INDERSCIENCE PUBLISHERS
Linking academia, business and industry through research

International Journal of Environment and Waste Management

ISSN online: 1478-9868 - ISSN print: 1478-9876
https://www.inderscience.com/ijewm

Factors affecting community participation in an e-waste recycling program

Hong Thi Thu Nguyen, Chun-Hung Lee, Hang Thi Thu Nguyen, Thi Thanh Thuy Phan, Van Viet Nguyen, Rern-Jay Hung

DOI: 10.1504/IJEWM.2023.10051889

Article History:
Received: 13 January 2022
Accepted: 29 August 2022
Published online: 30 December 2024

Factors affecting community participation in an e-waste recycling program

Hong Thi Thu Nguyen

Faculty of Chemistry,
The University of Danang – University of Science and Education,
Le Duan Road, Danang 550000, Vietnam
Email: ntthong@ued.udn.vn

Chun-Hung Lee

Department of Natural Resources and Environmental Studies,
College of Environmental Studies and Oceanography,
National Dong Hwa University,
Hualien 97401, Taiwan
Email: chlee@gms.ndhu.edu.tw

Hang Thi Thu Nguyen

Department of Academic Affairs,
Danang University of Medical Technology and Pharmacy,
Hung Vuong Road, Danang 550000, Vietnam
Email: thuhang119@gmail.com

Thi Thanh Thuy Phan

Department of Natural Resources and Environmental Studies,
College of Environmental Studies and Oceanography,
National Dong Hwa University,
Hualien 97401, Taiwan
and
Faculty of Natural Resources and Environment,
Dong Nai Campus,
Vietnam National University of Forestry,
Bien Hoa 810000, Dong Nai, Vietnam
Email: pttthuy@vnuf2.edu.vn

Van Viet Nguyen

Department of Natural Resources and Environmental Studies,
College of Environmental Studies and Oceanography,
National Dong Hwa University,
Hualien 97401, Taiwan
and
Faculty of Silviculture,
Dong Nai Campus,
Vietnam National University of Forestry,
Bien Hoa 810000, Dong Nai, Vietnam
Email: nvviet@vnuf2.edu.vn

Rern-Jay Hung*

International Bachelor Degree Program in Finance,
National Pingtung University of Science and Technology,
Pingtung 91201, Taiwan
Email: bruce@mail.npust.edu.tw
*Corresponding author

Abstract: In the process of moving towards a sustainable society and circular economy, the recycling of e-waste has been an indispensable target for all nations from the perspectives of environmental protection and resource utilisation. As citizens are considered key implementers in the recycling system, the study aims to grasp factors affecting community participation in the e-waste recycling program in Vietnam. The logistic regression model was used to analyse the data of 600 household members collected via face-to-face interviews. The results suggest that 'abstract norms' and 'conveniences and incentives' are the most important indicators in positively explaining recycling participation. It is also detected that only income has a significant influence on residents' decision whether to be involved in e-waste recycling. This study is expected to share necessary information to policymakers, especially, for some countries whose e-waste regulations are under revision, aiming to ensure environmentally sound management of hazardous waste and circular economy.

Keywords: community participation; e-waste recycling; abstract norms; conveniences and incentives; circular economy; sustainable development goals.

Reference to this paper should be made as follows: Nguyen, H.T.T., Lee, C-H., Nguyen, H.T.T., Phan, T.T.T., Nguyen, V.V. and Hung, R-J. (2025) 'Factors affecting community participation in an e-waste recycling program', *Int. J. Environment and Waste Management*, Vol. 36, No. 1, pp.95–110.

Biographical notes: Hong Thi Thu Nguyen is a Lecturer at The University of Danang, University of Science and Education, Vietnam. She received her PhD in Environmental Science and Management from International College, National Pingtung University of Science and Technology, Taiwan in 2021. Her research interests include water treatment, waste management, and environmental policy and management. Her current work focuses on the consumers' behaviour, intention, willingness, and preference toward waste recycling.

Chun-Hung Lee has worked in the Department of Natural Resources and Environmental Studies, National Dong-Hwa University, Taiwan, and focused on the economics evaluation for the ecotourism and ecosystem services based on the methodology of ecological economics. He published seven SSCI papers, one Econlit, 17 TSSCI papers, and joined over 37 international conferences. He got 18 Ministry of Science and Technology Projects, and 19 research projects from government in Taiwan. He will extend the topics to environmental valuation and sustainability and sustainable tourism, and have a chance to apply the methodology of ecological economics in Thailand, Indonesia, Vietnam, China, Nepal, and the USA.

Hang Thi Thu Nguyen is a Lecturer at Danang University of Medical Technology and Pharmacy, Vietnam. She received her Master's in Organic Chemistry from the University of Danang, Vietnam in 2012. She is interested in doing research that is related to organic chemistry, organic contaminants from e-waste, and health consequences of exposure to hazardous substances in e-waste.

Thi Thanh Thuy Phan is currently a PhD student in Department of Natural Resources and Environmental Studies, College of Environmental Studies and Oceanography, National Dong Hwa University. Her research has been focused on waste management.

Van Viet Nguyen is a PhD student in Department of Natural Resources and Environmental Studies, College of Environmental Studies and Oceanography, National Dong Hwa University. His research has been focused on the management, conservation and sustainable development of natural resources.

Rern-Jay Hung is a Professor and the Chair of International Bachelor degree Program in Finance, National Pingtung University of Science and Technology, Taiwan, where he teaches corporate finance, investments, and project evaluation. He has published 34 journal papers, covering financial markets volatility and microstructure, futures and options pricing and hedging, and sustainability related issues. He has also published nine books covering the topics of project evaluation and wealth management. He has implemented more than 58 research projects, where most of them are investment project evaluation related and also serves as a financial consultant for the government.

1 Introduction

An ever-alarming electrical and electronic equipment waste (e-waste) production is a thorny problem in contemporary societies and its proper management has caused a significant challenge for most countries around the world. The United Nations (UN) reported that the global generation of e-waste was approximately 53.6 million metric tonnes (Mt) in 2019 with an estimation to reach 74.7 Mt by 2030 (Forti et al., 2020). Faced with this serious issue, along with the traditional technical solutions, for example, disposal through incineration or in landfills, the development of the recycling approach has been considered a promising effective method for environmentally sound management. Recycling benefits both the environment and the economy by minimising the amount of waste that delivers to incineration or landfills and enabling the process of transforming old materials into new products, which harmonises with the concept of

circular economy (Shevchenko et al., 2019). It also contributes to the achievement of sustainable development goals, particularly, goal 12 that aims to "ensure sustainable consumption and production patterns" (UN, 2016).

However, the statistics released by the UN showed that the percentage of e-waste recycled globally was only 17.4% in the year of 2019, particularly, only 11.7% of e-waste was formally collected and properly recycled in Asia where the majority of the e-waste has been generated (Forti et al., 2020). The very low recycling rate in Asia may relate to several aspects such as politics, economics, culture, society, and legislation. One of the key identified barriers is the lack of public cooperation in returning obsolete electronic products for recycling (Tanskanen, 2013). In fact, it is inevitable that community involvement is of greatest importance to the success of the recycling scheme, which is heavily reliant on the willingness of householders to do recycling (Darby and Obara, 2005; Fraige et al., 2012; Shevchenko et al., 2019). Therefore, an emphasis should be placed on strategies linked to enhancing individual and societal behaviours in favour of recycling (Vicente and Reis, 2008).

Recent researches have been conducted with the aim of understanding which factors affect community's willingness to participate in recycling and the results are diverse (Colesca et al., 2014; Gonul Kochan et al., 2016; Jafari et al., 2017; Qu et al., 2019; Siringo et al., 2020; Vicente and Reis, 2008). Several empirical studies have suggested various determinants, such as legislative policies (Pandebesie et al., 2019), consultancy (Siringo et al., 2020), conveniences (Miliute-Plepiene et al., 2016), incentives (Jafari et al., 2017), individuals' responsibility and awareness on environmental protection (Tanskanen, 2013), can be used to explore e-waste recycling behaviour. In addition, evidence showing the importance of socio-economic and demographic variables toward recycling were also obtained in researches by Nnorom et al. (2009), Song et al. (2012) and Zhong and Huang (2016).

Like most of the developing countries in Asia, Vietnam is experiencing significant challenges in the application of sustainable e-waste recycling management (Trung, 2020). Vietnam currently lacks official statistical data on e-waste generation. According to estimates by the UN, Vietnam generated around 257,000 tonnes of e-waste annually, at a rate of 2.7 kg/person in 2019, which has not included the huge amount of undetected e-waste rooted from illegal importation (Forti et al., 2020; Herat, 2021). Currently, e-waste management is mainly informal market-driven, which causes a big concern on the risk to human health and the environment. Struggled with the tremendous expansion of e-waste quantity and the inefficiency of e-waste management, the Vietnamese National Assembly has recently passed a new law on environment protection (called Environment Protection Law 2020), which has introduced a new management regime for solid wastes, including the application of extended producer responsibility (EPR) policy approach to promote recycling businesses to form a circular ecosystem. This year, for the first time, the important role of residents involved in waste recycling is highly emphasised and specific regulations set on e-waste recycling is introduced in the draft decree that is currently open for public comment. The worse situation of e-waste, therefore, is expected to improve thanks to the innovation of proposed new rules that will be implemented in Vietnam from 2024.

Despite remarkable progress, there is still a concern among Vietnamese authorities on the difficulty of how to encourage citizens to participate in e-waste recycling. Lessons gained from other developed countries showed that the high rate of community involvement is the key factor driving to successful EPR enforcement (Shevchenko et al.,

2019; Tanskanen, 2013). Nevertheless, very little has been done to assess the willingness of the community to participate in the e-waste recycling scheme in Vietnam and other developing countries as well (Nguyen et al., 2018; Dhir et al., 2021). The present research, therefore, aims to identify factors influencing the publics' participation in the proposed e-waste recycling scheme using a logistic regression model. Several factors are studied:

1 abstract norms that include norms of environmental protection and norms of law compliance

2 conveniences and incentives

3 socio-economic and demographic variables such as gender, age, and income.

Diagnosing the effect of each mentioned factor on the community's propensity toward e-waste recycling gives an insight into supporting future strategies aimed at fulfilling the goals of sustainable development and circular economy. The paper is prepared at a time when the Vietnamese Government is looking for suggestions on the new waste recycling approach that is currently revising in order to enhance the efficiency of EPR implementation; thus, the current study's findings may provide insights to those who are working for establishing systems for e-waste recycling.

This paper is organised as follows. The next section will be the description of the methodology, followed by the presentation of results and discussion. Finally, the conclusion and future recommendations will be presented.

2 Methodology

2.1 The selection of explicative variables and hypotheses development

There are several important variables influencing the community in participating in the e-waste recycling strategy, such as abstract norms, convenience infrastructures, and incentives (Babcock, 2009; Jafari et al., 2017; Pandebesie et al., 2019; Siringo et al., 2020; Tanskanen, 2013). It has been reported that abstract norms have enormous potential to favour behaviours related to energy conservation (Babcock, 2009; Vandenbergh and Steinemann, 2007); however, there has been less previous evidence showing the connection between the norm and individuals' perception of e-waste recycling. The most typical abstract norms are norms of environmental protection and norms of law compliance (Babcock, 2009). The importance of legislation attributes in interpreting the propensity to participate in the e-waste recycling scheme has been examined but the findings are inconsistent. Research by Pandebesie et al. (2019) found that regulation was a positive influence on recycling participation, while Wang et al. (2011) and Saphores et al. (2012) revealed a non-significant correlation between knowledge of e-waste laws and residents' engagement. Consulting services that provide the public with knowledge and skills to get better information on how to dispose of used electronic devices safely and properly have been also proved an important factor promoting their involvement in recycling (Cooper and Mayers, 2000; Siringo et al., 2020; Tanskanen, 2013). In terms of personal environmental responsibility, Tanskanen (2013) stated that positive individuals' attitude towards recycling of e-waste, which indicated their role and awareness on optimum recovery of the material contained in e-waste, was

crucial for augmenting the efficient and successful recycling process. From these points of view, the following hypothesis is proposed:

Hypothesis 1 (H1) Abstract norms positively affects the community's propensity to participate in e-waste recycling.

Previous studies also revealed that convenient access to recycling facilities had a significant effect on recycling participation. Sufficient and appropriate collection infrastructures in aspects of collection modes, collection distance, and collection frequency have been considered key important points motivating the community to participate in the e-waste recycling scheme (Darby and Obara, 2005; Miliute-Plepiene et al., 2016; Siringo et al., 2020). Nnorom and Osibanjo (2008) and Jafari et al. (2017) stated that offering economic incentives increased resident participation in the recycling program, while Nduneseokwu et al. (2017) argued that there was no correlation between incentives and recycling commitment. With regard to this concept, this study propose the following hypothesis:

Hypothesis 2 (H2) Conveniences and incentives positively affect the community's propensity to participate in e-waste recycling.

Among socio-economic and demographic variables, gender, age, and income have shown contradictory results on the relationship with the community's propensity to participate in e-waste recycling (Vicente and Reis 2008). In this research, their correlations with residents' recycling decisions will be scrutinised and the following hypotheses are proposed:

Hypothesis 3 (H3) Gender affects the community's propensity to participate in e-waste recycling.

Hypothesis 4 (H4) Age affects the community's propensity to participate in e-waste recycling.

Hypothesis 5 (H5) Income affects the community's propensity to participate in e-waste recycling.

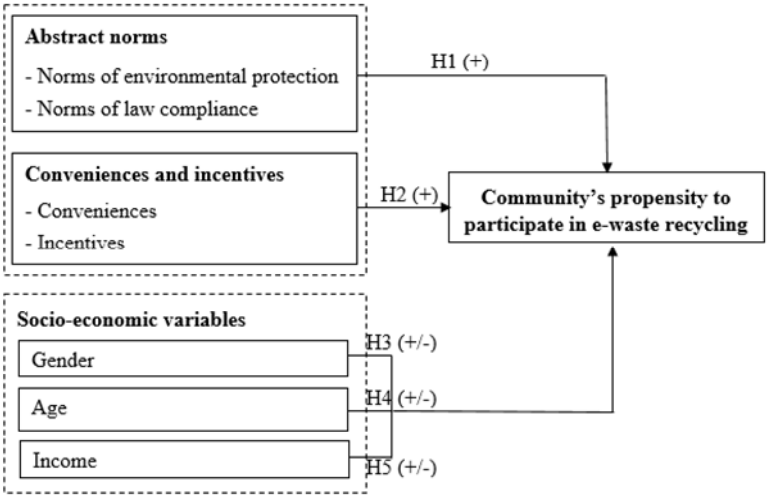
Based on the above-discussed factors, this study will focus on exploring the effect of abstract norms (norms of environmental protection and norms of law compliance), incentives and conveniences (collection mode, collection distance, and collection frequency), and socio-economic variables (gender, age, and income) on community's participation. The research proposed hypotheses are demonstrated in Figure 1.

2.2 Questionnaire design

The questionnaire consists of three major sections, written in Vietnamese language, concerning the disposal of five large electronic devices such as, refrigerators, air conditioners, washing machines, televisions, and desktop computers, beginning with the brief description designed to explain the concept of the survey and relevant information related to e-waste. Its aim is to provide respondents with a clear outlook of the questionnaire's content, which helps them to decide whether to continue doing a survey or not. The following section covers a set of eight items designed to measure the importance of various above-selected variables. Five-point Likert scale is employed to measure the important levels, ranging from 1 = very unimportant, 2 = unimportant, 3 =

neutral, 4= slightly important, 5 = very important. The items were constructed on the basis of the previous studies' findings (Babcock, 2009; Qu et al., 2019; Siringo et al., 2020; Wang et al., 2016). The question of whether respondents decide to participate in recycling e-waste (Yes, I am willing to participate in the proposed e-waste recycling program or No, I am not willing) is added at the end of Section 2 of the questionnaire. The third section gathers respondents' identities, including gender, age, and income.

Figure 1 Research model



To evaluate the feasibility of the questionnaire, the pilot study was carried out prior to a larger study. After gathering information from ten volunteers who participated in this test, it was confirmed that the main study is feasible without changes to the proposed questionnaire.

2.3 Sample and data collection

The study was conducted in Danang that is a class-one municipality located in the central coast region of Vietnam. It covers eight administrative areas, including six urban districts (Hai Chau, Thanh Khe, Cam Le, Son Tra, Ngu Hanh Son, and Lien Chieu) and two rural districts (Hoa Vang and Hoang Sa). According to the information announced in the official website of Danang government, Danang has been home to roughly 1.17 million people, with GDP per capita was at 2,283 USD in the year 2021 (https://www.danang.gov.vn/chinh-quyen/chi-tiet?id=712&_c=49,50,51). The city's leaders are strategising the master plan by 2035, with a vision towards 2050, aimed at turning Danang into a green, sustainable, and circular economy hub. However, there is so far no formal and proper e-waste management implemented in Danang. Therefore, to complete the above-proposed mission, proper e-waste management approaches should be the top priority; thus, the current research focusing on local residents' perspectives toward e-waste recycling is necessary and appropriate, which may be relevant to those who are affected by actions a voice to influence decisions.

The research's questionnaires were distributed to community members' homes for more than one month from the end of 2020. Representatives from each household of six

urban districts were invited to participate in the survey via a face-to-face interview. Among 625 participants, 606 questionnaires were filled completely, yielding a response rate of 96.96%. After data cleaning, 6 answers were unqualified, ensuring that 600 samples were valid for further analysis.

2.4 Statistical data analysis

This research preliminarily adopted exploratory factor analysis (EFA) and reliability test by using Statistical Packages for Social Sciences (SPSS, version 22, IBM Corp., Armonk, NY). Firstly, EFA was performed to seek the underlying structure of a set of eight items covered in the questionnaire. The main quality indexes involved in EFA used in this study are:

1 assessing the suitability of the sample for EFA that includes the Kaiser-Meyer Olkin (KMO) measure of sampling adequacy (> 0.70) and Bartlett's test of sphericity (significant at $p < 0.001$)

2 rotation (varimax)

3 eigenvalue (> 1) or percentage of variance explained (> 50%)

4 factor loadings (> 0.50) (Hair, 2010).

To check the reliability of Likert scale questions, the test of Cronbach's alpha was used and its acceptable value was in the range of (0.45–0.98) (Maskey et al., 2018; Streiner, 2003), in particular, it has been reported that the value of greater than 0.6 is commonly accepted (Hair, 2010).

The dependent variable used in this study is "community's propensity to participate in e-waste recycling" in a binary form; hence, it is reasonable to employ a logistic regression model in order to explore its relationship with exploratory factors that were extracted from EFA. The performance of the model is evaluated and diagnosed as follows:

1 Omnibus test used to check the new model (with explanatory variables included) is an improvement over the baseline model (p-value of Chi-square tests < 0.05)

2 Hosmer and Lemeshow test of the goodness of fit (small Chi-square values with large p-values >0.05)

3 the explanatory power of the model, represented by a percentage of well-classified cases (Vicente and Reis, 2008).

3 Results and discussion

3.1 Respondents' demographic profile

The detailed information of respondents' identities is summarised in Table 1. Around two-thirds of the interviewees were male (62.5%), indicating that most of the households' heads participated in this survey. The sample consisted of people being older than 18 years old, with more than half of them (345 out of 600) were in the range from 18 to 30 years old, which nearly doubled those who aged (31–50) years old, making the

participation of persons whose ages being higher than 51 years old was the least (composing of only 10.67%). The result of average income in this study showed that there were nearly 54% of the households had lower or equal 6 million Vietnamese Dong (VND) per month, while the rest of them earned more than that. This is consistent with the report of the General Statistics Office (GSO, 2021), which shows that the monthly household income of citizens living in urban areas was at 5.6 million VND in the year of 2020.

Table 1 Respondents' demographic profile

Variable	*Frequency (respondents)*	*Percentage (%)*
Gender		
Female	225	37.50
Male	375	62.50
Age (years old)		
18–30	345	57.50
31–50	191	31.83
More than 51	64	10.67
Household monthly income (VND)*		
Lower or equal 6 million	323	53.83
More than 6 million	277	46.17
Total	600	100.00

Note: *1 VND is approximately 0.000044 USD.

Table 2 Results of EFA (KMO = 0.790, Bartlett: $p < 0.0001$)

Components	*Loadings*	*% of variance explained*	*Cronbach's alpha*
Component 1: Abstract norms		27.664	0.627
Item 1: Obeying and respecting the law	0.764		
Item 2: Being acquired information related to e-waste recycling and how to recycle	0.708		
Item 3: Having personal environmental responsibility	0.562		
Item 4: Concerning pollution reduction and resource conservation	0.553		
Component 2: Conveniences and incentives		23.992	0.550
Item 5: Being satisfied with the collection distance provided	0.838		
Item 6: Receiving incentives (cash, voucher, gift, reward points,…)	0.626		
Item 7: Being satisfied with the collection mode offered	0.576		

3.2 Factor analysis

The performance of EFA with eight initial items is presented in Table 2. One of the items that illustrated the convenience of collection frequency was removed because its factor loading was less than 0.5, resulting in seven items left, which allowed two main components to be extracted and account for almost 52% of variance explained (KMO = 0.790, Bartlett: $p < 0.0001$). The new dimensions are labelled as follows: Component 1 – 'Abstract norms' and Component 2 – 'Conveniences and incentives', whose Cronbach's values are 0.6227 and 0.550, respectively. The former component covers environmental norms and norms of law compliance. The latter is a set of accessibilities and stimuli that support and motivate individuals to recycle e-waste.

3.3 Factors influencing community's propensity to participate in the e-waste recycling scheme

The logistic regression model contains three groups of explanatory variables:

1 abstract norms

2 conveniences and incentives

3 socio-economic and demographic variables including gender, age, and income.

The dependent variable in this study is the community's propensity to participate in e-waste recycling, which is coded as '1 = willing to participate' and '0 = unwilling to participate'. Details are illustrated in Table 3.

Table 3 Definitions, descriptions, and codes for variables entering the analysis

Variable	*Description*	*Data type*	*References*
Dependent variable			
Community's propensity to participate in e-waste recycling	0 = 'No, I am not willing to participate in the proposed e-waste recycling program'. 1 = 'I am willing to participate in the proposed e-waste recycling program'.	Discrete (binary)	
Independent variables			
Abstract norms	Mean value of (item 1, item 2, item 3, item 4)	Continuous	Babcock (2009), Qu et al. (2019), Siringo et al. (2020), Wang et al. (2016)
Conveniences and incentives	Mean value of (item 5, item 6, item 7)	Continuous	
Gender	0 = 'female', 1 = 'male'	Nominal	
Age (years)	0 = '18-30' , 1 = '31–50', 2 = '>51'	Nominal	
Monthly income (million VND per month)	0 = '<=6, 1 = '>6'	Nominal	

For checking whether the new model with the inclusion of explanatory variables has a better performance over the baseline model, Chi-square tests are used in the Omnibus test of model coefficients. The result in Table 4 shows that Chi-square is highly significant,

with the value of 65.92, df = 6, p < 0.0001, indicating the accuracy of the model improves when explanatory variables are included. With regard to the Nagelkerke R^2, its value equals 0.156, suggesting that the model explains 15.6% of the variation in the outcome. Moving on, the Hosmer and Lemeshow test of the goodness of fit reveals the model is a good fit to the data as p = 0.778 (much greater than 0.05). In addition, the percentage of correctly classified cases in the new model shows a slight increase to 78%, compared to that of 76% in the null model.

Table 4 Coefficients of the logistic model explaining community' propensity to participate in e-waste recycling

Exploratory variables	*β*	*Exp(β)*	*p-value*
Abstract norms	*0.837*	*2.310*	*0.000*
Conveniences and incentives	*0.328*	*1.389*	*0.037*
Gender _'male'	–0.178	0.837	0.435
Age_base = '(18-30) years old'			
Age_'(31-50) years old'	–0.071	0.932	0.766
Age_'more than 51 years old'	0.595	1.812	0.168
Income_'more than 6 millions VND'	*–0.557*	*0.573*	*0.010*
Constant	–2.898	0.055	0.000
–2LL		595.369	
		$\chi^2 = 65.92$, df = 6, p < 0.0001	
Nagelkerke R^2		15.6%	
Hosmer and Lemeshow test		p = 0.778	
Classification accuracy		78%	

The paramount part that reveals the relationship between explanatory variables and the outcome is presented in Table 4. It can be seen from the result that both abstract norms and conveniences and incentives have statistically significant positive influences on the community's willingness toward e-waste recycling. With its coefficient of 0.837 (p-value < 0.000), abstract norms are observed to be more robust than conveniences and incentives (0.328, p-value = 0.037) in explaining the propensity of individuals' participation. Specifically, a positive effect of abstract norms confirms the importance of environmental protection and law compliance norms in motivating the community to get involved in recycling activities. Looking at the outcome of the odds ratio, it can be seen that with a one point increase on the five-point abstract norms, there is an increase in the odds of recycling participation by a factor of 2.31 or 131%. This is in agreement with earlier investigation outcomes, which stated that there was a strong positive correlation between e-waste recycling intention with governmental regulation and information provided (Darby and Obara, 2005; Pandebesie et al., 2019; Siringo et al., 2020; Vicente and Reis, 2008). In fact, it is clear that once householders have better knowledge of the benefits of recycling actions and how to do recycling, the awareness of environmental protection will be naturally improved in their minds, which can also be reinforced by the commitment to comply with regulations related waste recycling. Therefore, consulting the community about the information on why and how to do recycling will effectively promote the publics' involvement in recycling. It is also stated that people need assistance and consultancy which helps to enhance their skills in doing recycle

(Pandebesie et al., 2019). Residents who are well informed on how to recycle have a higher tendency to get involved in recycling than those without being informed. In the context of Vietnam, as the observation during this research's survey, some Vietnamese people have knowledge on the harmful effects of e-waste on the environment and human health; however, they do not know how to discard their used electronic products properly. Hence, besides strengthening the community's awareness and responsibility on environmental protection, what needs to be done is to provide citizens with clear guidelines on e-waste management and apprehensible instructions on how to recycle properly. To achieve this goal, two important targets should be set; the first one is to consolidate environmental law and regulations specified on e-waste management; the second one is to establish communication campaigns focused on providing the community with necessary information on e-waste recycling. These measures are expected to arouse the abstract norms among residents, which drives them to actively join in recycling activities.

Another observation from this study is that the feasible involvement of publics in e-waste recycling is significantly influenced by conveniences and incentives. To be more specific, for each one-point interval increase, those who have higher expectations on the component of conveniences and incentives will be 1.4 (1.389) times more likely to engage in recycling. This emphasises the power of convenience in motivating people to participate in recycling, which was also reported in the literature (Miliute-Plepiene et al., 2016; Siringo et al., 2020; Tanskanen, 2013). If the question of how and why to do e-waste recycling is discussed above, here, the issue of where to discard obsolete electronic equipment is a big challenge. The development of the collection strategy that focuses on collection methods and collection infrastructures is considered the best solution to deal with this problem (Tanskanen, 2013). The study of Sidique et al. (2010) pointed out that an improvement in conditions of waste collection such as accessibility of collection sites, recycling bins and services was the important way to get more public recycling cooperation. On the one hand, a review on which collection methods, pick-up and/ or drop-off should be applied is of vital importance (Bai et al., 2018; Nixon and Saphores, 2007). On the other hand, the design for the location of recycling sites should also be calculated carefully by optimising the proximity that end-users need to travel to discard their used devices. Opposite to the findings of Nduneseokwu et al. (2017), the importance of incentives is proven to be a factor affecting residents' participation in this study, which is consistent with the results of Jafari et al. (2017). It is true in the reality of Vietnam where the majority of people have a habit of selling used electronic products to informal agents with the aim to get economic benefits. However, in countries under the process of developing like Vietnam, economic stimulus is really a big challenge faced by the government and relevant stakeholders. An example of this is the experience from a program called 'Vietnam recycles', the first free e-waste take-back and recycling program initiated by electronic manufacturers (Apple Vietnam and Hewlett-Packard Technology Vietnam Company). Although 'Vietnam recycles' is making big efforts to achieve the maximum collection rate of e-waste, it is struggling with the difficulty in encouraging people to voluntarily bring used electronic equipment to collection points; as a result, the number of households' involvement is still not as expected. The effort to create a sustainability-minded society is believed to be one of the best suggestions to tackle this difficulty. In fact, Vicente and Reis (2008) concluded that with a firm conviction about the better environment gained through recycling and the sense of responsibility of collaboration among the community, incentives become of lesser

importance. Overall, the issues of incentives should be discussed carefully to get reasonable solutions, which may lead to a great chance of encouraging the publics to participate in the proposed recycling program.

The significant influence of individuals' socio-demographic factors in explaining recycling participation has also been scrutinised; however, the findings are contradictive (Colesca et al., 2014; Vicente and Reis, 2008). Zhong and Huang (2016) investigated that except for age, most of the individuals' characteristics such as gender, education, income were not the determinants of household recycling collaboration. On the contrary, in another research carried out by Song et al. (2012), age, education, and family income were significant factors affecting e-waste behaviour. These contradictory results can be explained by the fact that the political, economic, cultural, and social peculiarities of each nation may cause the difference in which factors affect people's engagement in recycling (Colesca et al., 2014). In this study, only income, among three examined variables, is a significantly influential factor in predicting households' readiness to cooperate with recycling. To be precise, results in Table 4 demonstrates a negative correlation between income and recycling participation with the coefficient of –0.557 and significant at 1% level. As the low-income group is set as a reference category, the negative coefficient implies that increasing average monthly income is associated with decreased odds of participating in e-waste recycling. Meanwhile, families with an income of more than 6 million VND per month are 42.7% less likely to recycle than those whose income being equal to or less than 6 million VND/month. This similar interesting finding was also demonstrated in previous reports of Hadler and Haller (2011) and Echegaray and Hansstein (2017) who expressed that income was negatively associated to the likelihood of community to do recycling. The possible explanation for this observation is that the high-income group may face the difficulty of time-required spent in recycling e-waste (Van Beukering and van den Bergh, 2006). Furthermore, in the Vietnamese context, it may relate to the fact that the majority of people who are living in low or medium economic condition would like to return their old electronic products with the hope of gaining incentives, being similar to what they have been received when selling those devices to informal sectors.

4 Conclusions and policy implications

Faced with the globally booming e-waste generation, there is an urgent need to find solutions for effective environmental sound management of e-waste. One of the favourite strategies is recycling that can optimise the whole value chain to achieve the best performance for the sustainable environment and the economic recovery of valuable material for reuse. By detecting determinants of a community's recycling participation in a Vietnamese urban area, this study gives insights into better e-waste practices among households. It is found that abstract norms referring to environmental protection norms and norms of law compliance are the most important driver motivating citizens' involvement in e-waste recycling. This finding highlights the fundamental role of individuals in ensuring the efficiency and success of the whole recycling process. This means that a new set of priorities should be placed with the aim to enhance public understanding of environmental benefits, regulations, and guidelines associated with e-waste recycling. Another primary factor that can explain households' participation in recycling comes from the conveniences and incentives. The introduction of a suitable

system to collect e-waste, which is focused on the modes of collection and the location of collection points, is the triggers to get more public interest in e-waste recycling. Under this condition, e-waste stakeholders should take this opportunity to gain the success of launched e-waste recycling initiatives, especially in the process of collection that requires high participation from the consumer's side. Regarding socio-economic characteristics, the research's finding shows that only income has a significant influence on residents' decision whether being involved in e-waste recycling. The interesting observation is that families who have a higher amount of monthly income are less likely to join in recycling than those with lower or equal 6 million VND per month. This paradox may be caused by the fact that the high-income people have no time to do recycling. Therefore, the strategic programs that focalise on flexible and accessible facilities can help to improve increase the participation rate of this class of society.

Based on the aforementioned results, the overall target for a comprehensive e-waste management plan should be the formation of a sustainable recycling society and circular economy. This involves building up vigorous mechanisms and infrastructures supporting the process of collection and recycling, along with continuous efforts to raise public awareness. More extensive investigations should be examined widely to explore other determinants of household' recycling involvement, for example, other aspects of abstract norms or other demographic variables.

Although the findings provide several significant contributions to the scientific community and policy makers as well, this study has some limitations. Firstly, the target respondents was narrowed in Danang city; hence, future studies may expand to include some other cities to have a comprehensive perspectives of community' propensity to participate in e-waste recycling in the whole Vietnam. Secondly, the numbers of input variables used in this study are limited; therefore, it is suggested that other influential indicators such as privacy insurance or personal norms should be added in other investigations, with the aim to have deeper understandings of which factors affecting the propensity of individuals toward recycling.

References

Babcock, H.M. (2009) 'Assuming personal responsibility for improving the environment: moving toward a new environmental norm', *The Harvard Environmental Law Review*, Vol. 33, No. 1, pp.117–175.

Bai, H., Wang, J. and Zeng, A.Z. (2018) 'Exploring Chinese consumers' attitude and behavior toward smartphone recycling', *Journal of Cleaner Production*, Vol. 188, pp.227–236, DOI: https://doi.org/10.1016/j.jclepro.2018.03.253.

Colesca, S.E., Ciocoiu, C.N. and Popescu, M.L. (2014) 'Determinants of WEEE recycling behaviour in romania: a fuzzy approach', *International Journal of Environmental Research*, Vol. 8, No. 2, pp.353–366, DOI: 10.22059/ijer.2014.726.

Cooper, T. and Mayers, K.M. (2000) *Prospects for Household Appliances*, Sheffield Hallam University (E-SCOPE), Sheffield, UK [online] https://irep.ntu.ac.uk/id/eprint/6671.

Darby, L. and Obara, L. (2005) 'Household recycling behaviour and attitudes towards the disposal of small electrical and electronic equipment', *Resources, Conservation and Recycling*, Vol. 44, No. 1, pp.17–35, DOI: https://doi.org/10.1016/j.resconrec.2004.09.002.

Dhir, A., Malodia S., Awan U., Sakashita M. and Kaur P. (2021) 'Extended valence theory perspective on consumers' e-waste recycling intentions in Japan', *Journal of Cleaner Production*, Vol. 312, DOI: https://doi.org/10.1016/j.jclepro.2021.127443.

Echegaray, F. and Hansstein, F.V. (2017) 'Assessing the intention-behavior gap in electronic waste recycling: the case of Brazil', *Journal of Cleaner Production*, Vol. 142, pp.180–190, DOI: https://doi.org/10.1016/j.jclepro.2016.05.064.

Forti, V., Baldé, C.P., Kuehr, R. and Bel, G. (2020) *The Global E-waste Monitor 2020: Quantities, Flows and the Circular Economy Potential*, United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam.

Fraige, F.Y., Al-khatib, L.A., Alnawafleh, H.M., Dweirj, M.K. and Langston, P.A. (2012) 'Waste electric and electronic equipment in Jordan: willingness and generation rates', *Journal of Environmental Planning and Management*, Vol. 55, No. 2, pp.161–175, DOI: 10.1080/09640568.2011.586492.

General Statistics Office (GSO) (2021) 'Press conference to announce the labor and employment situation in the second quarter and 6 months of 2021 and the results of the household living standards survey 2020' [online] https://www.gso.gov.vn/en/data-and-statistics/2021/07/press-conference-to-announce-the-labor-and-employment-situation-in-the-the-second-quarter-and-6-months-of-2021-and-the-results-of-the-household-living-standards-survey-2020/ (accessed 2 November 2021).

Gonul Kochan, C., Pourreza, S., Tran, H. and Prybutok, V.R. (2016) 'Determinants and logistics of e-waste recycling', *The International Journal of Logistics Management*, Vol. 27, No. 1, pp.52–70, DOI: 10.1108/IJLM-02-2014-0021.

Hadler, M. and Haller, M. (2011) 'Global activism and nationally driven recycling: the influence of world society and national contexts on public and private environmental behavior', *International Sociology*, Vol. 26, No. 3, pp.315–345, DOI: 10.1177/0268580910392258.

Hair, J.F. (2010) *Multivariate Data Analysis: A Global Perspective*, Pearson Education, Upper Saddle River, NJ; London.

Herat, S. (2021) 'E-waste management in Asia Pacific region: review of issues, challenges and solutions', *Nature Environment and Pollution Technology*, Vol. 20, No. 1, pp.45–53.

Jafari, A., Heydari, J. and Keramati, A. (2017) 'Factors affecting incentive dependency of residents to participate in e-waste recycling: a case study on adoption of e-waste reverse supply chain in Iran', *Environment, Development and Sustainability*, Vol. 19, No. 1, pp.325–338, DOI: 10.1007/s10668-015-9737-8.

Maskey, R., Fei, J. and Nguyen, H-O. (2018) 'Use of exploratory factor analysis in maritime research', *The Asian Journal of Shipping and Logistics*, pp.91–111, DOI: https://doi.org/10.1016/j.ajsl.2018.06.006.

Miliute-Plepiene, J., Hage, O., Plepys, A. and Reipas, A. (2016) 'What motivates households recycling behaviour in recycling schemes of different maturity? Lessons from Lithuania and Sweden', *Resources, Conservation and Recycling*, Vol. 113, pp.40–52, DOI: https://doi.org/10.1016/j.resconrec.2016.05.008.

Nduneseokwu, C.K., Qu, Y. and Appolloni, A. (2017) 'Factors influencing consumers' intentions to participate in a formal e-waste collection system: a case study of Onitsha, Nigeria', *Sustainability*, Vol. 9, No. 6, p.881.

Nguyen, H., Hung, R-J., Lee, C-H. and Nguyen, H. (2018) 'Determinants of residents' e-waste recycling behavioral intention: a case study from Vietnam', *Sustainability*, Vol. 11, p.164, DOI: 10.3390/su11010164.

Nixon, H. and Saphores, J-D.M. (2007) 'Financing electronic waste recycling Californian households' willingness to pay advanced recycling fees', *Journal of Environmental Management*, Vol. 84, No. 4, pp.547–559, DOI: https://doi.org/10.1016/j.jenvman.2006.07.003.

Nnorom, I., Ohakwe, J. and Osibanjo, O. (2009) 'Survey of willingness of residents to participate in electronic waste recycling in Nigeria –a case study of mobile phone recycling', *Journal of Cleaner Production*, Vol. 17, No. 18, pp.1629–1637, DOI: 10.1016/j.jclepro.2009.08.009.

Nnorom, I.C. and Osibanjo, O. (2008) 'Overview of electronic waste (e-waste) management practices and legislations, and their poor applications in the developing countries', *Resources, Conservation and Recycling*, Vol. 52, No. 6, pp.843–858, DOI: https://doi.org/10.1016/j.resconrec.2008.01.004.

Pandebesie, E.S., Indrihastuti, I., Wilujeng, S.A. and Warmadewanthi, I. (2019) 'Factors influencing community participation in the management of household electronic waste in West Surabaya, Indonesia', *Environmental Science and Pollution Research*, Vol. 26, No. 27, pp.27930–27939, DOI: 10.1007/s11356-019-05812-9.

Qu, Y., Wang, W., Liu, Y. and Zhu, Q. (2019) 'Understanding residents' preferences for e-waste collection in China – a case study of waste mobile phones', *Journal of Cleaner Production*, Vol. 228, pp.52–62, DOI: https://doi.org/10.1016/j.jclepro.2019.04.216.

Saphores, J-D.M., Ogunseitan, O.A. and Shapiro, A.A. (2012) 'Willingness to engage in a pro-environmental behavior: An analysis of e-waste recycling based on a national survey of U.S. households', *Resources, Conservation and Recycling*, Vol. 60, pp.49–63, DOI: https://doi.org/10.1016/j.resconrec.2011.12.003.

Shevchenko, T., Laitala, K. and Danko, Y. (2019) 'Understanding consumer e-waste recycling behavior: introducing a new economic incentive to increase the collection rates', *Sustainability*, Vol. 11, No. 9, p.2656.

Sidique, S.F., Lupi, F. and Joshi, S.V. (2010) 'The effects of behavior and attitudes on drop-off recycling activities', *Resources, Conservation and Recycling*, Vol. 54, No. 3, pp.163–170, DOI: https://doi.org/10.1016/j.resconrec.2009.07.012.

Siringo, R., Herdiansyah, H. and Kusumastuti, R.D. (2020) 'Underlying factors behind the low participation rate in electronic waste recycling', *Global Journal of Environmental Science and Management*, Vol. 6, No. 2, pp.203–214, DOI: 10.22034/gjesm.2020.02.06.

Song, Q., Wang, Z. and Li, J. (2012) 'Residents' behaviors, attitudes, and willingness to pay for recycling e-waste in Macau', *Journal of Environmental Management*, Vol. 106, pp.8–16, DOI: https://doi.org/10.1016/j.jenvman.2012.03.036.

Streiner, D.L. (2003) 'Starting at the beginning: an introduction to coefficient alpha and internal consistency', *Journal of Personality Assessment*, Vol. 80, No. 1, pp.99–103, DOI: 10.1207/S15327752JPA8001_18.

Tanskanen, P. (2013) 'Management and recycling of electronic waste', *Acta Materialia*, Vol. 61, No. 3, pp.1001–1011, DOI: https://doi.org/10.1016/j.actamat.2012.11.005.

Trung, N.N. (2020) *Country Report on E-waste of Viet Nam*, Bangkok, February.

United Nations (UN) (2016) 'Goals 12 – ensure sustainable consumption and production patterns', [online] https://sdgs.un.org/goals/goal12 (accessed 28 October 2021).

Van Beukering, P.J.H. and van den Bergh, J. (2006) 'Modeling and analysis of international recycling between developed and developing countries', *Resources, Conservation and Recycling*, Vol. 46, pp.1–26, DOI: 10.1016/j.resconrec.2005.06.002.

Vandenbergh, M.P. and Steinemann, A.C. (2007) 'The carbon-neutral individual', *New York University Law Review*, Vol. 82, pp.1673–745.

Vicente, P. and Reis, E. (2008) 'Factors influencing households' participation in recycling', *Waste Management & Research*, Vol. 26, No. 2, pp.140–146, DOI: 10.1177/0734242x07077371.

Wang, Z., Guo, D. and Wang, X. (2016) 'Determinants of residents' e-waste recycling behaviour intentions: evidence from China', *Journal of Cleaner Production*, Vol. 137, pp.850–860, DOI: https://doi.org/10.1016/j.jclepro.2016.07.155.

Wang, Z., Zhang, B., Yin, J. and Zhang, X. (2011) 'Willingness and behavior towards e-waste recycling for residents in Beijing city, China', *Journal of Cleaner Production*, Vol. 19, No. 9, pp.977–984, DOI: https://doi.org/10.1016/j.jclepro.2010.09.016.

Zhong, H. and Huang, L. (2016) 'The empirical research on the consumers' willingness to participate in e-waste recycling with a points reward system', *Energy Procedia*, Vol. 104, pp.475–480, DOI: 10.1016/j.egypro.2016.12.080.