Using Contingent Valuation Method to Explore the Households' Participation and Willingness to Pay for Improved Plastic Waste Management in North Vietnam

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Abstract This study aims to inquire into residents' awareness and responses to plastic waste, and their willingness to pay for enhancing plastic waste treatment in the North of Vietnam. We employed the contingent valuation method (CVM) and randomly surveyed 525 households in 25 provinces in Northern Vietnam. Findings suggest that a majority are interested and aware of impacts of plastic waste pollution, and 76.8% are willing to contribute to a fund designated for plastic waste pollution alleviation. Residents' willingness to pay range from VND 680,775 to VND 944,461 per household per month. Age, gender, perceived effects of waste pollution, illness due to pollution, and care of plastic waste pollution are top factors influencing the households' voluntary financial contribution to environmental fund. This study provides several evidence-based policy recommendations to improve the quality of plastic treatment in the North of Vietnam.

Keywords Willingness to pay · Awareness of waste treatment · Plastic waste pollution in Vietnam · Plastic waste

1 Introduction

Plastic pollution (white pollution) is a global concern for not only its prevalence (in the ground, in the air and in the ocean) but also its non-biodegradable nature. Recent studies show that a plastic bottle costs centuries to decompose into small pieces which may flow into the sea and kill fish and birds through plastic ingestion (Hossain & Mahbub Tuha, 2020). Other tiny microplastic particles are suspended in the atmosphere. They will pass through the respiratory tract, accumulate in human lungs, causing respiratory diseases (Thompson et al., 2009). The COVID-19 pandemic has exacerbated plastic waste pollution (Khoo et al., 2021). The demand for single-use

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plastic has been on the rise, which intensifies the pressure to control plastic waste globally (Peng et al., 2021). Scientists predict that by the end of this century, nearly all of the plastic waste associated with the COVID-19 pandemic will ultimately litter the seabed or shorelines. To illustrate, the total amount of plastic waste generated by the COVID-19 pandemic lying on the seabed was 28.8%, and the amount of plastic waste floating on the ocean surface accounted for about 70.5% (Hien et al., 2021).

Vietnam is currently one of the top plastic consumers in the world. According to the Ministry of Natural Resources and Environment, each year, 1.8 million tons of plastic waste are discharged into the environment in Vietnam, of which 0.28 million–0.73 million tons end up in the sea (i.e., accounting for about 6% of the total plastic waste into the sea worldwide) (Binh, 2022). To prevent plastic waste pollution in Vietnam, the government, management agencies, and local authorities have coordinated with international organizations to launch projects and action programs (Nam, 2021). One of the key solutions is to change awareness, help people better understand the harmful effects of ocean plastic waste, and understand more about the government's policies and regulations on this issue. Increasing awareness of the importance of environmental protection encourages people to use environmentally friendly products to reduce plastic waste (Khaleeli & Jawabri, 2021). According to a survey by the Environment magazine, the percentage of people who had knowledge about plastic waste accounted for 97.6%, while 2.4% were unable to distinguish plastic waste from other types of waste (Thao et al., 2021). Most people are aware of its harmful effects on the environment, so there are ways to reuse or reduce the use of plastic waste. Even so, tackling plastic pollution still poses many challenges as 20% of them believe that this responsibility belongs to the authorities and firms. Thus, in order to solve the environmental problem, apart from raising environmental awareness, the cooperation and joint contribution of people to environmental protection is the key.

This study aims to improve the understanding of residents' awareness and willingness to contribute to improve the quality of plastic waste treatment, which ultimately assists the implementation of circular economy approaches in Vietnam. The specific objectives of the study are: (1) to find out people's awareness and attitudes toward plastic waste, (2) estimate the level of voluntary payment to the environmental fund, and (3) identify the factors that affect the level of voluntary payments. The results of the study will contribute to the theoretical framework of environmental management and help strengthen the public–private partnership in environmental management and protection in Vietnam.

The research paper is structured as follows: Sect. 2 provides an overview of the study. Sections 3 and 4 present research methodology and results, respectively. Section 5 articulates discussions, and Sect. 6 concludes.

2 Literature Review and Hypotheses

2.1 Literature Review

Plastic waste has been a topic of broad interest to scholars worldwide due its severe impacts on human survival. Studies have shown that most single-use plastic products lead to a large amount of microplastic emissions into the environment that vary in terms of types, which would enter both human and animal food chains and exert a long-term impact on the environment (Shams et al., 2021). Moreover, improper treatment of plastic waste, especially the burning of plastic waste, causes environmental pollution which has negative effects on the environment and human health (Khoo et al., 2021; Shams et al., 2021). In other words, plastic waste is a natural environmental pollutant and a primary source of pollution (Kedzierski et al., 2020).

Many strategies to deal with plastic pollution have been proposed. The reduce–recycle–reuse (3Rs) strategy is one of the most popular methods that aims at promoting environmentally friendly behavior at an individual level. This method is believed to not only significantly reduce plastic waste thanks to large-scale participation but also facilitate the development of a circular economy (Manickam & Duraisamy, 2019). In addition, novel trends in plastic waste management such as converting waste to energy and chemical recycling have emerged in recent years (Idumah & Nwuzor, 2019; Kijo-Kleczkowska & Gnatowski, 2022; Zhang et al., 2021), which enhances prospects for effective solutions.

Since households are one of the key stakeholders in plastic consumption and plastic waste generation, many researchers have investigated the influencing factors on public behavior regarding environmental activities. As regards pro-environmental behavior, studies have shown that public awareness plays an important role in reducing plastic waste and encouraging consumers to purchase sustainable products (Bhattarai, 2015; Fujii, 2006; Khaleeli & Jawabri, 2021). In Vietnam, there are several studies on residents' intention to reduce the use of plastic bags, all of which underline the role of people's awareness of environmental problems and impacts on their health (Cong, 2020; Dung & Cuc, 2021).

In developing countries where resources are limited, in order to address such complicated issues as plastic pollution, the need for public–private partnership is particularly emphasized. Willingness to pay for the improvement of solid waste management has been studied by researchers worldwide. Maskey and Singh (2017) found that monthly household income, education of household head, environmental awareness and waste collection service significantly influenced households' WTP in Nepal (Maskey & Singh, 2017). Their study also revealed that these factors, apart from education of household head, affected the maximum amount of money that households were willing to pay. Another study conducted in China looked more closely into demographic factors, including gender, age, education and income (Han et al., 2019). Results also showed that demonstration projects, public awareness of waste treatment necessity, propaganda and perception of environmental pollution were positively correlated with WTP. Essential as improved solid waste management

is, few studies investigating WTP of households have been conducted in Vietnam. One example could be the study in the Mekong Delta, focusing on urban residents (Xuan et al., 2021). According to the study, the determining factors are bid level, households who have already classified waste, urban residents who intend to support the program, and urban residents' income.

Although the above-mentioned studies have provided certain insights on plastic waste pollution, the impact of plastic waste on health and the environment and some related measures has not been well studied. Until now scientific knowledge on environmental education and solutions associated with environmental culture, including awareness and action to reduce plastic waste, cooperation and financial contribution in the environmental fund are still lacking and unsystematic. This study is expected to fill the gap in theory and practice mentioned above.

2.2 Hypotheses

Income and spending are positively correlated. Higher incomes will boost consumption, meaning higher spending. This situation is especially true when people are highly conscious of changes in wealth (Epley et al., 2006). Moreover, education has a significant influence on one's perception and behavior. Well-educated citizens tend to protect the environment (Anjum, 2013; Banga et al., 2011; Bhattarai, 2015; Danso et al., 2006; De Feo & De Gisi, 2010; Ezebilo, 2011; Song et al., 2016). Besides, place of residence is also an important factor affecting the willingness to pay (Schäufele & Hamm, 2017). First, people living in urban areas often have higher income than those in rural areas, so they tend to spend more, including on environmental protection. Second, urbanites are often better educated or get better access to more information. In addition, age is positively associated with saving behavior (Aggrey & Douglason, 2010; Banga et al., 2011; Padi et al., 2015). The older a person is, the clearer his/her tendency to save is. Therefore, we propose the first set of hypotheses regarding the following demographic variables:

> Hypothesis (A): Male, higher income, better education can contribute higher WTP number. Meanwhile, WTP is negatively associated with age.

Attitudes and perceptions exert an influence on environmental protection behavior. People who care about the environment in general, and plastic waste pollution in particular, are more likely to pay for environmental funds (Anjum, 2013; Maskey & Singh, 2017; Mukherji et al., 2016; Padi et al., 2015). Furthermore, their living environment directly affects their health and standards of living. If residents are aware of pollution in their neighborhood, they will take actions to mitigate the negative impacts or improve the living environment (Han et al., 2019). Besides, having experiences with the consequences of environmental pollution also plays a crucial role in influencing environmental protection behavior. Those who suffer from environmental

pollution-related illnesses would be more conscious of the importance of the environment, hence more willing to pay for environmental protection funds. Therefore, we propose the second group of hypotheses:

> Hypothesis (B): The perceived impacts of plastic pollution, health problems due to plastic pollution, care of plastic waste lead to higher WTP number for plastic waste reduction and treatment solutions.

3 Methods and Materials

3.1 Contingent Valuation Method (CVM)

In this study, we use the contingent valuation method (CVM). The contingent valuation method is one of the non-market pricing approaches and is widely used to estimate non-market values in environmental impact assessment and environmental cost–benefit analysis (Champ et al., 2017).

In the contingent valuation method, the interviewer directly asks the respondent to collect information related to the evaluation of the value of a certain type of good or service. More specifically, this method asks informants whether they agree to pay voluntarily for non-market goods. Respondents will answer "Yes" or "No," and a Yes means that the respondent will choose the level that they pay voluntarily for non-market goods. Among the question types, namely close, binary, and card-type, the card-type question has many strengths in providing information about the interviewee due to the wide range of payment options. Therefore, the payment card question of the selected CVM method was applied. In fact, this method has been used a lot in the past (Khuc et al., 2022a, 2022b). Accordingly, the team will make an assessment of people's willingness to pay voluntarily for the treatment of plastic waste and estimate the mean value of WTP.

3.2 Experimental and Questionnaire Design

We carried out our survey in Northern Vietnam because this region accounts for roughly one-third of Vietnam's area and is home to nearly 37% of the total population, making it one of the leading generators of plastic waste (General Statistics Office of Vietnam, 2015). In addition, two of the five municipalities of Vietnam, Hanoi, and Hai Phong City, are situated in the North. Due to their large population, high rate of urbanization, and economic development, plastic pollution is one of the most thorny issues (Salhofer et al., 2021; Vietnamnet, 2016). We designed and used a questionnaire to collect information on the perception and need for waste treatment of survey participants. Specifically, there are a total of 42 questions divided into four main parts as follows: Part A is the demographic information of the interviewees. Part

B examines their awareness of plastic waste treatment in the province/locality where they live. Part C deals with measures to improve and enhance the efficiency of waste treatment. Part D is participation and voluntary payments for plastic waste treatment. During the questionnaire design process, we employed the focus group method and held a discussion with experts in the waste management field in order to ensure the suitability and easy-to-understand feature. Then we recuited students, who are studying at universitties in Hanoi, from various northern provinces as interviewers. We conducted a meeting to make sure that they understand the goal of the project and equip them with the necessary interviewing skills and techniques. We followed the steps of Champ et al., (2017), Khuc (2021) in the primary data investigation method. Before entering the official survey, our team completed a pilot survey with 23 responses to ensure that there would be no potential confusion or misunderstanding between surveyors and survey respondents. Afterward, our team used both direct and online survey methods through social networking sites to reach people living in 25 northern provinces/cities for three weeks from January 16, 2022, to February 6, 2022 (See Table 5 for more information). At the end of the survey, the group gathered data from 534 observations; however, after clearning the data, only 525 observations were retained for further analysis. With this sample size, the data is suitable and large enough to be analyzed and processed (Vanvoorhis & Morgan, 2007) through descriptive statistical analysis and maximum reasonable estimation of the interval regression model in the next section.

3.3 Model and Variables

In this study, we employ the interval regression model with data collected from the payment card formulated questions to estimate the willingness to pay (WTP) of residents. According to Champ et al., (2017), the theorectical model and estimate values of WTP are as follows:

$$\log\left(\mathrm{WTP}_i^T\right) = \beta' x_i + \varepsilon_i \tag{1}$$

$$E(\mathrm{WTP}) = \exp\left(\beta' x_i\right) \cdot \exp\left(\frac{\hat{\sigma}^2}{2}\right) \tag{2}$$

where x_i represents a vector of independent variables; β is population regression coefficients of the corresponding independent variables; ε_i is the residual and σ is an error term.

Next, we built the empirical model from literature review and real observation. We underwent many steps to arrive in the final model. First, the model included all possible candidate variable. Then we kept only the variables that have a high correlation with the WTP variable. Iteratively, the best empirical model with the highest log-likelihood values was constructed, shown below.

$$\begin{aligned} \text{WTP}_i = {} & \beta_0 + \beta_1(\text{Gender})_i + \beta_2(\text{Age})_i + \beta_3(\text{Education})_i + \beta_4(\text{Income})_i \\ & + \beta_5(\text{Perceived effects})_i + \beta_6(\text{Illnesses})_i + \beta_7(\text{Care})_i + \varepsilon_i \end{aligned} \quad (3)$$

where the explanatory variables are presented in Table 1 below:

Table 1 Independent variables description

Variables	Definition and scale	Expected sign	Mean	Standard Deviation
Group 1	*Demographic variables*			
Gender	Gender of the respondent 1 = Male; 0 = Female	+	0.42	0.49
Age	Age of the respondent 1 = Below 18; 2 = 18–30; 3 = 30–45; 4 = Above 45	-	2.22	0.74
Education	The highest degree or level of school the respondent has completed 1 = Junior high school or below; 2 = High school; 3 = Trade/technical/vocational training; 4 = Bachelor's degree; 5 = Master's degree; 6 = Doctorate degree	+	3.48	0.91
Log income	General logarithm of midpoints of household income of the respondent (unit: million dong/month)	+	16.20	1.07
Group 2	*Attitudes and awareness*			
Perceived effects	The environmental impacts of plastic pollution to the respondent's life 1 = No impact; 2 = Moderate; 3 = High; 4 = Very high	+	2.74	0.80
Illnesses	Any members in the respondent's family suffers from illnesses caused by environmental issues 1 = Yes; 0 = No	+	0.15	0.36
Care	The respondent's level of care of plastic waste pollution 1 = Very low; 2 = Low; 3 = Moderate; 4 = High; 5 = Very high	+	3.93	0.86

Source Authors

4 Results

4.1 Respondents' Awareness of Plastic Waste Treatment

Figure 1a shows the level of the respondents' care of plastic waste. 85.8% of the respondents are concerned about plastic pollution, whereas 14.2% are indifferent and choose Don't care about this issue. Figure 1b shows the detailed level of concern about plastic waste issues of the respondents. Approximately, 27.7% are highly concerned, and 43.5% are concerned. Although the remaining are concerned about these issues, their level of concern is moderate or very low. Figure 1c presents the reasons why the respondents pay little attention to plastic pollution. Three main reasons are: I don't have time (36.8%), Plastic waste does no harm (29%), and I don't care about environmental issues (34.2%).

Figure 2a presents an assessment of the impacts of plastic waste on the respondents' lives. Approximately, 60% of the respondents answered that plastic waste pollution has a serious and moderate impact on their lives. Figure 2b shows the respondents' opinion of plastic pollution in their neighborhood compared with previous years. 36.4% of the interviewees feel that plastic pollution is better now than in the past, while the opposite opinion is shared among 14.4% of the respondents, and well over 40% feel that the situation is similar to previous years. Figure 2c provides information about the respondents' satisfaction with local plastic waste collection and treatment. More than half of the respondents chose neutral (60.5%), while 19.3% were dissatisfied with the available service. Overall, plastic waste pollution is assessed as relatively serious. People are increasingly conscious of its impacts. However, local plastic waste management still has many limitations and has not resolved the problem, making the residents regard it as unreliable and unsatisfactory.

4.2 Environmental Fund Contribution and Reasons

Results show that many people are concerned about plastic pollution and plastic waste treatment. To be specific, 76.8% of the respondents agree to contribute to the plastic waste treatment fund, whereas the remaining 23.2%, equivalent to 122 respondents, do not agree (Fig. 3).

Table 2 provides a breakdown of the reasons people refuse to contribute to this fund, with the most common one being they think this fund will not work effectively (money can be misused) (29.5%). In addition, having no control over the budget and the belief that it is the government's responsibility to fund this makes 21.3% and 35.2% of the respondents refuse to contribute, respectively.

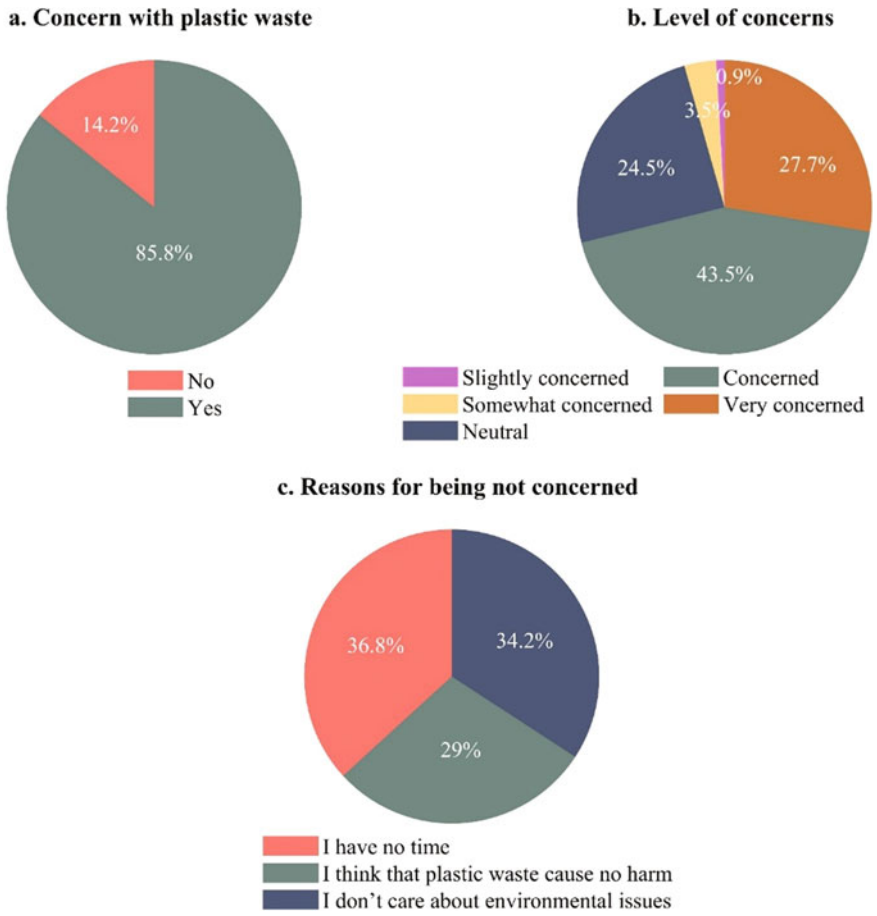

Fig. 1 Plastic waste concern. *Source* Authors

4.3 Results of Voluntary Payment for Improved Plastic Waste Management

Table 3 presents the results of the voluntary payment model to reduce plastic waste. The p-value of all five models is less than 0.001 (statistically significant), suggesting that all the models are good enough to explain the estimated results. The difference between the models is the number of variables.

The results show that many variables have a strong relationship with WTP. First, variable "*age*" has a negative coefficient (−0.265), which means that older people are less likely to contribute than younger ones. When all the other variables are unchanged and the variable "age" increases by one group, the WTP will decrease by 26.5%. Next, variable "*perceived effects*" has a positive coefficient (0.288), which

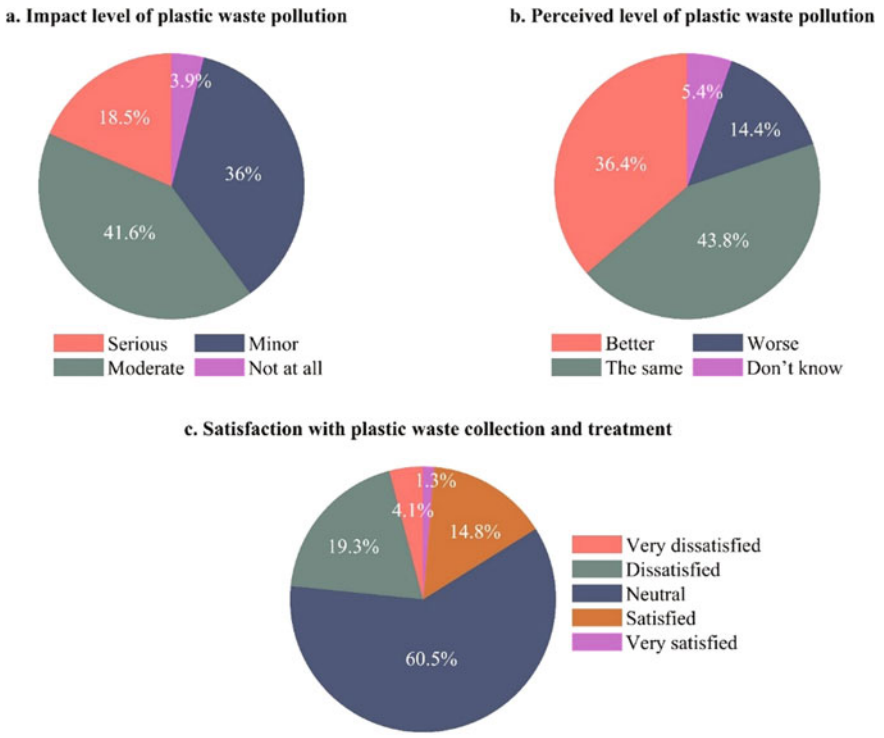

Fig. 2 Awareness of local plastic waste treatment. *Source* Authors

means that when the opinions about the impacts of plastic waste change, that is from low to high, their WTP value is likely to increase. It is apparent that the more severe influences the respondents feel, the higher their willingness to pay is. Similarly, variable "*illness*" is positively associated with WTP. For those who have suffered from illnesses caused by plastic waste issues, their WTP value is higher. Thus, the estimated results have partly supported all the three proposed hypotheses, with awareness being the most influential one, followed by demographics and measures. Variable "*care*" has a positive coefficient (0.281). This means that for those who have higher level of care about plastic waste pollution, they are likely to pay more for the environmental fund. We provided Model 2 to include those who did not care about plastic waste. This model does not include the variable "*care*". This leads to an important finding because Model 2 demonstrates that the variable "*gender*" has statistical significance. In other words, Model 2 produces the opposite result as the remaining four models. The variable "gender" has a negative coefficient −0.515), indicating that women are more likely than men to contribute to the fund. When it comes to estimating the size of voluntary payments, the estimated mean value of WTP ranges from the lowest (VND 680,775 in Model 5) to the highest value (VND 944,461 in Model 3).

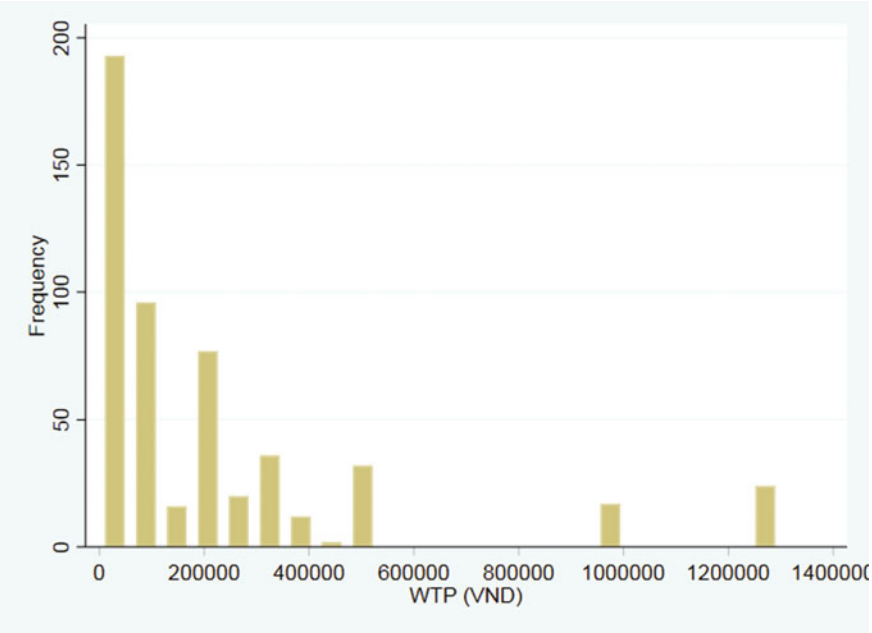

Fig. 3 Willingness to pay for plastic waste management. *Source* Authors

Table 2 Reasons for not willing to contribute to plastic waste treatment fund

Reasons	Observations	Compared to total number of responses (N = 122) (%)	Compared to total sample size (N = 525) (%)
I don't believe in the efficiency of the fund so I don't want to contribute	49	40.2	9.3
I think that this is not my responsibility, and the government should take the responsibility to finance plastic waste management	43	35.2	8.2
I have no money/my family is struggling financially	36	29.5	6.9
I have no control over my financial budget so I can't contribute	26	21.3	5.0

Source Authors

Table 3 Estimated results of interval regression model

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Gender	−0.304	−0.515**	−0.280	−0.346*	
	(0.209)	(0.218)	(0.211)	(0.209)	
Age	−0.265*	−0.602***	−0.221	−0.278*	−0.270**
	(0.144)	(0.142)	(0.145)	(0.145)	(0.134)
Education	0.0396	0.124	0.00144	0.0331	
	(0.115)	(0.119)	(0.115)	(0.115)	
Income (ln)	−0.0871	−0.0182	−0.0841	−0.0771	
	(0.0899)	(0.0959)	(0.0911)	(0.0903)	
Perceived effects	0.288**	0.648***	0.382***		0.269**
	(0.141)	(0.136)	(0.139)		(0.132)
Illness	0.776***	0.807***		0.898***	0.636**
	(0.263)	(0.283)		(0.257)	(0.255)
Care	0.281**		0.263**	0.368***	0.288**
	(0.124)		(0.126)	(0.117)	(0.116)
Constant	11.38***	10.64***	11.30***	11.75***	10.05***
	(1.557)	(1.609)	(1.576)	(1.556)	(0.604)
Observations	386	453	386	386	449
s	1.897	2.116	1.921	1.908	1.908
Log-likelihood	−1115.617	−1269.268	−1119.933	−1117.711	−1292.169
Prob > chi2	0.000	0.000	0.000	0.000	0.000
WTP (VND)	713,818	944,461	708,499	716,103	680,775

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Source Authors

Table 4 summarizes the outcomes of the hypotheses testing. Five of the seven proposed hypotheses are accepted. To be more specific, for the demographic hypotheses set, hypotheses of age and education level variables are accepted, while gender and income hypotheses are rejected. Accepted perception hypotheses include those concerning plastic waste, the impact of white pollution, and illness related to plastic pollution.

5 Discussions

The study delves into households' awareness and attitudes to plastic waste in Northern Vietnam and their willingness to contribute to waste management funds.

Table 4 Hypotheses testing results

Hypothesis	Results
H1: Man are usually willing to pay more	Rejected
H2: Age is negatively correlated with WTP	Accepted
H3: Highly educated people are generally willing to pay more	Accepted
H4: High income leads to higher WTP	Rejected
H5: The influence of plastic pollution is positively correlated with WTP	Accepted
H6: People who have had a disease often have a higher WTP	Accepted
H7: People who care about plastic waste will be willing to pay more	Accepted

Source Authors

This study employed the interval regression model to determine the factors influencing the households' contributions to the fund designated to combat plastic pollution. We find that demographic factors namely age, gender, and education, have significant impacts on respondents' intentions. Care, perceived effects of plastic pollution and plastic pollution-related illnesses are factors predicting willingness to contribute to waste management funds. Interestingly, waste sorting behavior, relocation intentions, and communication are not sources of motivations for fund contribution.

Results suggest that females show greater willingness to donate money to the environmental fund than males and the elderly, respectively. In Asian culture, women usually take responsibility for all family affairs from household chores to financial management to health conditions. Learning about adverse effects of plastic waste on human life and the existence of a plastic treatment fund, females are more likely to opt for fund donation for the sake of the family well-being.

Better awareness of its impacts on not only human health but also one's capabilities as fish and marine creatures increasingly ingesting plastic can lead to people being poisoned through consumption (Savoca et al., 2021), and plastic pollution is proven to affect sensory organs, and respiratory, nervous, and gastrointestinal systems (Ciel, 2019). The young generation has a long future ahead, so efforts in environmental alleviation or protection represent investments in their future survival and comfortable living conditions. Besides, those who pursue high levels of education are better equipped with knowledge (Meyer, 2015) on plastic pollution through either formal schooling or active information seeking since understanding of global issues are inherent in plenty of courses. They understand that small actions at home can curb the effects of plastic pollution to some extent, but bigger measures such as improvement in waste management systems can only be done by the government who needs to mobilize national financial resources. As a result, the young and educated people have a higher likelihood of contributing to the fund that can fight plastic pollution on a larger scale rather than individual pro-environmental practices only.

The purpose of this fund is to alleviate impacts of plastic pollution, which corresponds with their values, and values represent one's belief that dictates his/her actions

and attitudes (Moore & Asay, 2013). Those who concern themselves with environmental issues and are directly afflicted with plastic pollution are highly internally motivated to take actions with the hope of improving their life quality. Therefore, environment-conscious citizens demonstrate willingness to donate their money for environmental protection. In addition, if an individual or any member in his or her family suffers from illnesses caused by environmental issues, he or she has internal motivations and may feel more compelled to join the fight against plastic pollution. In line with previous research (Ajaps & McLellan, 2015; Tianyu & Meng, 2020), our result confirms that respondents' care about the environment, plastic-related illness sustained and perceived effects are positively associated with decisions on fund contribution.

Environmental culture is an essential factor influencing awareness and action to reduce plastic waste (Vuong, 2021). Building environmental culture for people is mandatory for sustainable development, for environmental values can be converted into economic values, yet not vice versa. As awareness is a prerequisite for actions, authorities or environmental activists can raise public awareness of detrimental impacts of plastic waste and propose measures that individuals can take through communication at school and regional level. The young should acknowledge their responsibility for the environment from an early age as global citizens, so teaching staff should incorporate environmental protection into curricula to help students internalize environmental values and actively act against plastic waste. Perhaps, these students can be the one who spreads this knowledge to family members ignorant of or less concerned about plastic pollution. Several demonstration projects can be launched to give the public a vivid illustration of people's lives before and after the world is rife with plastic waste, which can resonate with them and encourage their contribution to the fund.

Plastic pollution poses an increasingly grave threat, while this problem cannot be solved without public participation at the national level. An individual's attempt may be negligible when it comes to a global issue, yet concerted efforts make the most impact. Our study makes both theoretical and empirical contributions. Theoretically, we contributed to the literature review of how socioeconomic factors and perceived plastic impacts motivated or hindered households' intention on fund donation. Our results show that fund donation can be a viable solution to plastic pollution if a nation needs more budgets for waste management and treatment. Practically, our findings can provide a scientific backbone for the launch of a public fund designated to handle plastic waste. Also, this study acts as a source of reference for high authorities to specify certain segments of the population as main contributors to the fund, and then governing bodies can devise proper campaigns that align national values with their personal values to increase participation.

We acknowledge our limitations with regards to the dataset. Although we can identify factors that influence residents' decision over fund contribution, we could not specify underlying reasons for their willingness to pay due to data limitations. In our future study, we intend to obtain deep insights into households' decision-making process, using in-depth interviews and direct surveys and employing the mindsponge and serendipity framework (Nguyen et al., 2022; Vuong, 2022; Vuong

et al., 2022). We also used mindspong economics theory, the application of mindsponge in economics, which states that during the decision-making process, individuals can either absorb or reject information to select high-value options based on dynamic core values (Khuc, 2022). Future studies can expand research areas to explore key determinants and make possible comparisons to confirm whether there is a transregional difference to either suggest adaptation or strengthen grounds for plastic waste policies. Promoting environmental and eco-surplus culture, an enabler of sustainable development and favorable living conditions for future generations, can be a topic of broad interest for scholars when people have been exacerbating the already bad environment.

6 Conclusions

Increasingly severe plastic pollution has been well-documented worldwide, increasing the public awareness by a wide margin. Awareness and concern can be predictors of behavior or actions. There are environment-conscious people who willingly join the fight against plastic pollution and desire to make larger contributions, apart from small environmental practices such as waste sorting and use of personal bags. Meanwhile, in some cases, the national budget is insufficient to cover environmental expenses, let alone investments into effective waste treatment systems. Therefore, a fund established to cushion effects of plastic pollution can be seen as a practical solution to bridge the gap between citizens' willingness to contribute and national insufficient financial resources. This study aims to gain insights into awareness and attitudes toward plastic waste of residents in the North of Vietnam and their willingness to contribute to the plastic pollution alleviation fund, which can be applicable in future studies in other developing countries. We find that socioeconomic factors (gender, age), care, plastic-related illnesses, and perceived impacts of plastic pollution on daily lives do have significant influences on households' intention on fund contribution. The government can refer to our study to assess the feasibility and efficiency of the fund and determine certain segments of the population as the target of campaigns such as communication and demonstration ones in the North of Vietnam. This could lead to higher participation of citizens in fund donation, hence the success of the policy and ultimately the decreased impacts of plastic pollution.

Appendix

See Table 5.

Table 5 Lists of provinces/cities of respondents

No.	Province	Observations	Percent
1	Bắc Kạn	3	0.6
2	Bắc Giang	2	0.4
3	Bắc Ninh	104	19.8
4	Cao Bằng	11	2.1
5	Hà Giang	2	0.4
6	Hà Nam	20	3.8
7	Hà Nội	160	30.5
8	Hòa Bình	2	0.4
9	Hưng Yên	1	0.2
10	Hải Dương	15	2.9
11	Hải Phòng	23	4.4
12	Lào Cai	5	1.0
13	Lạng Sơn	1	0.2
14	Nam Định	13	2.5
15	Ninh Bình	15	2.9
16	Phú Thọ	8	1.5
17	Quảng Ninh	19	3.6
18	Sơn La	1	0.2
19	Thanh Hóa	4	0.8
20	Thái Bình	83	15.8
21	Thái Nguyên	14	2.7
22	Tuyên Quang	2	0.4
23	Vĩnh Phúc	4	0.8
24	Yên Bái	2	0.4
25	Điện Biên	11	2.1
Total		525	100

Source Authors

References

Aggrey, N., & Douglason, O. G. (2010). Determinants of willingness to pay for solid waste management in Kampala City. *Current Research Journal of Economic Theory, 2*(3), 119–122.

Ajaps, S., & McLellan, R. (2015). We don't know enough: Environmental education and pro-environmental behaviour perceptions. *Cogent Education, 2*(1), 1–17. https://doi.org/10.1080/2331186X.2015.1124490

Anjum, R. (2013). *Willingness to pay for solid waste management services: A case study of Islamabad*. PIDE working papers, (Vol. 3, pp. 1–21).

Banga, M., Lokina, R. B., & Mkenda, A. F. (2011). Households willingness to pay for improved solid waste collection services in Kampala city, Uganda. *Journal of Environment and Development, 20*(4), 428–448. https://doi.org/10.1177/1070496511426779

Bhattarai, K. (2015). Households willingness to pay for improved solid waste management in Banepa municipality, Nepal. *Environment and Natural Resources Journal, 13*, 14–25.

Binh, T. (2022). *Vietnam among 20 countries with largest plastic waste discharge*. Vietnamnet. https://vietnamnet.vn/en/vietnam-among-20-countries-with-largest-plastic-waste-discharge-820102.html

Carson, R. T. (2012). Contingent valuation: A practical alternative when prices aren't available. *Journal of Economic Perspectives, 26*(4), 27–42. https://doi.org/10.1257/jep.26.4.27

Champ, P. A., Boyle, K. J., & Brown, T. C. (2017). *A primer on nonmarket valuation*. Kluwer Academic Publishers, 101 Philip Drive, Norwell, MA 02061, USA.

Ciel. (2019). Plastic & health: The hidden cost of a plastic planet. https://www.ciel.org/wp-content/uploads/2019/02/Plastic-and-Health-The-Hidden-Costs-of-a-Plastic-Planet-February-2019.pdf

Cong, L. C. (2020). Intention to reduce use and discharge of plastic bags of coastal communities in Nha Trang Bay: The role of awareness of using plastic bags and awareness of environmental protection (Ý định giảm thiểu sử dụng và xả thải túi nhựa của cộng đồng dân cư ven bi. *In Journal of Asian Business and Economic Studies—JABES*, *1*, 75–92.

Danso, G., Drechsel, P., Fialor, S., & Giordano, M. (2006). Estimating the demand for municipal waste compost via farmers willingness-to-pay in Ghana. *Waste Management, 26*(12), 1400–1409. https://doi.org/10.1016/J.WASMAN.2005.09.021

De Feo, G., & De Gisi, S. (2010). Public opinion and awareness towards MSW and separate collection programmes: A sociological procedure for selecting areas and citizens with a low level of knowledge. *Waste Management, 30*(6), 958–976. https://doi.org/10.1016/J.WASMAN.2010.02.019

Dung, N. T. B., & Cuc, N. T. (2021). Factors affecting the intention to reduce the use of plastic bags of people in Da Lat city, Vietnam (Các yếu tố tác động đến ý định giảm sử dụng túi nylon của người dân tại thành phố Đà Lạt, Việt Nam). *TNU Journal of Science and Technology*, *226*(08), 274–282. https://doi.org/10.34238/tnu-jst.4408

Epley, N., Mak, D., & Idson, L. C. (2006). Bonus of rebate?: The impact of income framing on spending and saving. *Journal of Behavioral Decision Making, 19*(3), 213–227. https://doi.org/10.1002/BDM.519

Ezebilo, E. E. (2011). Economic valuation of private sector waste management services. *Journal of Sustainable Development*, *4*(4). https://doi.org/10.5539/jsd.v4n4p38

Fujii, S. (2006). Environmental concern, attitude toward frugality, and ease of behavior as determinants of pro-environmental behavior intentions. *Journal of Environmental Psychology, 26*(4), 262–268. https://doi.org/10.1016/j.jenvp.2006.09.003

General Statistics Office of Vietnam. (2015). Statistical yearbook of Vietnam—2015.

Han, Z., Zeng, D., Li, Q., Cheng, C., Shi, G., & Mou, Z. (2019). Public willingness to pay and participate in domestic waste management in rural areas of China. *Resources, Conservation and Recycling*, *140*(September 2018), 166–174. https://doi.org/10.1016/j.resconrec.2018.09.018

Hien, N. T. T., Linh, N. D., & Uyen, D. T. H. (2021). Ocean plastic pollution and COVID-19 (Ô nhiễm nhựa đại dương và Covid-19). *OSF Preprints*. https://doi.org/10.31219/osf.io/h6x7z

Hossain, M. I., & Mahbub Tuha, M. A. S. (2020). Biodegradable plastic production from daily household waste materials and comparison the decomposing time with synthetic polyethylene plastic. *International Journal of Advancement in Life Sciences Research*, *3*(3), 16–19. https://doi.org/10.31632/ijalsr.20.v03i03.002

Idumah, C. I., & Nwuzor, I. C. (2019). Novel trends in plastic waste management. *SN Applied Sciences, 1*(11), 1–14. https://doi.org/10.1007/S42452-019-1468-2/FIGURES/12

Kedzierski, M., Frère, D., Le Maguer, G., & Bruzaud, S. (2020). Why is there plastic packaging in the natural environment? Understanding the roots of our individual plastic waste management behaviours. *Science of the Total Environment, 740*, 139985. https://doi.org/10.1016/j.scitotenv.2020.139985

Khaleeli, M., & Jawabri, A. (2021). The effect of environmental awareness on consumers attitudes and consumers intention to purchase environmentally friendly products: Evidence from United

Arab Emirates. *In Management Science Letters*, 555–560. https://doi.org/10.5267/j.msl.2020.9.011

Khoo, K. S., Ho, L. Y., Lim, H. R., Leong, H. Y., & Chew, K. W. (2021). Plastic waste associated with the COVID-19 pandemic: Crisis or opportunity? *Journal of Hazardous Materials, 417*, 126108. https://doi.org/10.1016/J.JHAZMAT.2021.126108

Khuc, V. Q. (2021). Primary data survey: A step-by-step procedure for researchers in social sciences and humanities. OSF Preprints. https://doi.org/10.31219/osf.io/qpa9t

Khuc, V. Q., Dang, P. T., Tran, P. M., Nguyen, T., Pham, P., & Tran, D. T. (2022a). Exploring strategies to tackle plastic waste pollution: Evidence from Vietnamese household survey and Bayesian approach. OSF Preprints. https://doi.org/10.31219/osf.io/m73ef

Khuc, V. Q. (2022). Mindspongeconomics. OSF Preprints, Working paper Series No. 2022/9. https://doi.org/10.31219/osf.io/hnucr

Khuc, V. Q., Nong, D., & Vu, P. T. (2022b). To pay or not to pay that is the question—for air pollution mitigation in a world's dynamic city: An experiment in Hanoi, Vietnam. *Economic Analysis and Policy, 74*, 687–701. https://doi.org/10.1016/j.eap.2022.03.023

Kijo-Kleczkowska, A., & Gnatowski, A. (2022). Recycling of plastic waste, with particular emphasis on thermal methods. *Energies*, *15*(6), 2114. https://doi.org/10.3390/EN15062114

Manickam, P., & Duraisamy, G. (2019). 3Rs and circular economy. *Circular Economy in Textiles and Apparel: Processing, Manufacturing, and Design*, 77–93. https://doi.org/10.1016/B978-0-08-102630-4.00004-2

Maskey, B., & Singh, M. (2017). Households willingness to pay for improved waste collection service in Gorkha municipality of Nepal. *Environments—MDPI, 4*(4), 1–15. https://doi.org/10.3390/environments4040077

Meyer, A. (2015). Does education increase pro-environmental behavior? Evidence from Europe. *Ecological Economics, 116*, 108–121. https://doi.org/10.1016/j.ecolecon.2015.04.018

Moore, T. J., & Asay, S. M. (2013). Values, attitudes and behaviors: Understanding family choices. In *Family resource management* (pp. 99–110). SAGE Publications, Thousand Oaks, CA.

Mukherji, S. B., Sekiyama, M., Mino, T., & Chaturvedi, B. (2016). Resident knowledge and willingness to engage in waste management in Delhi, Indai. *Sustainability (switzerland), 8*(10), 1–14. https://doi.org/10.3390/su8101065

Nam, H. (2021). Why is public awareness of ocean plastic waste in Vietnam still limited? (Vì sao nhận thức về rác thải nhựa đại dương ở Việt Nam còn hạn chế?). https://vtc.vn/vi-sao-nhan-thuc-ve-rac-thai-nhua-dai-duong-o-viet-nam-con-han-che-ar647764.html

Nguyen, M. H., La, V. P., Le, T. T., & Vuong, Q. H. (2022). Introduction to Bayesian mindsponge framework analytics: an innovative method for social and psychological research. *MethodsX*, 101808. https://doi.org/10.1016/j.mex.2022.101808

Padi, A., Addor, J. A., & Fannam Nunfam, V. (2015). An econometric model of factors influencing households willingness to pay for improved solid waste management service within the Sekondi—Takoradi metropolis in the western region of Ghana. *Journal of Economics and Sustainable Development*, *6*(16), 15–30. http://www.iiste.org/Journals/index.php/JEDS/article/view/25291

Peng, Y., Wu, P., Schartup, A. T., & Zhang, Y. (2021). Plastic waste release caused by COVID-19 and its fate in the global ocean. *Proceedings of the National Academy of Sciences of the United States of America*, *118*(47). https://doi.org/10.1073/pnas.2111530118

Salhofer, S., Jandric, A., Soudachanh, S., Xuan, T. L., & Tran, T. D. (2021). Plastic recycling practices in Vietnam and related Hazards for health and the environment. *International Journal of Environmental Research and Public Health, 18*(8), 4203. https://doi.org/10.3390/IJERPH18084203

Savoca, M. S., McInturf, A. G., & Hazen, E. L. (2021). Plastic ingestion by marine fish is widespread and increasing. *Global Change Biology, 27*(10), 2188–2199. https://doi.org/10.1111/gcb.15533

Schäufele, I., & Hamm, U. (2017). Consumers' perceptions, preferences and willingness-to-pay for wine with sustainability characteristics: A review. *Journal of Cleaner Production, 147*, 379–394. https://doi.org/10.1016/J.JCLEPRO.2017.01.118

Shams, M., Alam, I., & Mahbub, M. S. (2021). Plastic pollution during COVID-19: plastic waste directives and its long-term impact on the environment. *Environmental Advances, 5*, 100119. https://doi.org/10.1016/j.envadv.2021.100119

Song, Q., Wang, Z., & Li, J. (2016). Exploring residents attitudes and willingness to pay for solid waste management in Macau. https://doi.org/10.1007/s11356-016-6590-8

Thao, P. T. M., Lieu, T. T. N., Khoi, N. D., Ngan, P. T. T., Linh, L. T., & Duyen, N. T. (2021). Evaluation of consumer awareness and behavior related to plastic waste generation in Hanoi city (Nghiên cứu đánh giá nhận thức và hành vi của người tiêu dùng liên quan đến phát sinh rác thải nhựa tại TP. Hà Nội). *Tạp Chí Môi Trường*, 9.

Thompson, R. C., Moore, C. J., Saal, F. S. V., & Swan, S. H. (2009). Plastics, the environment and human health: Current consensus and future trends. *Philosophical Transactions of the Royal Society b: Biological Sciences, 364*(1526), 2153–2166. https://doi.org/10.1098/rstb.2009.0053

Tianyu, J., & Meng, L. (2020). Does education increase pro-environmental willingness to pay? Evidence from Chinese household survey. *Journal of Cleaner Production, 275*, 122713. https://doi.org/10.1016/j.jclepro.2020.122713

Vanvoorhis, & Morgan. (2007). Understanding power and rule of thumb for determining sample sizes. *Tutorials in Quantitative Methods for Psychology*.

Vietnamnet. (2016). 40 m tall "mountain" of toxic waste in Hai Phong. Vietnamnet. https://vietnamnet.vn/en/40m-tall-mountain-of-toxic-waste-in-hai-phong-E162438.html

Vuong, Q. H. (2021). The semiconducting principle of monetary and environmental values exchange. *Economics and Business Letters*, *10*(3), 284–290. https://doi.org/10.17811/ebl.10.3.2021.284-290

Vuong, Q. H. (2022). Mindsponge theory. https://books.google.com.vn/books?id=OSiGEAAAQBAJ&redir_esc=y

Vuong, Q. H., Le, T. T., La, V. P., Nguyen, H. T. T., Ho, M. T., Khuc, V. Q., & Nguyen, M. H. (2022). Covid-19 vaccines production and societal immunization under the serendipity-mindsponge-3D knowledge management theory and conceptual framework. *Humanities and Social Sciences Communications, 9*(1), 1–12. https://doi.org/10.1057/s41599-022-01034-6

Xuan, H. T. D., Dung, K. T., & Khai, H. V. (2021). Urban residents willingness to pay for domestic solid waste management service in Mekong Delta: Parametric and Non-parametric approaches (Nghiên cứu mức sẵn lòng trả cho dịch vụ quản lý chất thải rắn sinh hoạt ở Đồng bằng sông Cửu Long: Cách tiếp cận tham. *Can Tho University Journal of Science*, *57*(Environment and Climate change), 25–31. https://doi.org/10.22144/ctu.jsi.2021.046

Zhang, F., Zhao, Y., Wang, D., Yan, M., Zhang, J., Zhang, P., Ding, T., Chen, L., & Chen, C. (2021). Current technologies for plastic waste treatment: A review. *Journal of CleaNer Production, 282*, 124523. https://doi.org/10.1016/J.JCLEPRO.2020.124523