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ORIGINAL ARTICLE

Consumers' willingness to pay an environmental fee for e-waste recycling in Vietnam: integrating the theory of planned behaviour and the norm activation model

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Abstract

E-waste is becoming a concern due to its toxic content and serious pollution effect. Many studies have focused on the detrimental impacts of hazardous e-waste and extended producer responsibility for e-waste recycling. There is, however, a lack of case studies from the perspectives of consumers' awareness of e-waste, and willingness to pay (WTP) for e-waste recycling. An e-waste management system cannot be efficient when consumers are not actively involved in. Based on a survey of 544 respondents in Ho Chi Minh City, this paper investigates the respondents' WTP for e-waste recycling and factors affecting their WTP by integrating the theory of planned behaviour and the norm activation model. The Contingent Valuation Method and Tobit model were applied to estimate and explain consumers' WTP for e-waste recycling. The model showed that subjective/social norms, moral/personal norms, inconvenience of recycling, perception of e-waste pollution, age, home ownership, and income significantly affected WTP for e-waste recycling. The estimated mean WTP from the Tobit model was 1.588% (Televisions), 1.644% (Computers) and 1.656% (Mobile phones) of the purchasing bills. The findings are useful for policy-makers in developing more effective environmental management policies for e-waste.

Keywords E-waste · Recycling behaviour · Contingent valuation method (CVM) · Willingness to pay (WTP)

Introduction

Electrical and electronic devices have become an essential part of human life [1] due to their availability, convenience, and great values. The rapid update of electronic products, however, generates a large amount of e-waste [2] that enters considerably in the waste stream. In 2019, 53.6 million tons of e-waste were generated around the world [3], equivalent to 7.3 kg per capita, and only 17.4% of this was properly collected and recycled. In Vietnam, the e-waste flow is mainly generated from households (electronic home appliances), offices (computers, photocopiers, fax machines, printers and scanners), electronic industries, and from imported secondhand products [4]. The e-waste from used electrical and electronic equipment discarded rapidly increased from 1.9 kg per capita (2014) to 3.7 kg per capita (2020) [5]. The number of discarded appliances is estimated about 17.2 million appliances (10.6 million units in 2020), equivalent to 567,000 tons in 2025 [6]. E-waste is collected with municipal solid waste and recycled at informal recycling facilities (junkshops and private individuals) where low-level or improper technologies were used, causing environmental pollution and health risks [7].

E-waste contains a large amount of toxic and hazardous substances such as heavy metals (lead, cadmium, mercury) [8] and hydrocarbons [9] that cause threatens human health and the environment [10]. Toxins from e-waste entering the soils and the food supply result in birth defects in children and health problems in adults [4]. Moreover, when the disposal and management of e-waste are conducted inappropriately at conventional landfill sites or burnt, polyaromatic hydrocarbons will be released to the atmosphere, triggering air pollution [11]. As a consequence, people suffer from respiratory diseases, lung and liver damage, and cancer [8]. The rapid increase in the amount of e-waste combined with

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inappropriate e-waste recycling boosts the need for the Vietnamese government to develop an effective e-waste management policy. This policy aims to control potentially hazardous materials contained in electrical and electronics devices, thereby contributing towards environmental protection and sustainable development.

The Vietnamese government formulates and implements a series of laws and regulations on waste management (Law on Environmental Protection, 1994 and an Amended Law on Environmental Protection, 2005; Decision No.155/1999/QD-TTG on Regulations of Hazardous Waste Management; the Decree No.59/2007/ND-CP on Solid Waste Management). In 2015, the government issues Decision No.16/2015/QC-TTG dated May 22, 2015 on prescribing retrieval and disposal of discarded products (replacing Decision No.50/2013/QC-TTG dated August 9, 2013). This decision is considered as the basic legislation for the application of the Extended Producer Responsibility (EPR) System for discarded products, including e-waste [5]. However, there are still difficulties for e-waste management and recycling in Vietnam. The challenges come from a lack of awareness in the potential hazards of e-waste; an absence of e-waste-specific legislation for the EPR system [12]; and a lack of funds and investment in improving e-waste recycling technologies [13]. The role of customers who are both users and disposers in the whole life cycle of e-waste have yet to be involved. The establishment and implementation of relevant policies and recycling facilities must be based on consumers' behaviour and their willingness to pay (WTP) to recycle e-waste [14]. Consumers who play an important role in the life cycle of e-waste should be actively involved in the e-waste management system [15] for sharing the recycling cost with producers [16]. Currently, most studies focus on the detrimental impacts of hazardous e-waste [4], an overview of electronic waste recycling [5, 17], the responsibilities of producers and government [12], while customers' awareness and behaviour on e-waste, and WTP for e-waste recycling have attracted insufficient attention. This puts forth a need for interconnection between government policies, the activities of producers, and the responsibility of consumers for effective e-waste management. In Vietnam, no studies have so far embarked on estimating consumers' WTP for e-waste. There has been only one recent study on residents' behavioural intention for e-waste recycling in Da Nang city, Vietnam [6] while WTP for e-waste has yet to be explored.

Previous studies on e-waste recycling have been conducted in countries such as America [18], Australia [19], Nigeria [20], China [21, 22], and India [23]. These scholars have investigated the perceptions, attitude, behaviour [16, 24], and willingness to participate in e-waste recycling. Saphores et al. [25] applied a generalized ordered logit model to explore factors affecting American consumers' WTP for e-waste. Song et al. [21] investigated the Chinese residents' e-waste recycling behaviour using a logistic regression model with a single-bounded dichotomous approach, while Afroz et al. [26] mainly evaluated public knowledge and awareness of the influence of e-waste on health and the environment, and households' WTP in Kuala Lumpur with the aim of improving an e-waste management. Nixon and Saphores [18] examined the impacts of beliefs about government and business roles, environmental attitude on California households' WTP an advanced recycling fee for e-waste. These studies have provided useful findings for governments in formulating policies for environmental management and mitigating hazards of e-waste with participation of consumers. Through the WEEE directive (2002/96/EC, 2023), the European Union applied EPR system for e-waste recycling while an advanced recycling fees was used in a number of states in the United State. Nixon and Saphores [18] argued that EPR programs could support to develop the recycling infrastructure but may not be cost-effective to recycle e-waste. Charging consumers a fee at the point of sale contributes to the fund for e-waste recovery and recycling programs. Financing is an important component of the new recycling infrastructure. Recent studies on e-waste in developing countries have also focused on the role of consumers in the e-waste management policy but such studies are still limited. There is also a difference in identifying WTP value for e-waste recycling. Nixon and Saphores [18] set an advance recycling fee when Californians buy new electronics. The value included 0%, 1%, 5%, and 10% based on the retail price of the product. The study found that over half of the respondents were willing to pay at least 1% advanced recycling fee but few were willing to pay at 5%. Ananno et al. [16] estimated an advanced recycling fee of 5–10% premium for sustainable e-waste recycling in Bangladesh. Meanwhile, Song et al. [14] gave WTP value choices for recycling e-waste in Macau ranged from $1 to $12.5 per month. Similarly, Cai et al. [27] designed the WTP value choices for recycling e-waste from $0.8 to $7.7 per month in Zhuhai city, China. This study is based on the approach of Nixon and Saphores [18] to estimate an environmental fee for e-waste as a percentage of the purchase price.

Moreover, when investigating the determinants impacting on WTP for e-waste, most studies just have paid attention to explain the impact relationship by single-discipline perspective such as economics (socio-economic and demographic characteristics, income) and psychology (personal values,

beliefs, attitudes). Previous studies have focused on applying the theory of planned behaviour (TPB) framework to explore residents' attitude and behaviour for e-waste recycling [14, 18]. However, individuals' pro-environment behaviour will be significantly enhanced when there is a mixture of pro-social motives and self-interest [26]. Therefore, this study extends the existing interdisciplinary literature on pro-environmental behaviour by integrating the TPB and norm activation model (NAM) in analyzing the determinants of customers' WTP for e-waste recycling. Furthermore, studies on the financing of recycling programs are still limited. There have been no published academic papers on financing e-waste recycling in Vietnam. This study provides the first look at an advanced environmental fee based on the percentage of the purchase price for e-waste recycling in developing countries, and particularly in Vietnam. The findings of the study also provide evidences of customers' role for e-waste management, thereby contributing to develop an effective policy in e-waste management with the involvement of all stakeholders.

Theoretical basis and research hypotheses

When designing effective policies for e-waste recycling, understanding which factors motivating people to participate in pro-environmental behaviour is essential. It requires examining the consumers' willingness to pay for those policies [18]. As a possible explanation for pro-environmental behaviour, the TPB has been proposed [28]. Liere and Dunlap [29] also argued that it was better to understand environmental concerns and their relationship to environmental behaviour when combing socio-psychological and socio-economic characteristics rather than basing on single-discipline studies. Meanwhile, Ajzen [28] and Schwartz [30] reported that pro-environmental behavior could be motivated by concern for other people, future generations, or self-interest. TPB and NAM provide trustworthy frameworks for investigating social psychological factors influencing self-interested and pro-social behaviours, respectively [31]. However, applying both theories in examining and predicting self-interested and pro-social behaviours have not been examined in the literature.

The theory of planned behaviour (TPB), an extension of the theory of reasoned action (TRA) [32], has been endorsed for its explanatory power concerning respondents' intention to perform a certain behaviour [28]. Three critical variables in the TPB involve (1) attitude that reflects the degree to which people evaluate their own behaviours towards an outcome; (2) subjective norms that describe the views of referees (such as relatives, friends and other social reference groups) about whether an individual should carry out the behaviour; and (3) perceived behavioural control which represents residents' perception whether it is likely effortless or difficult to perform a certain behaviour [33]. This theory has widely been adopted in previous studies on attitude, behaviour on recycling and WTP for e-waste and solid waste management [34, 35]. Meanwhile, the norm activation model (NAM), adopted in the field of pro-social behaviour by Schwartz [30] has been successfully applied to study various types of pro-environmental behaviour [36], recycling [37], and WTP for environmental protection [38]. These studies indicated that personal norms, social norms, and the awareness of consequence factors in the NAM influence pro-environmental behaviour [31] and recycling [39].

Zhang et al. [31], however, emphasized that the TPB is more appropriate for explaining the self-interest part of pro-environmental behaviour, while the NAM is more applicable for interpreting the pro-social or pro-environmental part of the behaviour. The understandings based exclusively on either TPB or NAM may not be sufficient, as pro-environmental behaviour is best considered as a mixture of pro-social motives and self-interest [40]. Therefore, to better understand the determinants of citizens' WTP for e-waste, the conceptual framework in this study is developed by integrating the extended version of the TPB [28] and the NAM [30]. Moreover, to fill the gap in the literature on the WTP for e-waste in Vietnam and improve the explanatory power of the model, the other two components to the core constructs of the TPB, namely e-waste recycling habit and perceived effectiveness of policies are added to the model. Besides the key components of the TPB and the NAM, the demographic socio-economic variables, and the perception of the e-waste pollution level are also included in the current conceptual framework to explain the determinants of citizens' WTP for e-waste recycling. A representation of the integration of the extended version of TPB and the NAM is depicted in Fig. 1.

Attitude/Awareness of consequences

In the NAM, the awareness of consequence is considered as one of the variables that activate the relationship between norm and behaviour [41]. Davies et al. [42] concluded that the intention to perform recycling would be increased by a higher awareness level of desirable outcomes of certain behaviour. In the TPB, Ajzen [28] measured attitude in terms of an individual's belief in the outcomes of behaviour

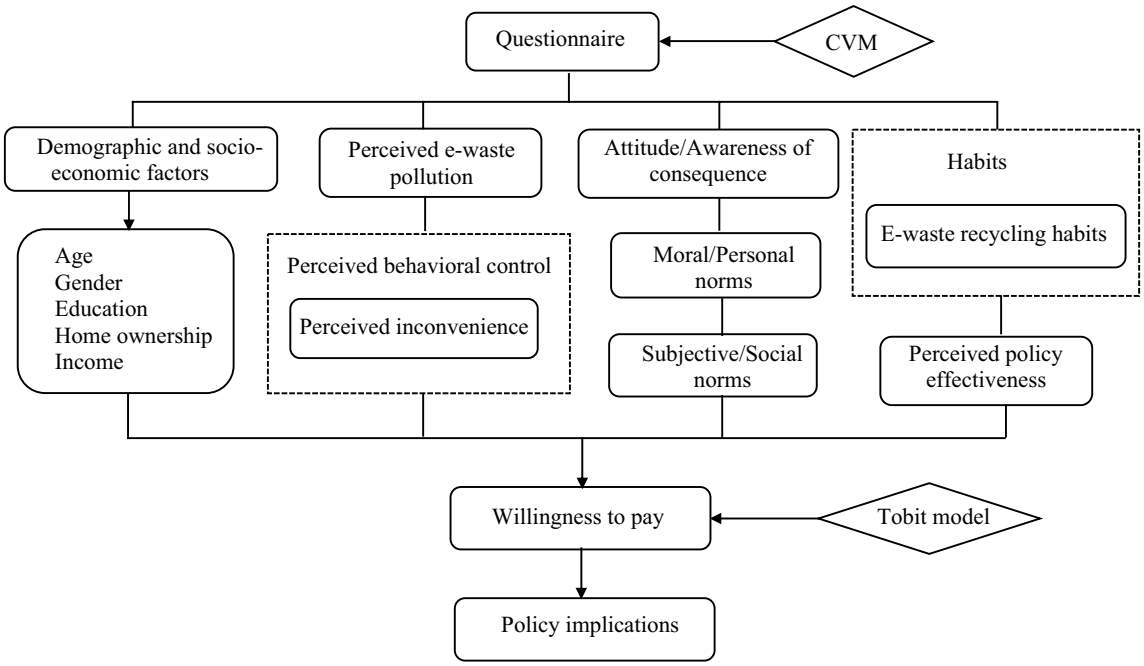

Fig.1 Questionnaire structure and the integration of the theory of planned behaviour (TPB) [28] and the norm activation model (NAM) [30]

by his or her evaluation of those outcomes. The attitudes which were proved to be a significant and direct predictor of recycling behaviour in the TPB [43] relate to the awareness of consequences in the NAM [41]. Thus, the attitudes or awareness of consequences in this study, which emphasize the individuals' knowledge of the consequences of recycling behaviour, is proposed in the following hypothesis.

Hypothesis 1 (H_1): Attitudes/Awareness of consequences relates positively to WTP for e-waste recycling

Moral/personal norms

Regarding performing pro-environmental behaviour, people are motivated by the perspective of morality in an individual mind and guided by the self or others' evaluation [36]. Moral norms which refer to an individual's sense of self-ethical obligation to perform a behaviour [44], directly affect environmental intention and behaviour [45]. Tonglet et al. [43] included a moral norm in their studies on recycling behaviour. Moral norms present concerns of an individual about ethical and social responsibilities in performing a certain behaviour [41]. The concept of moral norms in the TPB is similar to personal norms in the NAM [45]. According to NAM, personal norms reflect internalized values [30] and are experienced as self-expectations, sanctions, and obligations to engage in decision-making processes [36]. Thus, moral norms which emphasize the perceived moral obligation of e-waste recycling are included in this study.

Hypothesis 2 (H_2): Moral/Personal norms have a positive impact on WTP for e-waste recycling

Subjective/social norms

The normative influences and the context of people's daily lives often greatly affected their behaviour [36]. Subjective norms which have been recognized as a key component of motivation and behaviour, are relatively used within environmental protection behaviour [44]. In the TPB, subjective norms which represent the pressure and influence from the expectations of the referees (such as friends, peers, neighbours), have a positive impact on behaviour [32]. In the NAM, social norms refer to the values and attitudes of the referent being commonly agreed upon in a society [39]. Social norms in the NAM and subjective norms in the TPB are conceptualised in a similar manner [41]. Social/subjective norms play a critical role in shaping behaviour, thus, is included in H_3.

Hypothesis 3 (H_3): Subjective/Social norms relate positively to WTP for e-waste recycling

Perceived inconvenience

Several studies have highlighted that perceived inconvenience representing the perceived behavioural control factor [46] in the TPB, reduces participation in recycling activities [47]. Inconvenience could be associated with a lack of storage space, perceived risks associated with recycling, excessive time requirements, or the requirements of bringing recycling products to a drop-off location [25]. Saphores et al. [48] and Wang et al. [22] revealed that the convenience of recycling facilities and service is a vital guarantee for residents' effective e-waste recycling. Thus, the following hypothesis is proposed.

Hypothesis 4 (H_4): Perceived inconvenience relates negatively to WTP for e-waste recycling

E-waste recycling habits

Habits are found as one of the critical factors of e-waste recycling behaviour because of their prolonged and endurable influence [49]. Gurauskienė [15] highlighted that people's habitual behaviour involving separating e-waste from regular waste had a significant impact on their e-waste recycling bahaviour. Besides, Aboelmaged [50] emphasized that recycling habits play a key role in e-waste recycling behaviour and should be considered as an indispensable task for thea long-term construction of e-waste management. Thus, the following hypothesis can be suggested.

Hypothesis 5 (H_5): E-waste recycling habits relate positively to WTP for e-waste recycling

Perceived policy effectiveness

The policy measures that rely on incentive, regulation, and education, serve as motivational devices to change people's mindset and behaviour [51]. Steg and Vlek [52] emphasized that the perceived effectiveness of policy measures facilitates pro-environmental behaviour. Performing a particular behaviour would be induced if a motivational device built by the government is perceived as more effective [52]. Investigating how perceived policy effectiveness motivates people to perform recycling behaviour is relatively minor [41]. In the context of recycling behaviour, the perceived policy effectiveness is expected to correlate with the behaviour [53]. In this study, the perceived policy effectiveness is proposed by asking respondents about their perceptions of what the public authority provides regarding effectiveness and adequacy. Thus, the hypothesis is proposed.

Hypothesis 6 (H_6): Perceived policy effectiveness relates positively to WTP for e-waste recycling

Perceptions on e-waste pollution, demographic and socio-economics characteristics

Perceptions of the level of e-waste pollution will be positively associated with WTP for e-waste. Perceptions of environmental issues and concerns for the state of the environment are predicted as a favourable tendency towards specific pro-environmental behaviour [54]. The more respondents think that the environmental situation of their country is poor, the higher their behaviour to recycling e-waste [55]. In this paper, the perception of the level of e-waste pollution is measured by asking how the respondents perceive on e-waste pollution, via a five-point Likert scale with 1 indicating a totally unpolluted status and 5 indicating a totally polluted status.

Besides behavioural aspects, demographic and socio-economic variables were also added to the model to investigate their relationships with the willingness to pay and recycling behaviour towards e-waste recycling [20, 22, 27]. The most commonly used factors are age, gender, education, marital status, household size, occupational status, and income.

Materials and methods

Questionnaire design and data collection

The questionnaire was designed based on recycling and WTP for e-waste literature and the integration of TPB [28] and NAM [30] theoretical framework (see Fig. 1). The questionnaire consists of four parts: (1) ownership and usage behaviour of electronic devices; (2) items for the major independent variables: attitude/awareness of consequences, moral/personal norms, subjective/social norms, perceived inconvenience, e-waste recycling habits, perceived policy effectiveness, perceived e-waste pollution level; a five-point Likert scale that was used to measure the components in the TPB and the NAM, with 1 indicating a totally disagree response and 5 indicating a totally agree response; a five-point Likert scale being used to measure

the perception of the e-waste pollution level, with 1 indicating a totally unpolluted status and 5 indicating a totally polluted status; (3) the scenario and questions regarding the dependent variable of WTP for e-waste recycling; and (4) demographic and socio-economic information (such as age, gender, education, household size, monthly income, and home ownership).

The data have been collected from the residents who are living and working in Ho Chi Minh City. The total number of households (n) was determined using the following formula:

$$n = \frac{N}{1 + Ne^2} \quad (1)$$

where n = sample size, N = total number of households in Ho Chi Minh City (9,038.6 thousand in 2019 [56]), and e = error (5%). A total of 560 households living and working in Thu Duc District, District 2, District 9, Go Vap District, Phu Nhuan District, District 3, District 11, Tan Phu District, were surveyed based on their location, ranging from the city center to the periphery, income level, education, and far or adjacent to the e-waste collection centers. The initial data collection was undertaken from April to July 2021. Due to the serious Covid-19 pandemic in Ho Chi Minh City during the expected survey time, only 100 random respondents (every 20 respondents who are from District 3, District 11, Thu Duc, Go Vap, Phu Nhuan districts) were firstly face-to-face interviewed via home visits. The time of the interview was usually in the evening when people were back home from work. Some retired, housewives, and home-based traders were surveyed during office hours. The remaining 460 consumers were interviewed online. We sent emails, facebook messages or posted the survey information on citizens' fanpages with the google form attached for the survey. Respondents were asked about their willingness to participate in the survey before they agreed to respond to the questionnaire. Sixteen observations were excluded due to incomplete information; thus 544 observations remain for data analysis.

Before the formal survey, a focus group discussion was conducted, including participants (environmental economists, a staff of the Vietnam recycling program, a staff of the Department of Natural Resources and Environment Ho Chi Minh City, and households). Households, who are teachers, officer staffs, students, and housewives, are different in career, age, and education in District 11, Thu Duc, Go Vap, and Phu Nhuan districts. Focus group discussion provides preliminary information regarding respondents' WTP for e-waste recycling. Such information has been used as inputs for finalizing the questionnaire, which was developed prior based on the literature review. WTP chosen values are from 0% to more than 10% of the bill of electronic products at the time of the purchasing. The study opted for three main e-waste items: television, computer, and mobile phone. The pretested interviews in April 2021 with 40 randomly selected consumers were also undertaken to identify the level of WTP and to ensure questionnaire clarity and comprehension. The results of the WTP value from the focus group discussion and the pre-test of 40 interviewees showed that no one responded WTP to more than 10%. So, the WTP value is set to the maximum value of 10% for the formal survey.

Willingness to pay for e-waste

Contingent Valuation Method (CVM) is the most popular approach being used to compute the value of commodities without market [14]. In a hypothetical market, CVM is a type of stated-preference technique to extract WTP or willingness to accept environmental goods [57]. CVM used either an open-ended question or a close-ended question to ask customers' WTP for a commodity. Regarding the open-ended question, the obtained information is the real consumers' WTP, solving the disadvantages of the close-ended question which is only the bound value of WTP with "yes" or "no" for willing to pay. For the open-ended question, the payment card approach has more advantages than the bidding game and open-ended question. The payment card method tackles the limitation of deviation from the starting point in the bidding game and the outliers from observations that have a very high or very low WTP compared to the average sample of the open-ended question [58].

This study employed the payment card to elicit WTP. Respondents were asked about their WTP after being illustrated the adverse impacts of e-waste and the scenario displaying the expected funding of e-waste recycling and management. The payment card with 11 levels of price was ranged from 0 to 10%. Respondents will choose a number from 11 provided levels, representing their maximum WTP for e-waste recycling.

To estimate the WTP and further explore the influential factors on the WTP, the Tobit model was used. The Tobit model is suitable for the dependent variables being censored at a lower or upper limit and tackling the limiting value for a substantial number of respondents [59]. In this study, a considerable part of respondents paid the maximum amount at 1% on the payment card, which makes the sample left-censored with clustering at 1. Thus, the censoring threshold is set to 1.

The latent variable regression can be written by the following formula:

$$WTP_i^* = \beta X_i + \varepsilon_i \quad (2)$$

With $WTP_i = \left\{ \begin{array}{c} Y_i^* if Y_i^* > 1 \\ 1 if Y_i \le 1 \end{array} \right\}$ X_i is a set of independent variables and ε_i is an error term.

Estimation of Eq. (2) is usually done through the Maximum Log-Likelihood [60]. The log-likelihood function can be written as:

$$Ln(\beta, \sigma | WTP_i, X_i) = \sum WTP_{i=1} Ln\left[1 - \phi\left(\frac{\beta_0 + \beta_1 X_{1i} + \cdots + \beta_k X_{ki}}{\sigma}\right)\right] - \frac{1}{2}\sum WTP_{i>1} \left[\ln(2\pi) + ln\sigma^2\right] - \frac{1}{2}\sum WTP_{i>1} \frac{\left[WTP_i - (\beta_0 + \beta_1 X_{1i} + \cdots + \beta_k X_{ki})\right]^2}{\sigma^2} \quad (3)$$

The value of mean WTP is estimated by the following formula [61]:

$$E\left[\overline{WTP}\right] = \phi\left(\frac{\beta_0 + \beta_1 \overline{X}_1 + \cdots + \beta_k \overline{X}_k}{\sigma}\right)\left[(\beta_0 + \beta_1 \overline{X}_1 + \cdots + \beta_k \overline{X}_k) + \sigma \frac{\varnothing\left(\frac{\beta_0 + \beta_1 \overline{X}_1 + \cdots + \beta_k \overline{X}_k}{\sigma}\right)}{\phi\left(\frac{\beta_0 + \beta_1 \overline{X}_1 + \cdots + \beta_k \overline{X}_k}{\sigma}\right)}\right] \quad (4)$$

The marginal effect of the independent variables X_k on the dependent variable WTP is calculated as [62]:

$$\frac{\partial E\left[\overline{WTP}\right]}{\partial X_k} = \beta_k \phi\left(\frac{\beta_0 + \beta_1 \overline{X}_1 + \cdots + \beta_k \overline{X}_k}{\sigma}\right) + \sigma_k \sqrt{\sigma} \varnothing\left(\frac{\beta_0 + \beta_1 \overline{X}_1 + \cdots + \beta_k \overline{X}_k}{\sigma}\right) \quad (5)$$

whereas, σ is the standard error of residuals. ϕ is the standard cumulative normal distribution function. ∅ is the probability density function of the normal distribution.

Results and discussion

Reliability and validity analysis

To condense the information on the components in the TPB and the NAM into a small number of factors, Principal component analysis (PCA) with varimax rotation is used. A threshold value of 0.3 was applied to suppress values with low power in the factor loading analysis [61]. Kaiser–Meyer–Olkin (KMO) and Barlett indicators were employed to check the sustainability of the sample. The PCA results are presented in Table 1.

The Cronbach's alpha scores, which ranged from 0.614 to 0.859 (Table 1), proved that the reliability of the scales was fairly well and that the data were reliable. The result of KMO and Bartlett's test (i.e. KMO values were greater than 0.5 and the p-values were less than 0.001) indicated that the sample has a high degree of adequacy and the PCA is available. The total variances ranged from 52.15% to 72.13%. These results explained a good validity of the scales for indicators (attitudes/awareness of consequences, moral/personal norms, subjective/social norms, perceived inconvenience, e-waste recycling habits, and perceived effectiveness of policy).

Respondents' socio-economic characteristics and perceived e-waste pollution

Of the sampled households who responded to the questionnaire, as shown in Table 2, there were 53.49% of households responded that e-waste pollution was at a polluted level. 26.65% of respondents perceived e-waste pollution as totally polluted status. The age of the respondents ranged from 19 to 66 years old (31.16 years old on average). The respondents were females (63.42%) or males (36.58%). Regarding the education level, the average schooling years of respondents was 15.32. About 40.07% of respondents had a monthly income from 5 to below 10 million VND and 65.07% had home ownership.

Mean WTP and factors affecting WTP for e-waste

Regarding respondents' WTP for e-waste, only 25.55% of respondents expressed their unwillingness to pay an environmental fee for each e-waste (television, computer, mobile phone), while 74.45% were willing to pay. Whereas, 31.99%, 31.07%, and 32.35% of respondents agreed to pay an environmental fee of 1% of WTP for television, computer, and mobile phone, respectively. Table 3 presents the number of

Table 1 Results of the principal components analysis (PCA)

Survey items and principal components	Factor loading	% Variance explained, Cronbach's alpha; KMO; Bartlett
PC1. Awareness of e-waste recycling consequence		$v = 67.96\%$ $\alpha = 0.838$ KMO = 0.802 Bartlett: $p < 0.000$
B4a. E-waste recycling contributes to improve environmental quality	0.855	
B4b. E-waste recycling contributes to create job opportunities for the society	0.765	
B4c. E-waste recycling contributes to ensure the safety of peoples' health	0.860	
B4d. E-waste recycling is everyone's responsibility	0.814	
PC2. Inconvenience of recycling		$v = 56.77\%$ $\alpha = 0.614$ KMO = 0.635 Bartlett: $p < 0.000$
B5f. I do not have suitable transport modes for bringing e-waste to the collection units	0.790	
B5g. I think there are no/very few places collecting e-waste in the areas where I am living and nearly regions	0.712	
B5h. I find it is difficult to categorize e-waste for recycling	0.756	
PC3. E-waste recycling habits		$v = 72.13\%$ $\alpha = 0.623$ KMO = 0.500 Bartlett: $p < 0.000$
B5i. Sorting/sending e-waste to the collection units has become a habit for me	0.911	
B5j. I must participate in the program of e-waste recycling and management as a habit	0.783	
PC4. Perceived policy effectiveness		$v = 52.15\%$ $\alpha = 0.703$ KMO = 0.717 Bartlett: $p < 0.000$
B6d. I have heard/known information about e-waste management from the Government	0.803	
B6e. E-waste collection units which are provided by the Government, are popular in all districts in Ho Chi Minh City	0.812	
B6f. The Government's official information on e-waste recycling help citizens understand the importance of e-waste recycling/management	0.705	
B6g. The environmental protection programs organised by the Government (3 T – Reduce – Reuse – Recycle in sustainable production and consumption) encourage me to recycle/manage e-waste	0.534	
PC5. Personal/ Moral norms		$v = 67.18\%$ $\alpha = 0.764$ KMO = 0.642 Bartlett: $p < 0.000$
B6a. I feel I should not throw away e-waste if it could be reused/ recycled	0.637	
B6b. I would feel guilty if I do not participate in e-waste recycling/management	0.895	
B6c. Not participating in e-waste recycling/management goes against my principles	0.899	
PC6. Subjective/social norms		$v = 70.45\%$ $\alpha = 0.859$ KMO = 0.802 Bartlett: $p < 0.000$
D2a. My family and relatives impact me in e-waste recycling/ management	0.890	
D2b. My friends and colleagues impact me in e-waste recycling/ management	0.895	
D2c. My neighbors and colleagues impact me in e-waste recycling/ management	0.834	
D2d. Media impact me in e-waste recycling/ management	0.728	

respondents that are willing to pay for e-waste recycling. The mean value of WTP was calculated by the weighted arithmetic mean method for television (1.867%), computer (1.917%), and mobile phone (1.945%). Meanwhile, the estimated mean WTPs from the Tobit model following the above Eq. (4) were 1.588% (television), 1.644% (computer), and 1.656% (mobile phone).

Reasons for willing and unwilling to pay for e-waste recycling were presented in Fig. 2. Most respondents thought that recycling e-waste was the enterprises' responsibility (23.92%) and the government's responsibility (18.27%). Lower income (15.61%) and high environmental fee (14.95%) were also important reasons. They thought that payment for e-waste would increase their cost of living in the future. Moreover, at present, respondents earn money from selling e-waste to the second-hand market or collecting agencies (13.29%). Meanwhile, reasons for willing to pay were the importance of human health, families, and communities (21.13%); the clean and safe environment when e-waste was managed (17.71%), saving time to handle e-waste for households (12.24%), reasonable fee to pay (14.23%), households' awareness of the dangers of e-waste for the environment (16.16%), everyone's responsibility for environmental protection (18.40%); and others (0.13%).

Table 4 reports the results of the Tobit model about the factors affecting the respondents' WTP for e-waste recycling. The respondents' social economic characteristics were found to have a significant correlation with their WTP for three electrical and electronic devices (television, computer, mobile phone). Age had a negatively significant relationship with WTP at the 1% significance level for three products. The older people were unwilling to pay for e-waste recycling. This may be because they do not see e-waste as a major contributor to environmental pollution. Meanwhile,

Table 2 The demographic characteristics of respondents and perception on e-waste pollution level

Description	*N*	Percentage	Mean	Std.err	Min	Max
Perceived e-waste pollution level			4.02	0.78	1	5
Total unpolluted	3	0.55				
Unpolluted	19	3.50				
Neutral	86	15.81				
Polluted	291	53.49				
Total polluted	145	26.65				
Demographic characteristics						
Age			31.16	10.04	19	66
Gender			0.63	0.48	0	1
Male	199	36.58				
Female	345	63.42				
Education			15.32	2.33	6	24
Home ownership			0.65	0.48	0	1
Ownership	354	65.07				
Rent	190	34.93				
Monthly income (million VND)			10.46	8.12	1	50
Below 5	87	16.00				
5 – 10	218	40.07				
10 – 15	116	21.32				
15 – 20	54	9.93				
20 or above	69	12.68				

the younger generation used electrical and electronic equipment frequently and was willing to pay [20]. Young people were more knowledgeable about environmental protection and hope to take appropriate approaches to improve their living environment [14].

Home ownership was found to have a positive influence on respondent's WTP for three types of e-wastes. The coefficient and marginal effect of home ownership showed that the residents who owned a house were more likely to pay for e-waste recycling compared to the respondents rented a house.

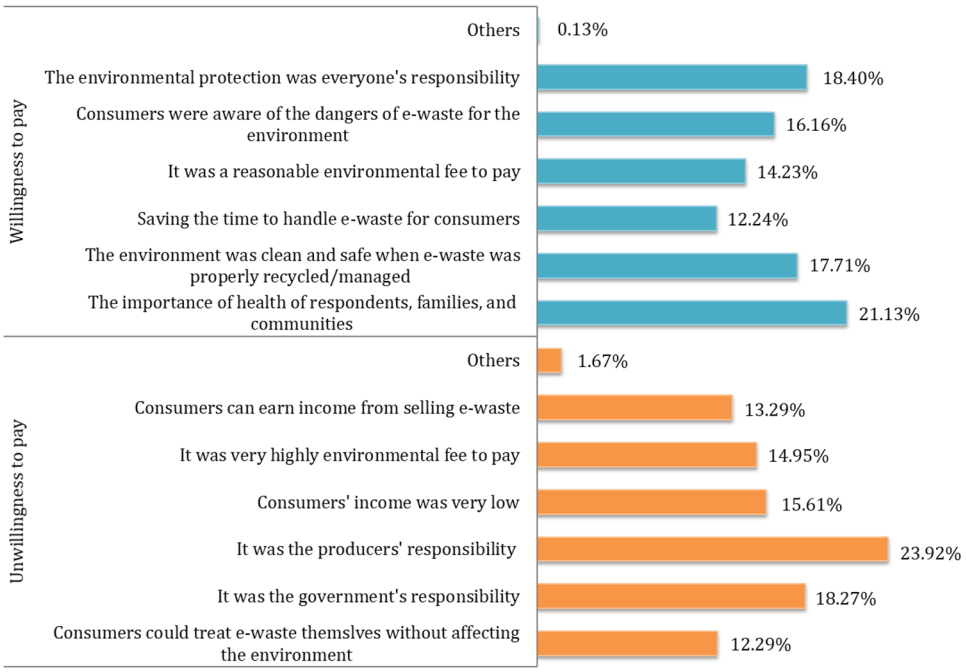

Fig.2 Reasons for willing and unwilling to pay an environmental fee for e-waste

Table 3 Mean WTP from the weighted arithmetic method and Tobit model

Willingness to pay (%)	TV		Computer		Mobile phone	
	The number of respondents	Percentages	The number of respondents	Percentages	The number of respondents	Percentages
0	139	25.55	139	25.55	139	25.55
1	174	31.99	169	31.07	176	32.35
2	78	14.34	68	12.50	63	11.58
3	62	11.40	73	13.42	61	11.21
4	15	2.76	14	2.57	23	4.23
5	56	10.29	58	10.66	61	11.21
6	3	0.55	3	0.55	0	0.00
7	6	1.10	12	2.21	9	1.65
8	5	0.92	4	0.74	3	0.55
9	1	0.18	1	0.18	1	0.18
10	5	0.92	3	0.55	8	1.47
Total	544	100.00	544	100.00	544	100.00
Mean WTP from the weighted arithmetic method		1.867%		1.917%		1.945%
Mean WTP from Tobit model		1.588%		1.644%		1.656%

Income group had a significantly positive correlation with respondents' WTP for e-waste. The results indicated that the higher the monthly income of respondents, the greater their WTP. Respondents earning from 15 to 20 million VND/month were more willing to pay for three items compared to the base group (less than 5 million VND/month). People who had income ranging from 10 to 15 million VND/month were more willing to pay for mobile phone waste at a 5% significance level. A possible explanation is that the high likelihood of higher-income respondents implies their higher awareness of the environment and the dangers of e-waste, so they may be willing to pay more to improve or protect the environment [48]. This result is in line with the findings of Colesca et al. [49], Echegaray and Hansstein [55], Islam et al. [19], and Yin et al. [63], which showed that high-income households were more likely to participate in e-waste recycling and were willing to pay for e-waste. However, the study carried out by Borthakur and Govind [64] in India, indicated that the number of consumers who were aware of e-waste recycling decreases with increasing in income level. Their study concluded that higher income did not necessarily imply a greater environmental responsibility.

Education, however, was found with insignificantly negative coefficients for the three products. This may be related to the lack of clarity about recycling responsibility and insufficient publicity. Respondents with higher education often tend to think that e-waste recycling or management should be the responsibility of the government or the manufacturers. This finding is in line with Cai et al. [27] who indicated that residents with higher education levels refused to pay because they believed that it was the government's responsibility, thereby leading to ineffective practical actions in Zhuhai, China. In addition, Hansmann et al. [65] showed that education was negatively related to environmental recycling behaviour because the preservation of the environment required the contribution of all relevant stakeholders.

Among the key components of the TPB and NAM, subjective/social norms were the most significant predictors for the WTP for the three items (television, computer, and mobile phone). This implies a greater role of society in encouraging the WTP for e-waste recycling. People are more willing to pay for e-waste because they feel guilty about not to pay or feel obligated to pay an environmental fee if they believe that their family members, friends, colleagues, and other people in their community pay an environmental fee for e-waste. These findings supported H_3. This is consistent with the previous research that social and personal norms affect recycling and WTP for e-waste [36]. Echegaray and Hansstein [55] and Najmi et al. [66] also reported that social norms had a positive relationship with willingness to participate in e-waste recycling activities.

Personal/moral norms were also found to have a significantly positive relationship with WTP for e-waste. This implies that respondents' moral obligation to perform WTP for e-waste in the public domain is fundamental to obtain a deeper understanding of their environmental awareness. This finding aligns with Razali et al. [67] who found that moral/personal norms significantly affect waste separation behaviour in Malaysia. Juliana et al. [68] found that residents feel guilty if they do not practice recycling, and not recycling would be contrary to their principles. Psychological factors and intrinsic motivation through moral norms play a crucial role in guiding pro-environmental behaviour among households. Tonglet et al. [43] asserted that someone who believes it is necessary to recycle is more likely to include personal norms in the decision-making of recycling behaviour.

Table 4 Factor affecting the respondents' WTP for e-waste

Variables	Television			Computer (PC, laptop)			Mobile phone		
	Coeff. (std. err)	*P*-value	Mar. (std.err)	Coeff. (std.err)	*P*-value	Mar. (std.err)	Coeff. (std.err)	*P*-value	Mar. (std.err)
C	2.396 (1.437)	0.096		2.805 (1.380)	0.043		2.097 (1.565)	0.181	
Perceived e-waste pollution	*0.406 (0.224)	0.071	0.222 (0.122)	*0.386 (0.214)	0.071	0.219 (0.121)	**0.574 (0.240)	0.017	0.311 (0.129)
Awareness of consequence	0.171 (0.218)	0.433	0.094 (0.119)	0.166 (0.208)	0.426	0.094 (0.118)	0.117 (0.224)	0.602	0.063 (0.121)
Inconvenience of recycling	*−0.278 (0.159)	0.081	−0.152 (0.087)	**−0.328 (0.158)	0.038	−0.186 (0.089)	*−0.316 (0.177)	0.074	−0.172 (0.095)
Personal/ Moral norms	***0.567 (0.206)	0.006	0.311 (0.112)	**0.405 (0.200)	0.043	0.229 (0.113)	**0.518 (0.226)	0.023	0.281 (0.122)
Perceived policy effectiveness	−0.018 (0.197)	0.927	−0.010 (0.108)	0.087 (0.192)	0.653	0.049 (0.109)	0.051 (0.207)	0.806	0.027 (0.112)
E-waste recycling habits	0.180 (0.225)	0.424	0.098 (0.123)	0.189 (0.215)	0.380	0.107 (0.122)	0.099 (0.231)	0.670	0.053 (0.125)
Subjective/ social norms	***0.593 (0.188)	0.002	0.325 (0.102)	***0.601 (0.184)	0.001	0.340 (0.103)	***0.548 (0.201)	0.007	0.297 (0.108)
Age	***−0.079 (0.020)	0.000	−0.043 (0.011)	***−0.084 (0.020)	0.000	−0.048 (0.011)	***−0.100 (0.022)	0.000	−0.054 (0.012)
Gender	−0.322 (0.325)	0.321	−0.177 (0.178)	−0.498 (0.319)	0.119	−0.281 (0.180)	−0.378 (0.342)	0.269	−0.205 (0.185)
Education	−0.104 (0.075)	0.168	−0.057 (0.041)	−0.105 (0.072)	0.144	−0.059 (0.040)	−0.118 (0.081)	0.147	−0.064 (0.044)
Home_ownership	*0.664 (0.353)	0.061	0.364 (0.193)	**0.687 (0.342)	0.045	0.389 (0.193)	*0.740 (0.386)	0.055	0.401 (0.208)
5–10 million VND	−0.177 (0.484)	0.715	−0.097 (0.265)	−0.126 (0.494)	0.798	−0.071 (0.279)	0.212 (0.551)	0.700	0.115 (0.299)
10–15 million VND	0.628 (0.537)	0.243	0.344 (0.194)	0.774 (0.538)	0.151	0.438 (0.303)	**1.280 (0.609)	0.036	0.694 (0.328)
15–20 million VND	*1.244 (0.704)	0.078	0.681 (0.384)	**1.432 (0.670)	0.033	0.810 (0.377)	**1.716 (0.716)	0.017	0.931 (0.386)
Above 20 million VND	0.196 (0.620)	0.752	0.108 (0.040)	0.179 (0.633)	0.777	0.101 (0.358)	0.829 (0.706)	0.240	0.450 (0.381)
Log pseudolikelihood	−770.287			−944.571			−782.434		
F (15, 529)	4.98			4.98			4.28		
Prob > F	0.000			0.000			0.000		
Left censored observations	313			308			315		
Right censored observations	0			0			0		
Uncensored observations	231			236			229		
Pseudo R^2	0.047			0.050			0.045		
Total observations	544			544			544		
Var (e.E2a)	9.836 (1.006)			9.396 (0.897)			11.155 (1.142)		

The values in the brackets are Robust Standard Errors; *; **; *** indicate significance at 10%; 5%; and 1%, respectively

Therefore, the government can make public efforts to foster residences' feeling of moral obligation to recycle e-waste. School education, media campaign and community education could be used to enhance the social desirability and moral correctness of environmental protection.

The negative direction of recycling inconvenience indicated that this was barrier for respondents to participate in e-waste recycling and less likely to pay. The drop-off e-waste centers and facilities were unavailable in the study area, and there were few professional collectors providing e-waste recycling services on the spots. About 47.8% of respondents answered that they did not have adequate means to bring e-waste to the drop-off centers; and 78.5% of respondents indicated that there were no or very few professional collecting and recycling spots in their living and nearby areas. This is in line with the findings of [18] that show that no nearby recycling center was an important factor for being less likely to pay an advanced recycling fee for e-waste in California.

Perceived e-waste pollution had a significant positive impact on the respondents' WTP. Respondents who perceived high pollution of e-waste; were more willing to pay. When people were aware of the dangers of e-waste that directly affect their health and surround their living environment, they will easily accept paying an environmental fee for e-waste.

Perceived policy effectiveness and e-waste recycling habits were two new factors added to the model to examine their effects on the WTP for e-waste in Vietnam. The results showed that there was no significant relationship between these two factors and WTP for e-waste recycling. However, the positive direction of the perceived policy effectiveness with the WTP for computer and mobile phone disposal and the negative relationship of this factor with the WTP for television e-waste highlight that the government's efforts through policy for e-waste should be enhanced. The descriptive statistics showed that about 51.47% of respondents answered that they have heard/known the information about e-waste collecting/recycling and management from the government. Additionally, around 70.40% of respondents agreed that the government's official information on e-waste recycling and management helped them understand and be aware of the importance of e-waste recycling. This result is in contrast with the findings of Borthakur and Govind [64] that 95.8% of residents were unaware of any formal recycling channels. However, about 43.83% of respondents disagreed with the statement "E-waste collection units which are provided by the Government, are popular in all districts in Ho Chi Minh City". This indicated that the government's policies of e-waste recycling have not been widely and effectively disseminated to the general public. Therefore, the government should make an effort to disseminate relevant information about e-waste laws, policies, and recycling channels to residents. Arain et al. [69] reported that proposing effective policies for e-waste recycling focused on raising public awareness of formal recycling facilities and methods. Wang et al. [37] also concluded that the information and knowledge of formal e-waste recycling methods and channels promoted residents' participation in recycling. Furthermore, despite insignificant impacts, the positive coefficients of e-waste recycling habits implied that education for children should be considered as an indispensable task for the long-term development of an e-waste management system. Families with a recycling culture are more likely to recycle e-waste. Developing recycling habits is a long process [49]. Therefore, students should be educated about the importance of sustainability, environmental protection, and pollution at a young age. Dwivedy and Mittal [23] also emphasized that recycling habit could be cultivated by projecting the concept of environmental protection and sorting household waste at home to impressionable young minds beginning in primary school.

Conclusions and policy considerations

Recycling of e-waste in Vietnam is still in its initial stages. And the serious pollution effects of e-waste have become a potential threat to human health and the environment. With the purpose of developing new and effective policies for e-waste recycling, the findings of this study are useful for understanding the role of customers in e-waste recycling, the customers' WTP for e-waste recycling, for policy-makers and could be used to promote the recycling of e-waste. This paper contributes to develop an effective e-waste management system at the consumer level. The study estimates the mean WTP for e-waste, examine and presents the combination of the TPB and the NAM that can successfully predict respondents' WTP for e-waste recycling.

The findings of the integrative model provided both theoretical and practical implications for studying social-economics and psychological determinants of customers' willingness to pay for e-waste recycling in particular and waste management in general. Personal norms and subjective norms were found to have a significant impact on the respondents' WTP for e-waste recycling. This implies that the feeling of personal moral obligation played an important factor in determining individuals' behavior for e-waste recycling. Furthermore, other people's expectations and their actual environmental behavior would influence a person's evaluation and perception about the behavior whether it was morally right. Therefore, this study provided a useful and comprehensive framework for explaining pro-environmental behavior by combining TPB and NAM factors.

In terms of practical implications, the Tobit model results indicated that the respondents were willing to pay about 1.588% (television), 1.644% (computer), 1.656% (mobile

phone) of the purchasing bills. However, a modest environmental fee could be insufficient to cover the current recycling cost for e-wastes. Thus, the responsibility of producers, consumers, retailers should be considered to take advantage of economies of scale and design effective policies for e-waste management in the future. Perfect laws and policies should also be considered by the government to clarify the main responsibilities of relevant stakeholders for e-waste recycling. Furthermore, obsolescent recycling technologies should be replaced. The proper infrastructure for e-waste recycling needs to be built towards caring for the environment and health issues.

Regarding psychological factors, subjective/social norms and personal/moral norms had a significantly positive influence on the respondents' WTP for e-waste recycling. Therefore, the government can enhance its publicity efforts via creating a social atmosphere for e-waste recycling through online channels such as news and public service advertisements and offline media (i.e. community and neighborhood committees). The authorities could cooperate with schools and universities in educating the young generation about recycling habits through a compulsory course in environmental protection. Through these useful channels, knowledge about environmental protection may be disseminated and a pro-environmental social climate can be built. The formation of subjective norms contributes to the development of higher levels of personal norms, which would considerably enhance residents' e-waste recycling and environmental protection behaviour.

The perceived inconvenience of e-waste recycling was a barrier for the residents' WTP. Thus, the e-waste recycling infrastructures or facilities should be highlighted in the first step as the foundation for the e-waste management system. The perceived e-waste pollution was found to have a significantly positive association with the respondent's WTP. Therefore, public information and educational campaigns could be enhanced to increase public awareness of relevant laws and of the adverse environmental consequences of improper disposal of e-wastes, which may increase the support for environmental fee.

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Declarations

Conflict of interest The authors declare no conflict of interest.

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