy interventions must prioritize establishing convenient collection infrastructure to immediately capitalize on the existing high WTH. Subsequently, targeted educational campaigns are essential to elevate knowledge, which is a necessary prerequisite for improving WTP and ensuring the long-term sustainability of e-waste management in the region.

Keywords: E-Waste; Knowledge; Attitude, Behavior (KAB); Willingness to Pay; Household Behavior; Mekong Delta.

1. Introduction

Electronic waste (e-waste) is the world's fastest-growing waste stream, with an annual growth rate of approximately 4 to 5%, driven by the increasing consumer demand for the latest electrical and electronic equipment (EEE) [1, 2]. Despite its inherent material value, a large proportion of e-waste is disposed of through informal or unsafe practices, such as open burning, backyard dismantling, and unregulated landfilling, particularly in developing countries [3, 4]. These methods have led to severe environmental pollution and significant human health risks associated with exposure to heavy metals and persistent organic pollutants (POPs) [5, 6]. Similar to other developing nations, e-waste has emerged as a considerable environmental challenge in Vietnam in recent years. The current e-waste management system in Vietnam is not yet well-established; collection is primarily handled by the informal sector, and recycling efforts are largely limited to manual dismantling and separation for low-efficiency metal recovery [7]. Furthermore,

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the absence of specific legal frameworks governing e-waste management has contributed to the prevalence of unregulated collection and environmentally unsound recycling activities [7]. This situation poses significant risks of environmental contamination in the surrounding recycling areas [8-10].

While several studies have focused on assessing heavy metal contamination and environmental pollution resulting from e-waste recycling activities in Vietnam [11-13], limited attention has been given to understanding the human dimension of e-waste management. Specifically, the public's knowledge, attitudes, and behavior (KAB) toward e-waste remain poorly understood, despite their crucial role in shaping effective collection and recycling systems. This gap highlights the urgent need for research to assess the public's KAB, as well as the risk perceptions related to e-waste in Vietnam, to ensure its environmentally sound and effective management. Public awareness of e-waste is one of the crucial pathways to achieving the long-term goal of sustainable e-waste management [14]. A lack of awareness and information regarding effective and appropriate e-waste management practices can pose significant health hazards, particularly when handling or reusing end-of-life products. Licy et al. [15] indicated that the problem of waste generation cannot be entirely eliminated but can only be mitigated and controlled through community awareness and proper practices. Additionally, the study by Nuwematsiko et al. [16] demonstrated that research on e-waste knowledge and awareness is vital for enhancing public consciousness, which significantly influences decision-making for effective e-waste management strategies. Conversely, without favorable behavioral intentions and the public's willingness to participate in sorting and recycling activities, proposed management policies and strategies cannot be implemented smoothly and effectively [17].

Studies assessing KAB in e-waste management within Vietnam are relatively scarce. Existing research conducted in Vietnam includes the study by Nguyen et al. [18], which identified factors influencing recycling intentions in Da Nang; Pham et al. [19] analyzed the willingness to pay of residents in Ho Chi Minh City based on the Theory of Planned Behavior; and Kim et al. [20] analyzed the e-waste recycling behavior of consumers in Ho Chi Minh City and Dong Nai province. However, there has not been extensive research on e-waste in the Mekong Delta region. Can Tho City serves as an economic, cultural, and scientific hub of the Mekong Delta region and is considered one of the urban centers with the highest potential for generating electronic waste in the area [21]. The city's rapid urbanization and strong industrial development particularly in processing and manufacturing sectors [22] have placed increasing pressure on the local environment, especially concerning solid waste management. At present, household e-waste generation in Can Tho lacks an organized collection system and dedicated financial resources for proper treatment. Peddlers remain the primary agents involved in e-waste recovery and aggregation, typically operating outside formal waste management structures. The prevailing treatment practices are limited to manual dismantling and material recovery from components and circuit boards, without the application of environmentally sound recycling technologies [21, 23]. It is evident that public participation in proper e-waste collection and recycling remains limited. Although Trinh et al. [24] conducted a study in Can Tho City, it was restricted to university students and lacked a focus on households in general. Understanding how residents perceive and respond to e-waste issues is essential for designing effective management strategies.

The Knowledge, Attitude, and Behavior (KAB) framework has been widely acknowledged as a robust theoretical approach for examining behavioral dynamics and the diffusion of innovations within communities [25]. It provides a systematic means to evaluate existing conditions, test behavioral assumptions, and generate insights that contribute to evidence-based policy formulation [26]. The framework has been extensively applied in environmental psychology and sustainable consumption studies to elucidate how individuals progress from awareness to concrete action, particularly in domains such as waste management, recycling participation, and other pro-environmental behaviors [25-28]. Given its emphasis on the interconnections between knowledge, attitudes, and behavioral responses, the KAB framework is particularly well-suited for investigating public engagement and behavioral change in the context of e-waste management.

Motivated by the research gaps stated above, this study investigates the factors affecting household e-waste-related activities in Can Tho City, utilizing the KAB framework. The findings of this research will provide valuable scientific information to enhance public awareness and support the development of effective e-waste management strategies for Can Tho City in particular and Vietnam as a whole in the future. This study is structured in three main sections: the following section describes the methodology and data collection procedures; this is followed by an analysis and discussion of the key findings. The paper concludes with a summary of the main insights and practical recommendations for policymakers and practitioners.

2. Research Methodology

2.1. Questionnaire Design

The research employed a mixed-method approach combining literature review and field survey. The steps of data collection and analysis were conducted according to the procedure shown in Figure 1.

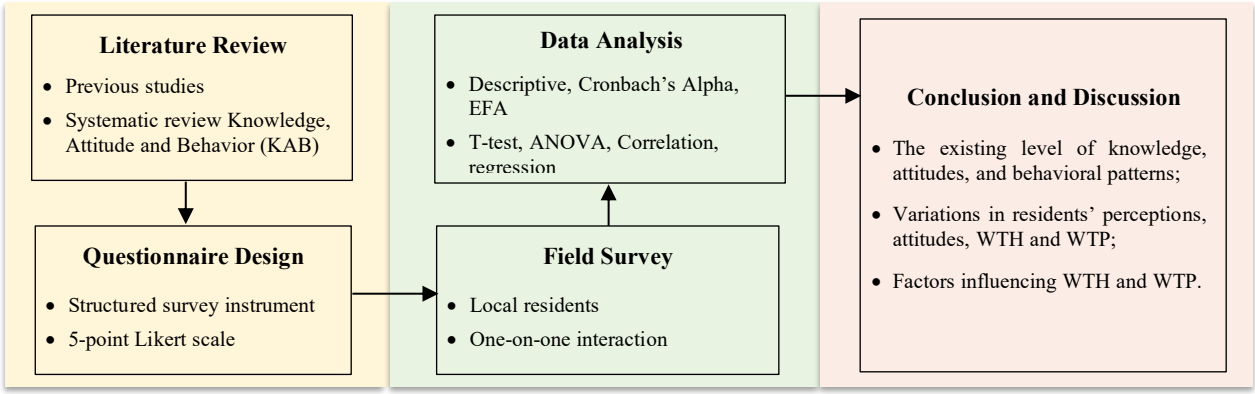

Figure 1. Research Methodology Framework

This study examines the knowledge, attitude, and behavior of households in Can Tho City toward two main objectives: (1) Willingness to hand over obsolete electronic devices to formal recycling programs (WTH) and (2) Willingness to pay for e-waste segregation and recycling (WTP). The measurement items for knowledge, attitude, and behavior were adapted from validated scales in previous studies [14, 29-32] and refined through expert consultations. All research items were measured using a five-point Likert scale, a widely adopted tool in global waste management research [18, 29, 32]. The Likert scale in this study ranged from 1 – ' Not knowledgeable at all ' / 'Strongly disagree' / 'Never' to 5 – 'Very high' / 'Strongly agree' / 'Always' (Table 1). The full questionnaire is provided in Appendix I.

Table 1. Survey variables of the study

Variables	Name	Sign	Scale
Dependent variables	Willingness to hand over obsolete electronic devices to formal recycling programs	WTH	1 = Very unwillingness 2 = Unwillingness 3 = Neutral 4 = Willingness 5 = Very willingness
	Willingness to pay for e-waste segregation and recycling	WTP	0 = Unwillingness 1 = Willingness
Knowledge and awareness	Definition of e-waste	K1	1 = Not knowledgeable at all 2 = Low level 3 = Moderate 4 = High 5 = Very high
	Awareness of substances and components in e-waste	K2	
	Perception of e-waste as a potential resource when properly managed	K3	
	Knowledge of e-waste collection and treatment sites	K4	
	Perception of appropriate e-waste treatment methods	K5	
	Perception of e-waste management for environmental sustainability	K6	
	Perception of stakeholder responsibility in e-waste collection and treatment	K7	
	Perception of environmental and social impacts of e-waste	K8	
Attitude	Attitude toward producer responsibility for e-waste collection and treatment	A1	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly agree
	Attitude toward governmental regulations and enforcement in e-waste management	A2	
	Attitude toward citizen responsibility in e-waste management	A3	
	Attitude toward formal programs and facilities for e-waste collection and recycling	A4	
	Attitude toward community awareness of e-waste	A5	
	Attitude toward environmental protection for future generations	A6	
	Attitude toward receiving detailed guidance on e-waste segregation	A7	
Behavior	Segregating e-waste from municipal solid waste	B1	1 = Never 2 = Rarely 3 = Occasionally 4 = Frequently 5 = Always
	Selling e-waste to collection facilities	B2	
	Recycling and reusing damaged electronic devices	B3	
	Giving obsolete electronic devices	B4	
	Encouraging relatives to manage e-waste properly	B5	
	Limiting unnecessary purchases of electrical and electronic devices	B6	

2.2. Sample Size and Data Collection

The survey employed a convenience-based random sampling approach to collect data from residents across all nine districts of Can Tho City between 2023 and 2024. The sampling covered both urban districts (Ninh Kieu, Cai Rang, Binh Thuy, O Mon, and Thot Not) and rural districts (Phong Dien, Vinh Thanh, Thoi Lai, and Co Do). In total, 83 wards and communes were included in the sampling frame. Within each administrative unit, 15 households were randomly selected and interviewed using a structured questionnaire. This approach ensured broad spatial coverage and representativeness across the city while capturing diverse demographic and behavioral characteristics related to household awareness and behavior concerning e-waste management.

Data was collected through face-to-face interviews using a pre-designed and pilot-tested questionnaire. The pilot survey, conducted with 30 respondents in Can Tho City, ensured that all items were clear, comprehensible, and reliable before the full-scale implementation. In conclusion, 1,245 responses were collected, of which 900 valid questionnaires were retained for statistical analysis.

Participants were required to be at least 18 years old and current residents of the selected districts. The survey process received approval from the local People's Committees of the respective communes and wards. Household participation was voluntary and based on respondents' willingness and accessibility. The demographic characteristics of the sample are summarized in Table 2.

Table 2. Characteristics of the interviewed households

Demographic background		Frequency	Percentage (%)
Gender	Male	447	49.70
	Female	453	50.30
Age	18 – 30 years old	88	9.80
	31 – 45 years old	246	27.30
	46 – 60 years old	336	37.30
	> 60 years old	230	25.60
Ethnic groups	Kinh	831	92.30
	Hoa	34	3.80
	Khmer	35	3.90
Education background	No formal education – Secondary school	527	58.60
	High school	154	17.10
	College	76	8.40
	University of above	143	15.90
Occupation	Student	18	2.00
	Merchant	299	33.20
	Government/Company employees	148	16.40
	Pensioner/Housewife	230	25.60
	Worker	15	1.70
	Farmer	122	13.60
	Self employed	68	7.60
Residence period	< 5 years	36	4.00
	5 – 10 years	78	8.70
	10 – 15 years	66	7.30
	> 15 years	720	80.00
Income	< 5,000,000 VND	98	10.90
	5,000,000 – 10,000,000 VND	381	42.30
	10,000,000 – 15,000,000 VND	177	19.70
	> 15,000,000 VND	244	27.10

2.3. Data Analysis

All statistical analyses were performed using IBM SPSS Statistics, version 27.0. Descriptive statistics were used to provide an overall overview of the households' knowledge, attitude, and behavior toward e-waste. Demographic characteristics, including gender and ethnicity, were also incorporated into the descriptive analysis. To identify the factors influencing households' willingness to hand over obsolete electronic devices (WTH) and willingness to pay for e-waste segregation and recycling (WTP), the study conducted reliability and validity tests for the factors included in the regression model. The Cronbach's Alpha coefficients for the knowledge, attitude, and behavior ranged from 0.603 to 0.932, indicating acceptable to excellent internal consistency. After removing items K4, K7, A5, B2, B3, and B6, the corrected item-total correlation coefficients of the remaining items were all above 0.3.

Exploratory Factor Analysis (EFA) was performed using Principal Component Analysis (PCA) with a Varimax rotation. The analysis was conducted twice because the factor loading of item A2 was below the 0.5 threshold in the initial run. Consequently, A2 was excluded from the final model. The final EFA retained 14 observed variables, comprising six items for knowledge, five for attitude, and three for behavior. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.894, and the total variance explained reached 59.27%, confirming the suitability of the data for factor analysis (Appendix II). The finalized research model is illustrated in Figure 2.

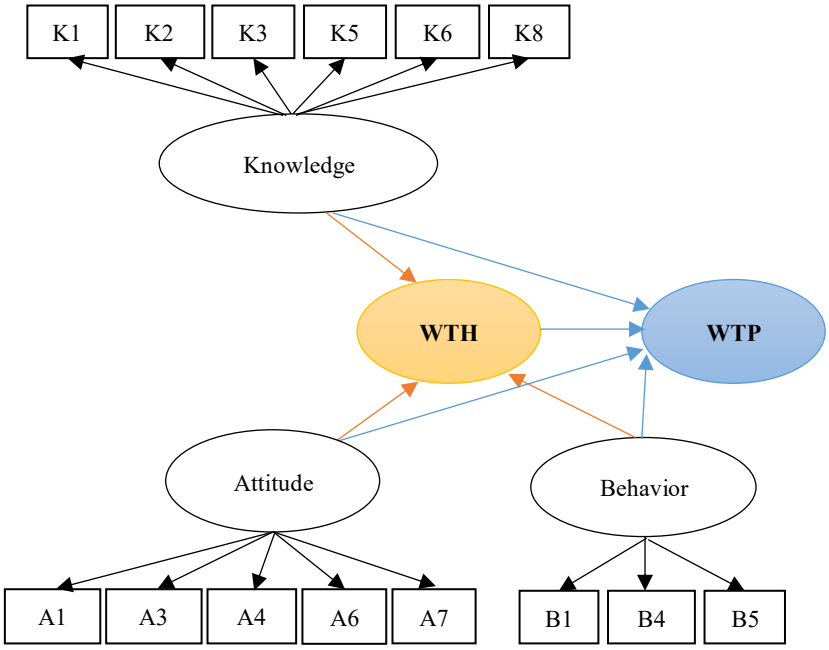

Figure 2. Research Model

3. Results

3.1. Knowledge, Attitude, and Behavior of Can Tho City Residents Regarding E-Waste

The findings indicate that residents' knowledge of e-waste in Can Tho City is very limited (Figure 3). More than half of the respondents reported low to not knowledgeable at all about this waste stream, including information about collection and treatment sites, disposal responsibilities, and the potential resource recovery from e-waste (mean scores ranging from 1.34 to 1.91). Although general awareness of e-waste issues was low, respondents demonstrated relatively higher concern regarding the environmental and health impacts of e-waste, as well as appropriate management practices, with mean scores of 2.07 and 2.18, respectively.

Significant variations in knowledge were observed among districts, with residents in Ninh Kieu and Cai Rang exhibiting greater understanding than those in other districts ($p < 0.05$) (Appendix III). Knowledge levels also differed significantly across gender, ethnicity, age group, occupation, educational level, length of residency, and total household income ($p < 0.05$) (Appendix III). These findings align with [29], which suggested that knowledge directly shapes attitudes and indirectly influences behavior through attitudinal pathways.

Previous studies have also shown that education and awareness programs can effectively enhance public understanding of e-waste and its environmental implications [33]. Therefore, targeted awareness campaigns are essential to strengthen public knowledge and mitigate the adverse environmental impacts associated with e-waste.

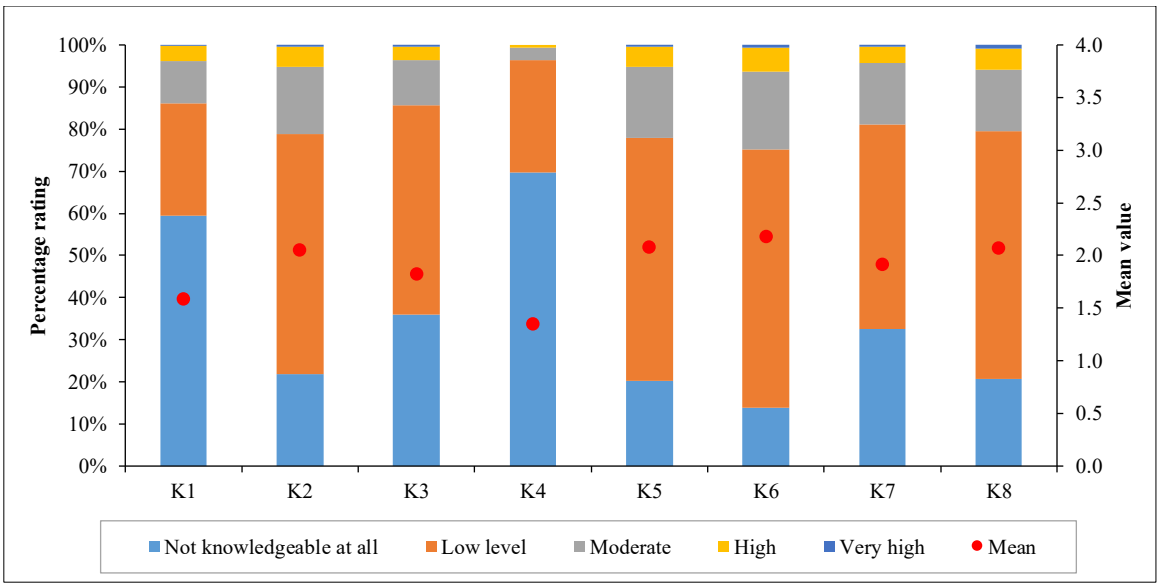

Figure 3. Knowledge of residents in the study area

In contrast to their limited knowledge, residents' attitude and behavior toward e-waste were generally more positive (Figure 4). Among attitudinal items, the statement "There should be formal programs/areas for e-waste collection and recycling" received the highest agreement (67.8%), while "The state needs to have regulations and sanctions for e-waste management" received the lowest (24.1%). This indicates that residents prioritize the establishment of dedicated e-waste collection and recycling systems as a means of protecting the environment and improving urban aesthetics. Other aspects, such as public perception, civic responsibility, environmental awareness, segregation guidance, and producer responsibility, were also rated positively, with mean scores ranging from 4.20 to 4.56.

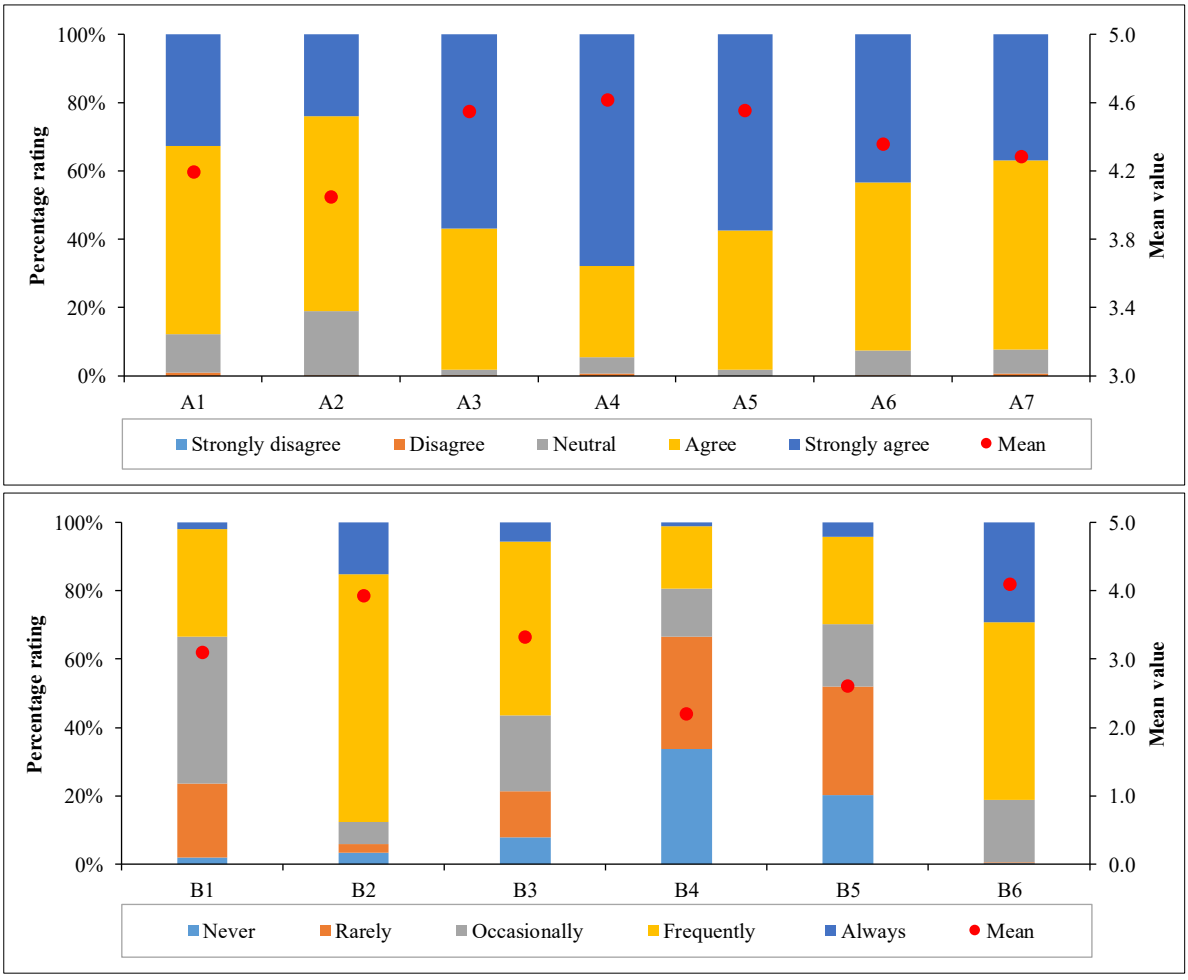

Figure 4. Attitude and behavior of residents in the study area

Attitude plays a pivotal role in shaping behavioral intentions, and positive environmental attitude is widely recognized to promote pro-environmental behaviors [34, 35]. Similar to knowledge, significant attitudinal differences were found among districts ($p < 0.05$) (Appendix III). Interestingly, residents in central urban districts exhibited less favorable attitudes compared to those in peripheral districts. Attitudinal differences were also significant across occupation, educational level, and total household income ($p < 0.05$) (Appendix III), while no significant differences were observed by gender, age, ethnicity, or length of residency ($p > 0.05$) (Appendix III).

As shown in Figure 4, e-waste-related behaviors among residents were performed at only a moderate level overall. Apart from the action "limiting the purchase of unnecessary electrical and electronic devices," which was frequently practiced (mean score = 4.09), most other behaviors were performed rarely or occasionally. Similar to knowledge and attitude, behavioral differences were statistically significant across districts ($p < 0.05$) (Appendix III), as well as by occupation, educational level, and total household income. However, no significant variations were observed according to gender, age, ethnicity, or length of residency ($p > 0.05$) (Appendix III). Consistent with previous research, these results emphasize that household attitudes and behaviors are critical determinants of the effectiveness of waste reduction, segregation, collection, and recycling programs [32, 36]. Accordingly, policy interventions and community-based initiatives are essential to promote behavioral change, foster public participation, and advance the transition toward a circular economy and the sustainable use of natural resources.

3.2. Relationship Between Knowledge, Attitude, Behavior, and the Dependent Variables

To examine the relationships among the three factors of knowledge, attitude, and behavior, and their associations with the two dependent variables, willingness to hand over (WTH) and willingness to pay (WTP), a correlation analysis was conducted. The results are summarized in Table 3, where the color intensity illustrates the strength of the correlation coefficient, with darker shades indicating stronger correlations.

Table 3. Results of the correlation analysis

	Knowledge	Attitude	Behavior	WTH	WTP
Knowledge	1	0.254**	0.396**	0.234**	0.204**
Attitude		1	0.135**	0.404**	0.273**
Behavior			1	0.292**	0.139**
WTH				1	0.268**
WTP					1

Note: ** Correlation is significant at the 0.01 level (2-tailed).

All three factors - knowledge, attitude, and behavior - were significantly correlated with one another and with both dependent variables ($p < 0.01$). Knowledge exhibited positive correlations with attitude ($r = 0.254$) and behavior ($r = 0.396$), both statistically significant at the 0.1% level ($p < 0.001$). This indicates that residents with greater understanding of e-waste are more likely to display positive attitudes and engage in appropriate e-waste management behaviors. This finding is consistent with [37], which reported that individuals possessing higher levels of e-waste knowledge tend to exhibit more favorable recycling practices in their daily lives.

The correlation between attitude and behavior was also positive but relatively weak ($r = 0.135$, $p < 0.001$), suggesting that households with favorable attitudes towards e-waste management are somewhat more likely to actively participate in related activities. Furthermore, all three independent variables were positively correlated with both dependent variables, albeit at varying strengths. For WTH, the correlation coefficients are 0.234 (Knowledge), 0.404 (Attitude), and 0.292 (Behavior). For WTP, the corresponding coefficients are 0.204, 0.273, and 0.139, respectively. The two dependent variables, WTH and WTP, also exhibited a weak but positive correlation with each other ($r = 0.268$). These results confirm that the independent variables are interrelated and likely influence the residents' WTH and WTP for e-waste management. Importantly, no high correlations (exceeding 0.9) were detected among the independent variables, indicating the absence of multicollinearity. Consequently, all independent variables were retained for the subsequent regression analysis.

3.3. Factors Influencing WTH and WTP

The results in Figure 5 indicate that a vast majority (93.11%) of Can Tho City residents are willing to hand over their used electronic devices to formal recycling channels. Specifically, 69.22% were 'willing' and 23.89% were 'very willing' to do so. However, 6.89% of residents remained hesitant or unwilling, often due to the residual value of their old electronics. They expressed a preference for keeping the items as mementos or selling them to the appliance repairing stores and peddlers to earn a small income. Statistical analysis further reveals that higher education levels are associated with greater willingness to hand over old electronic devices to formal recycling systems (Appendix III).

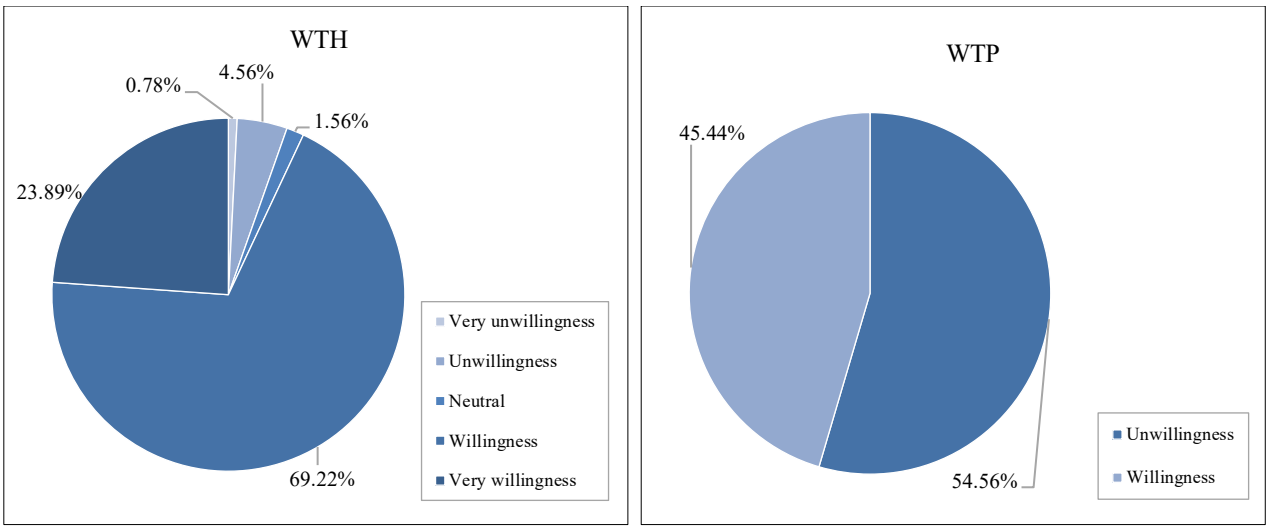

Figure 5. Residents' willingness to pay for e-waste segregation and recycling in the study area

Among the 900 surveyed households, 409 (45.44%) were willing to pay a fee for e-waste segregation and recycling in Can Tho City (Figure 5). Conversely, 54.56% (491 households) were unwilling to pay this cost. This willingness to pay (WTP) rate is lower than those reported in Macau (64.91%) [38] and in Ho Chi Minh City, Vietnam (74.45%) [19], but higher than the 38.2% found in Zhuhai, China [39]. Many residents noted that they could sell used electrical and electronic equipment for a small return, and some believed the recycling cost should be borne by the government or manufacturers or included in product prices. Younger and more educated residents were generally more willing to pay, while lower-income households or those experiencing financial hardship showed significantly lower WTP (Appendix III). The reasons for unwillingness reported in this study are highly consistent with the findings from [18, 38, 39].

The minimum and maximum amounts residents were willing to pay were 5,000 VND and 500,000 VND, respectively, with an average of approximately 23,000 VND (Figure 6). The most common payment brackets were 5,000–10,000 VND and 11,000–20,000 VND. This is substantially lower than the average WTP for municipal solid waste management in Vietnam, reported between 86,000 to 155,000 VND/month/household [40, 41]. The finding implies that residents' concern about e-waste remains limited, as many still prefer selling to the appliance repairing stores and peddlers rather than paying for proper recycling.

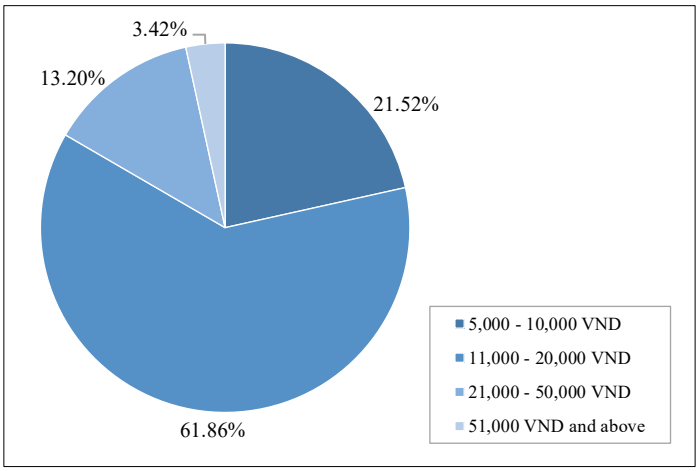

Figure 6. Amount residents are willing to pay for e-waste segregation and recycling in the study area

Regression analysis results indicate that attitude and behavior significantly influence households' willingness to hand over old electronic devices to formal recycling programs, with attitude being the primary factor (Figure 7). In contrast, knowledge does not affect WTH, as it was not statistically significant in the regression model ($p = 0.782 > 0.05$) (Appendix IV). This finding is consistent with [24], which identified attitude as the key determinant of student's willingness to hand over e-waste at Can Tho University. What's more, respondents highly valued the establishment of designated collection areas or formal collection programs, suggesting that accessible e-waste services play a crucial role in fostering positive attitudes and trigger pro-environmental habits. Numerous studies have confirmed that effective collection mechanisms substantially boost e-waste recycling rates [38, 42].

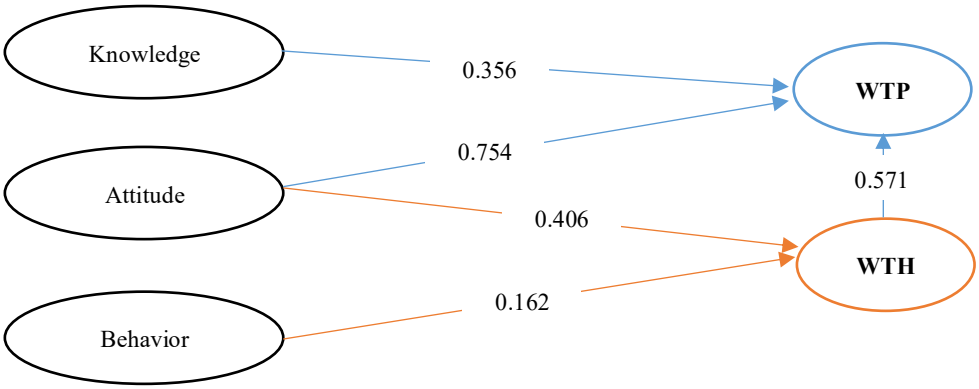

Figure 7. Factors impacting WTH and WTP

Regarding the willingness to pay (WTP), the regression results indicate that knowledge, attitude, and WTH significantly influence residents' WTP, while behavior does not (Figure 7). The model's prediction accuracy for the 491 unwilling cases was 75.80%, while its accuracy for the 409 willing cases was 44.70%. Overall, the model suggests that 302 of the 900 surveyed households are likely to pay a recycling fee (Appendix IV). For every one – point increase on the five-point scale for knowledge and attitude, the odds of a resident being willing to pay for recycling rise by 1.43 and 2.13 times, respectively (Appendix IV).

In terms of communication preferences, residents favored receiving e-waste information via television/radio (37.10%) and the internet/social media (28.45%) over other channels (Figure 8). This finding aligns with [43] in Malaysia. The research by [19] and [44] also highlighted social media as a powerful engagement tool due to its accessibility and stressed the need for early environmental education to build long-term awareness.

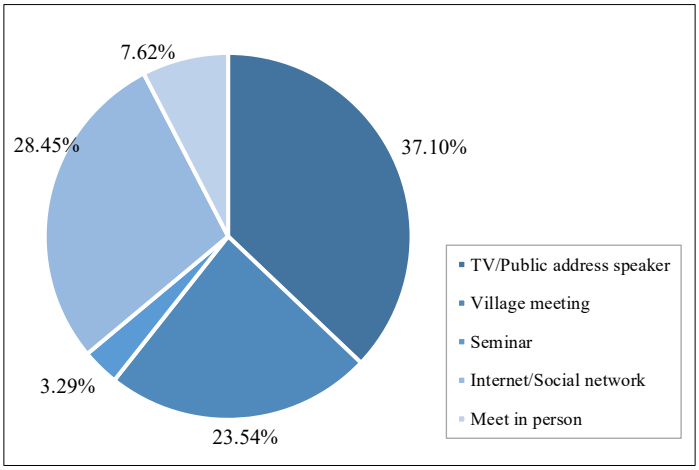

Figure 8. Preferred channels for raising awareness among Can Tho City residents

4. Discussion

The findings reveal that residents of Can Tho City generally possess a limited understanding of e-waste, indicating a critical gap in public awareness of this emerging environmental issue. The low level of knowledge regarding e-waste collection and treatment facilities, legal responsibilities, and potential resource recovery suggests that information dissemination efforts have been insufficient. The lack of awareness observed not only among households but also among university students [24] underscores the absence of systematic education and communication strategies. This aligns with global evidence showing that inadequate knowledge remains a major barrier to effective e-waste management, particularly in developing countries [4, 29, 43]. Despite the low level of understanding, residents demonstrated relatively high concern for the environmental and health implications of e-waste, indicating the presence of latent environmental consciousness that could be leveraged through targeted education programs [45]. The observed disparities in knowledge across districts and demographic groups - such as gender, education, and income - further highlight the importance of context-specific awareness initiatives. This results suggest that socio-economic and spatial factors influence how individuals perceive and access information about e-waste, echoing findings from prior studies in other developing contexts [33, 46].

In contrast, the strong agreement with the need for formal collection and recycling programs suggests that residents in Can Tho City recognize the importance of structured systems for managing e-waste, both for environmental protection and urban aesthetics. The Vietnam Recycles program currently offers home and station-based e-waste take-

back services, though its operations remain limited to Hanoi and Ho Chi Minh City, it has contributed to raising local knowledge and awareness [47, 48] emphasized the need for convenient and user-friendly collection programs. It also noted that implementing door-to-door e-waste collection services significantly increases recycling rates. This reflects an underlying environmental awareness and collective concern that, if properly guided, could be transformed into sustainable behavioral practices. Establishing a harmonized e-waste collection framework in Vietnam is essential, taking inspiration from international practices - such as Japan's mandatory retailer take-back policy, the voluntary integrated collection system in the United States, and the regulated combined collection model implemented across the European Union [49-51].

Although residents' attitudes were generally favorable, actual e-waste management behaviors were observed only at a moderate level. Most residents occasionally engage in proper disposal practices, and actions such as separating e-waste or delivering it to formal collection points remain uncommon. The lack of recycling infrastructure and specific legislation on e-waste management in Vietnam has resulted in low public consensus and limited participation in proper disposal practices [7, 52]. Notably, residents in peripheral or rural districts exhibited stronger environmental attitudes than those in central urban areas, potentially due to e-waste is often collected through peddlers or disposed of with general household waste, creating a sense of convenience and detachment from environmental consequences. The relationship among knowledge, attitude, and behavior observed in this study is consistent with the KAB framework. Low levels of knowledge have limited the formation of strong environmental attitudes and the translation of these attitudes into actual behaviors [27, 28]. The results reinforce the theoretical proposition of the KAB framework, which posits that knowledge serves as a precursor to attitude formation and behavioral change [29].

Education emerged as a key determinant influencing both willingness to hand over and WTP. Younger and more educated respondents demonstrated a higher level of engagement in formal e-waste recycling practices. This has been noted in research by [18] and [38]. Otherwise, households with lower income levels or financial constraints tended to favor informal channels, motivated by the small economic returns from selling used items. Studies by [19, 53] and [54] all indicate that higher-income households are more likely to pay for e-waste recycling. However, as noted by Borthakur & Govind [55], higher income does not necessarily equate to greater environmental responsibility. The study by Hien & Thao [8] also highlighted that Vietnamese residents still expect to be paid when handing over their old electronics to formal recycling programs. This behavior underscores the economic dimension of e-waste management, where financial incentives remain a primary driver for household decisions. Vietnam initiated the implementation of Extended Producer Responsibility (EPR) in 2013; however, the dominance of the informal recycling sector and various institutional challenges have hindered its effective realization [7]. On the other hand, the shortcomings of Extended Producer Responsibility (EPR) implementation stem from the limited awareness among the public and relevant stakeholders in Vietnam [56].

Regression results further demonstrate that attitude and behavior significantly affect residents' willingness to hand over e-waste, while knowledge alone does not show a direct influence. However, when combined with attitude and willingness to hand over, knowledge exerts a notable effect on WTP. The finding that attitude strongly predicts willingness to hand over (WTH) but not willingness to pay (WTP) suggests the presence of a behavioral gap between pro-environmental intention and financial commitment. This result is consistent with previous discussions that producers or government should cover recycling costs in developing countries [18, 39]. The need for policies that combine awareness campaigns with financial or institutional incentives to bridge the gap between attitude and actual payment behavior [19, 57]. Nguyen et al. [18] also found that WTP for e-waste recycling was related to the respondent's educational level. However, their study found that knowledge did not impact WTP in Da Nang. In contrast, research by Vassanadumrongdee & Kittipongvises [58] suggested that education played a minor or insignificant role in the WTP of Thai residents. Conversely, another study in China noted a complex relationship where, despite a general positive correlation between education and WTP, an inverse effect could also occur [39]. Furthermore, many previous studies have emphasized the crucial impact of attitude on the intention to engage in pro-environmental behaviors [35, 59].

This indicates that a community with strong positive attitudes towards environmental protection is more likely to participate in recycling programs [37]. Therefore, to promote the intention to pay, it is essential to enhance communication strategies and establish accessible e-waste recycling services in Can Tho City. A study in China also demonstrated that information dissemination is vital, and that a complete recycling channel with convenient facilities is needed to support public participation [60]. Without adequate understanding, residents are unlikely to adopt sustainable e-waste management practices. Therefore, comprehensive awareness and education campaigns are essential to bridge knowledge gaps, promote responsible behavior, and support the transition toward a formalized and sustainable e-waste management system in Can Tho City. Local governments can implement incentive-based programs and strengthen awareness campaigns through both online and community channels to promote e-waste recycling. Collaborating with schools and universities to integrate environmental education can further foster sustainable habits among younger generations. Empirical evidence suggests that strengthening public awareness and knowledge of e-waste contributes to cultivating a pro-environmental social climate [19]. While the study provides valuable insights,

certain limitations remain. The convenience sampling approach and reliance on self-reported data may introduce response bias, and the findings are context- specific to Can Tho City. Nonetheless, these limitations do not undermine the validity of the results; rather, they highlight opportunities for future longitudinal and comparative studies to further strengthen the understanding of e-waste management behaviors. Future research should integrate additional factors such as recycling costs, rewards, inconvenience of recycling, subjective norms, environmental concern, perceived behavioral control, all of which have been shown to influence e-waste recycling decisions [18, 61, 62].

5. Conclusion

This study provides a comprehensive assessment of the knowledge, attitude, and behavior (KAB) toward e-waste management in Vietnam's Mekong Delta. The findings reveal a critical disconnect: while public knowledge of e-waste is exceptionally low, residents exhibit a positive attitude towards proper disposal and a remarkably high willingness to hand over (WTH) used electronics to formal recycling programs (93.11%). However, this positive inclination does not translate into a strong willingness to pay (WTP), with only 45.44% of households prepared to cover recycling costs, reflecting a preference for informal markets or an expectation of producer and government responsibility. The regression analysis uncovers pivotal relationships for policy-making. Attitude, rather than knowledge, is the primary determinant of WTH, suggesting that behavioral intention is already present. In contrast, WTP is significantly influenced by both knowledge and attitude. This indicates that while the public is ready to participate in collection schemes, financial commitment requires a deeper understanding of the issue. Ultimately, this research highlights a significant opportunity. To bridge the gap between high participation intent and low financial willingness, a dual-pronged strategy is recommended. First, immediate efforts should focus on establishing convenient, accessible, and reliable collection systems to capitalize on the existing high WTH. Second, targeted educational campaigns, utilizing preferred channels like television and social media, are essential to elevate public knowledge. Enhancing this understanding is the crucial next step to fostering a sense of shared financial responsibility and ensuring the long-term sustainability of e-waste management in the region.

6. Declarations

6.1. Author Contributions

Conceptualization, N.T.G., T.T.K.H., and N.H.T.L.; methodology, N.T.G. and N.H.T.L.; software, N.H.T.L.; validation, N.T.G. and T.T.K.H.; formal analysis, N.T.G., T.T.K.H., and N.H.T.L.; investigation, N.H.T.L.; resources, N.H.T.L.; data curation, N.T.G. and N.H.T.L.; writing—original draft preparation, N.H.T.L.; writing—review and editing, N.T.G. and T.T.K.H.; visualization, N.T.G. and N.H.T.L.; supervision, N.T.G. and T.T.K.H.; project administration, N.T.G.; funding acquisition, N.H.T.L. All authors have read and agreed to the published version of the manuscript.

6.2. Data Availability Statement

The data presented in this study are available in the article.

6.3. Funding

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6.5. Institutional Review Board Statement

Not applicable.

6.6. Informed Consent Statement

Not applicable.

6.7. Declaration of Competing Interest

The authors declare that there are no conflicts of interest concerning the publication of this manuscript. Furthermore, all ethical considerations, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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Appendix I. Questionnaire

Items	Question	Responses				
Gender		□ Male	□ Female			
Age		□ 18 – 30 years old	□ 31 – 45 years old	□ 46 – 60 years old	□ > 60 years old	
Ethnic groups		□ Kinh	□ Hoa	□ Khmer		
Education background		□ No formal education–Secondary school	□ High school	□ College	□ University of above	
Occupation		□ Student □ Government/Company employees	□ Merchant □ Self employed	□ Pensioner/Housewife	□ Worker	□ Farmer
Residence period		□ < 5 years	□ 5 – 10 years	□ 10 – 15 years	□ > 15 years	
Income		□ < 5,000,000 VND	□ 5,000,000–10,000,000 VND	□ 10,000,000–15,000,000 VND	□ > 15,000,000 VND	

	Knowledge and awareness	Not knowledgeable at all (1)	Low level (2)	Moderate (3)	High (4)	Very high (5)
K1	Definition of e-waste	□	□	□	□	□
K2	Awareness of substances and components in e-waste	□	□	□	□	□
K3	Perception of e-waste as a potential resource when properly managed	□	□	□	□	□
K4	Knowledge of e-waste collection and treatment sites	□	□	□	□	□
K5	Perception of appropriate e-waste treatment methods	□	□	□	□	□
K6	Perception of e-waste management for environmental sustainability	□	□	□	□	□
K7	Perception of stakeholder responsibility in e-waste collection and treatment	□	□	□	□	□
K8	Perception of environmental and social impacts of e-waste	□	□	□	□	□
	Attitude	**Strongly disagree (1)**	**Disagree (2)**	**Neutral (3)**	**Agree (4)**	**Strongly agree (5)**
A1	Attitude toward producer responsibility for e-waste collection and treatment	□	□	□	□	□
A2	Attitude toward governmental regulations and enforcement in e-waste management	□	□	□	□	□
A3	Attitude toward citizen responsibility in e-waste management	□	□	□	□	□
A4	Attitude toward formal programs and facilities for e-waste collection and recycling	□	□	□	□	□
A5	Attitude toward community awareness of e-waste	□	□	□	□	□
A6	Attitude toward environmental protection for future generations	□	□	□	□	□
A7	Attitude toward receiving detailed guidance on e-waste segregation	□	□	□	□	□
	Behavior	**Never (1)**	**Rarely (2)**	**Occasionally (3)**	**Frequently (4)**	**Always (5)**
B1	Segregating e-waste from municipal solid waste	□	□	□	□	□
B2	Selling e-waste to collection facilities	□	□	□	□	□
B3	Recycling and reusing damaged electronic devices	□	□	□	□	□
B4	Giving obsolete electronic devices	□	□	□	□	□
B5	Encouraging relatives to manage e-waste properly	□	□	□	□	□
B6	Limiting unnecessary purchases of electrical and electronic devices	□	□	□	□	□
WTH	Would you be willing to hand over your end-of-life electronic devices to certified collection programs?	□ Very unwillingness	□ Unwillingness	□ Neutral	□ Willingness	□ Very willingness
WTP	Would you be willing to pay for proper e-waste recycling services	□ Unwillingness	□ Willingness			
What are your preferred channels for environmental awareness campaigns		□ TV/Public address speaker	□ Village meeting	□ Seminar	□ Internet/Social network	□ Meet in person

Appendix II. Results of Cronbach's Alpha and EFA Analysis

Variables	Items	Cronbach's Alpha Analysis		Cronbach's Alpha Analysis (second time)		EFA Analysis (first time)			EFA Analysis (second time)		
		Cronbach's Alpha	Cronbach's Alpha if Item Deleted	Cronbach's Alpha	Cronbach's Alpha if Item Deleted	KMO	Total Variance Explained	Factor Loading	KMO	Total Variance Explained	Factor Loading
Knowledge and awareness	K1	0.921	0.905	0.932	0.919	0.894	57.021%	0.857	0.894	59.274%	0.861
	K2		0.908		0.918			0.867			0.873
	K3		0.908		0.924			0.813			0.818
	K4		0.923		-			-			-
	K5		0.905		0.922			0.799			0.801
	K6		0.903		0.918			0.822			0.827
	K7		0.924		-			-			-
	K8		0.908		0.920			0.866			0.867
Attitude	A1	0.653	0.612	0.642	0.602			0.536			0.527
	A2		0.622		0.602			0.488			-
	A3		0.622		0.622			0.546			0.548
	A4		0.599		0.586			0.643			0.666
	A5		0.642		-			-			-
	A6		0.589		0.568			0.675			0.704
	A7		0.630		0.609			0.604			0.600
Behavior	B1	0.289	0.108	0.603	0.531			0.706			0.730
	B2		0.356		-			-			-
	B3		0.330		-			-			-
	B4		0.155		0.541			0.747			0.736
	B5		0.059		0.419			0.672			0.673
	B6		0.381		-			-			-

Appendix III. Differences Between Student Groups

Characteristic	K1	K2	K3	K4	K5	K6	K7	K8	A1	A2	A3	A4	A5	A6	A7
Gender[(a)]															
Sig.	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.009**	**0.000**	0.746	0.331	0.560	0.451	0.355
Male	1.75	2.20	2.00	1.42	2.21	2.30	2.03	2.22	4.26	4.13	4.55	4.64	4.57	4.38	4.27
Female	1.42	1.90	1.65	1.27	1.94	2.06	1.79	1.91	4.14	3.97	4.54	4.60	4.55	4.34	4.30
Age[(b)]															
Sig.	**0.000**	**0.000**	**0.000**	**0.005**	**0.000**	**0.000**	**0.001**	**0.000**	0.099	0.103	0.201	0.199	0.231	0.576	0.742
18-30 years old	1.97	2.43	2.18	1.43	2.39	2.53	2.02	2.49	4.17	4.15	4.55	4.68	4.48	4.42	4.23
31-45 years old	1.72	2.17	1.97	1.43	2.22	2.33	2.06	2.20	4.28	4.11	4.57	4.67	4.61	4.33	4.27
46-60 years old	1.44	1.93	1.72	1.29	1.96	2.04	1.80	1.94	4.14	4.01	4.50	4.58	4.54	4.35	4.29
> 60 years old	1.50	1.95	1.69	1.30	1.96	2.09	1.86	1.96	4.20	4.00	4.60	4.60	4.55	4.38	4.31
Education background[(b)]															
Sig.	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	0.188	**0.000**	0.612	**0.000**	0.854
No formal education – secondary school	1.27	1.78	1.57	1.23	1.79	1.90	1.69	1.79	4.07	3.91	4.51	4.54	4.54	4.28	4.27
High school	1.95	2.34	1.99	1.39	2.43	2.50	2.17	2.41	4.38	4.30	4.57	4.66	4.59	4.50	4.33
College	1.72	2.19	2.02	1.46	2.28	2.36	2.04	2.22	4.35	4.16	4.60	4.72	4.60	4.40	4.28
University of above	2.40	2.72	2.47	1.61	2.70	2.83	2.45	2.75	4.39	4.31	4.59	4.76	4.53	4.53	4.31
Ethnic group[(b)]															
Sig.	**0.004**	**0.005**	**0.032**	0.481	0.064	**0.032**	0.836	**0.030**	**0.099**	0.689	0.395	0.174	0.733	0.689	0.285
Kinh	1.57	2.05	1.83	1.34	2.08	2.18	1.91	2.07	4.20	4.06	4.55	4.62	4.56	4.35	4.28
Hoa	1.38	1.76	1.50	1.26	1.79	1.88	1.91	1.76	3.97	4.00	4.44	4.47	4.56	4.41	4.44
Khmer	2.00	2.37	1.94	1.43	2.20	2.34	1.83	2.26	4.29	3.97	4.49	4.74	4.49	4.43	4.23
Occupation[(b)]															
Sig.	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.000**	0.654	**0.060**	0.145	**0.003**	**0.001**
Student	2.17	2.50	2.17	1.17	2.28	2.50	2.17	2.44	4.22	4.17	4.44	4.67	4.44	4.67	4.33
Merchant	1.54	2.05	1.79	1.29	2.03	2.12	1.78	2.06	4.25	4.04	4.52	4.64	4.50	4.33	4.22
Government/Company employees	2.18	2.56	2.34	1.56	2.58	2.72	2.43	2.67	4.36	4.32	4.60	4.75	4.55	4.52	4.44
Pensioner/Housewife	1.38	1.83	1.61	1.27	1.92	2.00	1.71	1.84	4.10	3.95	4.53	4.56	4.58	4.33	4.24
Worker	1.60	2.13	1.60	1.47	2.13	2.33	1.87	2.13	4.07	4.07	4.47	4.47	4.73	4.27	4.27
Farmer	1.38	1.88	1.70	1.30	1.89	1.97	1.79	1.92	4.14	4.05	4.57	4.56	4.57	4.33	4.40
Self employed	1.40	1.82	1.79	1.47	1.97	2.12	2.19	1.71	4.01	3.81	4.60	4.59	4.68	4.22	4.15
Residence period[(b)]															
Sig.	**0.027**	0.295	0.059	**0.043**	**0.022**	**0.007**	**0.013**	0.503	1.000	**0.038**	0.651	0.686	0.888	0.826	0.307
< 5 years	1.72	2.25	1.78	1.44	2.28	2.44	1.86	2.22	4.19	3.89	4.64	4.69	4.56	4.33	4.17
5-10 years	1.82	2.13	2.05	1.46	2.28	2.38	2.18	2.14	4.21	3.88	4.54	4.62	4.55	4.37	4.19
10-15 years	1.64	2.06	1.77	1.44	2.09	2.21	1.98	2.06	4.20	4.03	4.59	4.68	4.61	4.42	4.27
> 15 years	1.55	2.03	1.81	1.32	2.04	2.14	1.88	2.05	4.20	4.08	4.54	4.61	4.55	4.35	4.30
Income[(b)]															
Sig.	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	0.301	**0.045**	0.440	0.078	0.477
< 5,000,000 VND	1.17	1.71	1.43	1.13	1.68	1.82	1.52	1.79	4.01	4.06	4.46	4.55	4.57	4.27	4.33
5,000,000 - 10,000,000 VND	1.38	1.87	1.67	1.34	1.90	2.02	1.88	1.85	4.12	3.89	4.55	4.60	4.58	4.34	4.28
10,000,000 - 15,000,000 VND	1.73	2.12	1.99	1.42	2.25	2.34	2.12	2.18	4.27	4.12	4.54	4.58	4.55	4.35	4.33
> 15,000,000 VND	1.96	2.41	2.10	1.38	2.38	2.46	1.96	2.44	4.33	4.24	4.58	4.71	4.51	4.44	4.24

Note: [(a)] Independent Sample T-test; [(b)] One-way ANOVA

Characteristic	B1	B2	B3	B4	B5	B6	WTH	WTP
Gender[a]								
Sig.	**0.010**	0.745	0.871	**0.050**	**0.000**	0.214	0.431	**0.017**
Male	3.17	3.95	3.32	2.27	2.79	4.06	4.13	0.49
Female	3.03	3.93	3.33	2.13	2.45	4.12	4.09	0.42
Age[b]								
Sig.	0.241	0.348	0.275	**0.031**	**0.001**	**0.000**	0.947	0.106
18-30 years old	2.95	4.00	3.38	2.33	2.76	3.77	4.14	0.57
31-45 years old	3.16	3.87	3.43	2.30	2.85	4.03	4.12	0.45
46-60 years old	3.10	3.95	3.29	2.21	2.48	4.16	4.09	0.42
> 60 years old	3.10	3.98	3.26	2.02	2.52	4.20	4.11	0.47
Education background[b]								
Sig.	**0.000**	0.235	0.345	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
No formal education – secondary school	3.00	3.97	3.28	2.06	2.31	4.25	4.02	0.39
High school	3.17	3.78	3.43	2.26	2.84	3.89	4.17	0.55
College	3.23	3.92	3.42	2.34	2.93	3.99	4.23	0.47
University of above	3.29	3.93	3.35	2.54	3.31	3.72	4.26	0.60
Ethnic group[b]								
Sig.	0.857	0.966	0.714	0.608	0.895	**0.003**	0.449	**0.000**
Kinh	3.11	3.94	3.32	2.20	2.62	4.10	4.11	0.47
Hoa	3.12	3.94	3.47	2.35	2.68	4.38	3.97	0.35
Khmer	3.03	3.97	3.31	2.09	2.54	3.80	4.17	0.14
Occupation[b]								
Sig.	**0.000**	0.244	0.631	**0.001**	**0.000**	**0.000**	0.447	**0.000**
Student	2.89	4.11	3.11	2.17	2.89	3.67	4.22	0.61
Merchant	3.01	3.96	3.27	2.30	2.45	3.98	4.08	0.42
Government/Company employees	3.36	4.00	3.42	2.33	3.22	4.01	4.22	0.62
Pensioner/Housewife	3.00	3.95	3.36	2.02	2.41	4.17	4.07	0.40
Worker	3.27	4.00	3.13	1.60	2.33	4.33	4.07	0.47
Farmer	3.08	3.78	3.30	2.05	2.56	4.34	4.11	0.52
Self employed	3.35	3.87	3.43	2.50	2.82	4.13	4.12	0.26
Residence period[b]								
Sig.	0.155	0.408	0.713	**0.026**	0.178	0.131	0.817	0.219
< 5 years	2.89	3.94	3.50	2.33	2.53	4.31	4.03	0.36
5-10 years	3.24	3.79	3.26	2.55	2.90	3.97	4.12	0.37
10-15 years	3.17	3.97	3.33	2.18	2.56	4.06	4.17	0.42
> 15 years	3.09	3.95	3.33	2.16	2.60	4.10	4.11	0.47
Income[b]								
Sig.	**0.001**	**0.003**	0.932	**0.000**	**0.000**	**0.000**	0.094	**0.027**
< 5,000,000 VND	2.91	3.91	3.31	1.74	1.97	4.63	4.08	0.44
5,000,000 - 10,000,000 VND	3.16	3.99	3.35	2.20	2.54	4.25	4.05	0.40
10,000,000 - 15,000,000 VND	3.24	3.75	3.29	2.36	2.88	4.00	4.16	0.49
> 15,000,000 VND	2.99	4.00	3.34	2.27	2.81	3.70	4.18	0.52

Note: [a] Independent Sample T-test; [b] One-way ANOVA

Appendix IV. Results of Regression Analysis

	WTH			WTP				
	R Square	**Sig.**	**p-value**	**Nagelkerke R Square**	**Sig.**	**p-value**	**Exp(B)**	**-2 Log likelihood**
Knowledge	0.209	0.782	0.009	0.119	0.003	0.356	1.427	1156.033
Attitude		0.000	0.406		0.001	0.754	2.127	
Behavior		0.000	0.162		0.949	-0.006	0.994	
WTH		-	-		0.000	0.571	1.770	

			WTP		Percentage Correct
			Unwillingness	**Willingness**	
Step 1	WTP	Unwillingness	372	119	75.8
		Willingness	226	183	44.7
	Overall Percentage				61.7

a. The cut value is .500