



## **Willingness to Pay for Improving Household Solid Waste Management in Vietnam**

**Phan Cong Chinh<sup>1</sup>, Nguyen Tri Quang Hung<sup>2,\*</sup>, Nguyen Minh Ky<sup>2,3</sup>,  
Nguyen Thi Le Ai<sup>4</sup>, Nguyen Minh Tam<sup>2</sup>**

<sup>1</sup> Journal of People's Security, The University of People's Security Km 18, Ha Noi Highway, Linh Trung Ward, Thu Duc District, Ho Chi Minh City, Vietnam

<sup>2</sup> Faculty of Environment and Natural Resources, Nong Lam University of Ho Chi Minh City Hamlet 6, Linh Trung Ward, Thu Duc District, HoChiMinh city, Vietnam

<sup>3</sup> Department of Environment and Natural Resources, Nong Lam University of Ho Chi Minh City – Gialai Campus, Gialai Province, Vietnam

<sup>4</sup> Sonadezi Environment Company, Bien Hoa City, Dong Nai Province, Vietnam

\* Corresponding author: [quanghungmt@hcmuaf.edu.vn](mailto:quanghungmt@hcmuaf.edu.vn)

### *Article History*

Submitted: 25 May 2020/ Revision received: 8 October 2020/ Accepted: 14 October 2020/ Published online: 26 March 2021

### **Abstract**

Management of solid waste is a major challenge in urban areas of most parts of the world, especially in developing countries. The study aimed to determine and estimate the willingness to pay (WTP) of the selected households for the improvement of solid waste management in Vietnam. The research evaluated WTP of household solid waste in case studies in Bien Hoa and My Tho cities using contingent valuation method (CVM). The data were collected through a closed-ended questionnaire survey and interviews with 200 households. The results showed that the most willingness to pay was equal to 10,000 and 15,000 VND per month. The respondents were willing to pay in Bien Hoa and My Tho with an average of 14,450 VND (0.63 USD) and 13,000 VND (0.56 USD) per month, respectively. Regression model identified influential factors on WTP of households in the two cities of Vietnam. The factors that significantly influence households' WTP were monthly household income, education of respondents, age, occupation and solid waste volume ( $p < 0.05$ ). The results of this study can be used for the urban planning and implemented the sustainable development process in Bien Hoa and My Tho cities.

**Keywords:** Household solid waste; Contingent valuation method; Willingness to pay; Management; Vietnam

## Introduction

The increasing volume and complexity of solid waste due to rapid urbanization has made solid waste management become a serious problem in poor and developing countries [1–2]. The management of solid waste is becoming more complex in most of these countries and the large challenges in urban areas or cities. The study of Guerrero et al. (2013) [3] in the rapidly growing cities showed that the management of solid waste continues to be a major challenge in urban areas throughout the world. According to UNEP (2004) [4], the generation of solid waste has become an environmental and public health issue. Additionally, lack of availability of solution for solid waste management has further enhanced the seriousness of the matter [5]. Meanwhile, the willingness to pay (WTP) have played a role in enhancing and improving the solid waste collection and disposal services. The WTP for such services depends on many socio-demographic factors. Addai and Danso-Abeam (2014) [6] presented in their analysis of the household's WTP for improved solid waste management in Ghana. Afroz et al. (2009) [7] carried out the study by using contingent valuation method to estimate the WTP of the respondents aim to improve the waste collection system. In another study, Banga et al. (2011) [8] found that willing to pay for improved solid waste collection services was important. Furthermore, in most studies such as [5, 9–10] showed that education and income had positive effects on WTP. In general, the different socioeconomic factors including family size, education and income level are associated with the amount, composition of municipal solid waste [11]. Different socioeconomic contributes influence the willingness of residential households to pay for solid waste disposal and management [12]. Many authors have analyzed the effects of socioeconomic on household's WTP for a service related to solid waste management.

Most of the developing countries (e.g. Vietnam) have lacked policies, regulations and

efficient municipal solid waste management programs [13–14]. According to the Vietnam Environmental Protection Law, the Ministry of Natural Resources and Environment plays a key role in managing the solid waste [15]. However, due to limited involvement of stakeholders in the policy making process, Vietnamese people are not aware of the negative impacts of waste on the environment. This study examining the cases in Bien Hoa and My Tho cities, Vietnam showed that the rapidly-increasing population was the main reason leading to a large solid waste volume, and this caused the difficulties in management activities, especially for the local government. Both Bien Hoa and My Tho cities are economic centres of Dong Nai and Tien Giang Provinces, respectively. However, the currently solid waste classification at source not only practiced in the cities but also the lack of advanced technology. The amount of solid waste in these areas is also increasing rapidly. Statistically, the quantity of household solid waste in Bien Hoa and My Tho were 564 and 132 t d<sup>-1</sup>, respectively [16–17]. The increase of the solid waste is a threat to environmental, social and economic aspects [18–19]. Poor solid waste management is a major threat against public health and environmental quality. This could be lead to risk and serious environmental issues, especially as health problem. Furthermore, the solid waste collection fee in both the cities was low. Thereby, the solid waste management plan may be a challenge for implementing sustainable management. Furthermore, it was the lack of stakeholders' participation that leads to the limit of the specific opportunity in the waste management. In order to make an effective action plan for proper management of municipal solid waste, thereby, the management plan could be supported from the WTP. The present study was conducted in the urban areas (i.e. the case studies in Bien Hoa and My Tho cities) to determine and estimate the WTP of the selected households for the improvement of solid waste management in Vietnam.

## Methods

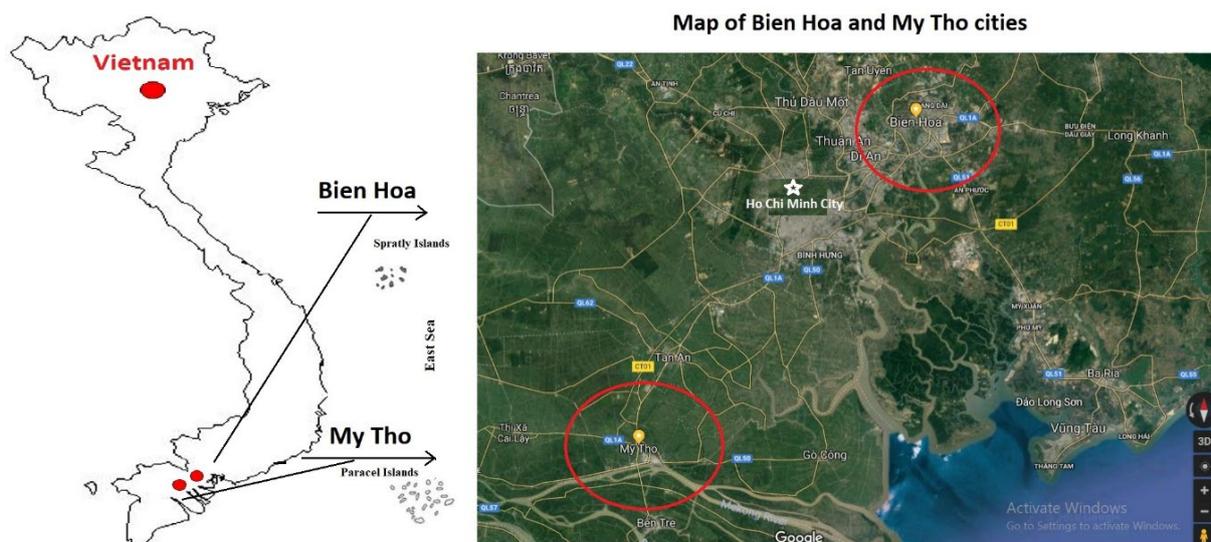
The study was conducted in My Tho and Bien Hoa Cities, Vietnam (Figure 1). Bien Hoa with an area of 264 km<sup>2</sup> is the provincial city of Dong Nai Province, about 30 km east of Ho Chi Minh City. Meanwhile, My Tho is, a social and economic centre of Tien Giang Province with area of 82 km<sup>2</sup>. My Tho was located in the Mekong Delta Region of South Vietnam, 70 km from Ho Chi Minh City. Besides, both of the cities located in tropical monsoon climate zone have two different seasons: dry and wet seasons.

The methods used to conduct the survey included face-to-face interview and closed-ended questionnaire. In this study, in order to identify the WTP for services, we used the contingent valuation method (CVM) to quantify each household's WTP for solid waste management [5, 20]. The CVM is developed by economists for the estimation of non-market environmental goods and services [21]. CVM can be used for the estimation of WTP based on change any the services. The contingent valuation question was recommended for respondents who willing to pay and financial contribution for improving household solid waste management. The respondents were required to show their willingness

by choosing Yes or No before deciding to choose the detail WTP [22–23]. The study conducted a pre-test on 12 respondents in Bien Hoa and My Tho Cities in order to find errors from the questionnaires and determining the range of bidding values. The WTP was surveyed with the prices ranging from 5,000 to 35,000 VND (the payment cards were 5,000; 10,000; 20,000; 25,000; 30,000 and 35,000 VND, respectively). The data were collected by using systematic random sampling techniques. The sample size formula is determined as follows by Eq.1 [24].

$$n = \frac{N}{1+N(e)^2} \quad (\text{Eq. 1})$$

With N is the studied area's population (Bien Hoa and My Tho cities' population are 916,184 and 215,996 households, respectively), and e is the level of precision (= 0.1), the needed sample size called n is 100 for each city. A total of 200 households were sampled from both areas, including 100 households for each city (Table 1). Accordingly, the study contributed sample size for each ward depend on its characteristics and total households used service of domestic waste collection.



**Figure 1** Map of Vietnam and studied areas.

**Table 1** Population of selected households in Bien Hoa and My Tho Cities

Bien Hoa City				My Tho City			
Ward	Population	Household	Samples	Ward	Population	Household	Samples
An Binh	47,475	14,649	27	Ward 1	8,192	1,632	35
Long Binh	61,719	22,541	38	Ward 9	8,750	2,488	35
Thanh Binh	6,853	1,137	15	Trung An <sup>1</sup>	22,513	8,484	30
Hiep Hoa	13,049	3,364	20	-	-	-	-

**Note:** <sup>1</sup> Trung An is an agricultural activities area, and the use of service of domestic waste collection is low.

A wide range of studies have provided evidence that households are willing to pay a large amount of money for the management of solid waste [25–26]. In this study, the contingent valuation method requires careful survey design, choice of survey mode and selection of random sample as shown in Eq. 2 [27].

$$\overline{WTP} = \frac{\sum_{k=1}^n WTP_k * n_k}{\sum_{k=1}^n n_k} \quad (\text{Eq. 2})$$

where, WTP: the households' average WTP for waste disposal; WTP<sub>k</sub>: willingness to pay for kth (kth is the value of different payment levels in range from 5,000 to 35,000 VND); n<sub>k</sub>: the number of households corresponding to WTP<sub>k</sub>. Multiple linear regression analysis is used to find the determinants of respondents' WTP in the relationship between the important factors and the improved solid waste management. The influence of respondents' demographic characteristics on WTP was assessed on the basis of multiple regression equation as follows by Eq. 3.

Several studies have shown that variables such as gender, age, income, household size, occupation and educational level affected household WTP for solid waste management [9, 33, 38,

40]. Gender is a challenging variable which refers to the role of female and male respondents to improved solid waste service. Gender of the respondent is expected to have positive or negative effects on WTP. Besides, age of the respondent is expected to affect WTP for waste management positively. Also, education involving the total number of years spent in school is expected with positive effects. Based on the theory of environmental goods demand that illustrated the highly the income level will be strongly contributed for improvement of environmental quality [41]. Due to the large number of people living in the house will increase solid waste and difficult management [25]. Concerning household size, the larger size is more likely to pay for the improved household waste management. The household size is expected to have a positive effect on WTP. This was found in other similar studies related to positive significance [29]. Furthermore, solid waste volume is expected to affect WTP positively. The increase of the solid waste leads to a challenge for collection, and it needs large cost to manage. This finding is similar to those found in some previous studies [26, 42].

$$WTP_i = \beta_0 + \beta_1 * Gen + \beta_2 * Ag + \beta_3 * Hs + \beta_4 * Edu + \beta_5 * D_1 + \beta_6 * D_2 + \beta_7 * D_3 + \beta_8 * D_4 + \beta_9 * Inc + \beta_{10} * SWv + u_i \quad (\text{Eq. 3})$$

It is worth noting that,  $WTP_i$  is WTP of respondent at  $i$  with the values varied from 5,000 to 35,000 VND;  $\beta_0$  is intercept;  $\beta_j$  is coefficients ( $j = 1 \div 10$ ); Gen = Gender of respondent (if male = 1, female = 0); Ag = Age in years; Hs = Household size; Edu = Educational level measured by number of years spent in the school; Inc = is per capita income; SWv = Quantity of solid waste per day ( $\text{kg d}^{-1}$ );  $D_1, D_2, D_3$  and  $D_4$  are variables of specific occupations (if officers = 1, other = 0; if businessmen = 2, other = 0; if workers = 3, other = 0; if farmers = 4, other = 0) and  $u_i$  is random error (Table 2).

**Table 2** Description, measurement and expected sign of the variable used in the linear regression model

Variable	Symbol	Description	Expected sign	References
<b>Gender</b>	Gen	The gender of the respondents (a dummy if male = 1, female = 0)	+/-	[7, 28–30]
<b>Age</b>	Ag	Year of respondents	+	[5, 7, 28, 31]
<b>Household size</b>	Hs	Household size of the respondent (person)	+	[5, 7, 31–33]
<b>Educational level</b>	Edu	Number of years of formal education	+	[5,7, 28, 31–32]
<b>Occupation</b>	$D_1, D_2,$ $D_3, D_4$	Officer, businessmen, worker, farmer	+/-	[9, 34–36]
<b>Income</b>	Inc	Average monthly income of respondent (VND per person monthly)	+	[5, 7, 32]
<b>Solid waste volume</b>	SWv	Quantity of solid waste per day ( $\text{kg d}^{-1}$ )	+	[37–39]

## Results and discussion

### 1) The socioeconomic characteristics of the respondents

Table 3 showed the descriptive statistics for the socioeconomic characteristics of the respondents. The gender of household in the surveyed area of Bien Hoa City consisted of male (45%) and female (55%), whereas the figures for My Tho City were 53% and 47% respectively. The results of descriptive statistics showed the age of the respondents ranged from 18 to 72 years old. Noticeably, the respondents aged from 31 to 40 years old occupied the highest percentage of all (37%) in Bien Hoa City whilst 35% of the respondents ranging from 41 to 50 years old was the most common group for My Tho City. Approximately a half of the respondents had more than 5 members per a household in Bien Hoa and 33% in My Tho, respectively. The average

household size in Bien Hoa and My Tho were 3.46 and 4.05 persons respectively. Regarding educational levels in Bien Hoa, about 26% of the participants had high school's degree and with 31% bachelor's degree, and 29% master or above education. Meanwhile, almost of respondents in My Tho obtained secondary school education (48%) and primary school (28%).

The majority of respondents in Bien Hoa were businessmen (33%), followed by officer (32%) and worker (27%). Meanwhile, only 8% of them were businessmen in My Tho City and the highest percentage was for officer (40%). The results indicated that more than a half of respondents in Bien Hoa (60%) reported that their household monthly income ranged from 5 to 15 million VND. Most of the respondents in My Tho had monthly income which was less than 5 million VND, accounting for 76%, and

only 3% of the respondents in My Tho had monthly income which was more than 15 million VND. The findings of the study also showed that about 38% of the solid waste volume in Bien

Hoa was 1.5–2.0 kg d<sup>-1</sup>. In My Tho, the household release solid waste volume was within the range of 0.6–1.4 kg d<sup>-1</sup> reaching 39%.

**Table 3** The basic information of the surveyed households

Variables	Group	Sample (n, %)	
		Bien Hoa City	My Tho City
<b>Gender</b>	Male	45 (45)	53 (53)
	Female	55 (55)	47 (47)
<b>Age (years)</b>	18–30	6 (6)	11 (11)
	31–40	37 (37)	21 (21)
	41–50	28 (28)	35 (35)
	51–60	22 (22)	23 (23)
	≥61	7 (7)	10 (10)
<b>No. of household member (person)</b>	1	4 (4)	7 (7)
	2	10 (10)	20 (20)
	3	13 (13)	26 (26)
	4	23 (23)	14 (14)
	≥5	50 (50)	33 (33)
<b>Education level</b>	Primary school or below	5 (5)	28 (28)
	Secondary school	9 (9)	48 (48)
	High school	26 (26)	2 (2)
	College	31 (31)	5 (5)
	Master or above	29 (29)	17 (17)
<b>Occupation</b>	Officer	32 (32)	40 (40)
	Businessmen	33 (33)	8 (8)
	Farmer	8 (8)	24 (24)
	Worker	27 (27)	28 (28)
<b>Income (10<sup>6</sup>.VND per month)</b>	1–5	9 (9)	76 (76)
	5–10	28 (28)	18 (18)
	10–15	32 (32)	3 (3)
	≥15	31 (31)	3 (3)
<b>Solid waste volume (kg d<sup>-1</sup>)</b>	≤0.5	5 (5)	7 (7)
	0.6–1.4	20 (20)	39 (39)
	1.5–2.0	38 (38)	29 (29)
	2.1–4.9	20 (20)	15 (15)
	≥5.0	17 (17)	10 (10)

## 2) Level of satisfaction with the current solid waste collection services

The results of satisfaction levels of solid waste collection service in Bien Hoa and My Tho Cities are shown in Figure 2. In general, almost all the community showed the high satisfaction levels (satisfied and very satisfied) of solid waste collection service with 43% (Bien Hoa) and 26% (My Tho) respectively. However, about 16% respondents in Bien Hoa were not satisfied with of solid waste collection service,

especially temporary transit stations on the streets, etc. In My Tho City, about 27% of the respondents were not satisfied (dissatisfied and very dissatisfied) with solid waste collection service. The average satisfaction levels were respectively 41 and 47% for Bien Hoa and My Tho cities. Thus, most of the respondents were cognitive and satisfied with the community responsible for solid waste management in the surveyed area.

### 3) Determinants of WTP for the Current Solid Waste Collection Services

Due to the lack of effective management programs and policies, the waste sources can affect health and environmental issues [14]. In case of Vietnam, regarding the policies of solid waste management and in order to improve the life quality, the Law on Environmental Protection 2014 has encouraged producers, organizations and households to develop sustainability through the recycling of wastes. Moreover, the Vietnamese Government also requires producers to pay a fee for environmental protection [43]. Vietnam has currently conducted the national integrated strategy of solid waste management to 2025 and vision to 2050. Through environment-friendly products, these current policies aim to waste reduction, reuse and recycling practices. In this study, the solid waste collection fees in Bien Hoa and My Tho City were 20,000 and 28,000 VND, respectively. The results showed that the most willing to pay was between 10,000 and 15,000 VND per month. The estimated WTP showed the total benefits were equal to 51.6 and 65.0% of the costs of household solid waste collection in Bien Hoa and My Tho Cities, respectively. This estimated value has played an important role in changing the community's awareness and increasing the effectiveness of household solid waste management [44]. In addition to promoting 3Rs (reuse, reduce and recycle), the local government may convince the community to pay a fee for solid waste management services and encourage the people to reduce waste from households. In My Tho City, the WTP survey was selected with high rate at 15,000 VND. Meanwhile, this was selected with the range from 10,000 to 15,000 VND in Bien Hoa City. The results showed that the respondents were willing to pay with an average of 14,450 VND (0.63 USD) and 13,000 VND (0.56 USD) per month in Bien Hoa and My Tho, respectively. In Vietnam, the important financial source support for solid waste manage-

ment comes from the government. This situation may be the cause of the lack of funding for municipal solid waste management. It could be recognized that although these values are less than solid waste collection services fee but this will contribute to the improvement of household solid waste management. The results showed the average WTP related to the additional fee which will be collected from households in Bien Hoa and My Tho Cities for improving household solid waste management.

The study found that none of respondents selected with  $WTP_k$  equal to 35,000 VND in both of cities. In regard to Bien Hoa  $WTP_k$ , most respondents (47%) have chosen  $WTP_k$  which ranged from 10,000 to 15,000 VND, while about 65% of those for My Tho City. Only 3% of the respondents have selected with  $WTP_k$  which was equal to 30,000 VND in Bien Hoa while there was no selection in My Tho City. The surveys also revealed major  $WTP_k$  selection were within low and medium values ranging from 10,000 to 25,000 VND (Table 4).

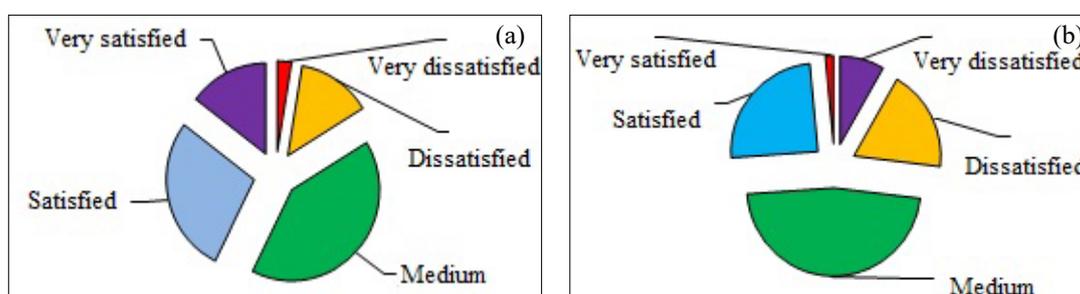
From the linear regression model showed that adjusted R square in Bien Hoa City was 0.600. It can be explained about 60.0% of data variation related to satisfaction levels of solid waste collection service. In My Tho City, the adjusted R square was equal to 0.626 and explained about 62.6% of data variation in studying model. In addition, the regression coefficients obtained with  $p < 0.001$  showed relevant model results. Multicollinearity test was measured by variance inflation factors (VIF) with VIF lower than 10 and the values were acceptable [45–46]. Thus, the multicollinearity test showed the formulation of multiple linear regression model was reliable. A regression model was developed to explore the influence factors on WTP. There is evidence of significant relationship between household income levels and amount of WTP for improving solid waste management in the study area. The results of the study are in line with the study conducted by Ashish and Uttam

(2013) [47], Tariq and Rashid (2014) [48] showed that income level, education level are associated with the amount of WTP for improved services of solid waste management.

A number of previous studies showed that WTP was much dependent on the per capita income [8, 49–50]. The results of linear model of WTP showed the regression coefficient of age variable ( $\beta_2$ ) were a positive sign of 0.058 (Bien Hoa) and 0.039 (My Tho). However, the gender factors were not statistically significant in both of cities ( $p > 0.05$ ). The results of the study also revealed that WTP for improved solid waste management is significantly related to level of education, household size, income and solid waste volume of the household. This means that when income ability of a person increases, it will increase the WTP for improved solid waste management [51]. The findings also illustrated that educational level can affect the WTP for solid waste management. The positive relationship between education levels and WTP have played a role in enhancing better solid waste management [6, 8, 28–30, 52–53].

Moreover, the regression coefficient of education and household income levels are positive. The result of the households' WTP was modelled as a function of socioeconomic factors. The R squared explains the proportion of variation in the observed values of the response variable explained by the regression. Education had a significantly positive effect on willingness to pay at 5% level of significance. In Bien Hoa, the solid waste volume had a positive coefficient ( $\beta_{10} = 0.235$ ) and was significant ( $p < 0.05$ ) on willingness to pay. Result of linear regression model in Bien Hoa as Eq. 4.

Some previous studies such as Altaf and Deshazo (1996) [37]; Fonta et al. (2008) [54] found that income positively influences household's WTP. In addition, Jin et al. (2006) [55] found that education positively influenced households' WTP. In My Tho City, low-income groups cannot afford to pay for proper waste disposal and they tend to dump domestic solid waste near their houses. From Table 5, linear regression model in My Tho as Eq. 5.



**Figure 2** Satisfaction levels of solid waste collection service in (a) Bien Hoa and (b) My Tho.

**Table 4** WTP results of surveyed households

WTP levels (k)	WTP <sub>k</sub> (VND per month)	Bien Hoa City			My Tho City		
		n <sub>k</sub>	Freq. (%)	Cum. Freq. (%)	n <sub>k</sub>	Freq. (%)	Cum. Freq. (%)
1	5,000	20	20	20	17	17	
2	10,000	25	25	45	30	47	
3	15,000	22	22	67	35	82	
4	20,000	15	15	82	12	94	
5	25,000	15	15	97	6	100	
6	30,000	3	3	100	0	100	
7	35,000	0	0	100	0	100	
Total		100	100	100	100	100	

**Note:** Freq. - Frequency; Cum. Freq. - Cumulative Frequency

$$Y_{BH} = -0.898 - 0.017*Gen + 0.041*Ag + 0.263*Edu + 0.135*Hs + 0.748*D_1 + 1.025*D_2 + 0.317*D_3 + 0.627*D_4 + 0.510*Inc + 0.147*SWv \tag{Eq. 4}$$

$$Y_{MT} = 0.795 - 0.016*Gen + 0.032*Ag + 0.249*Edu + 0.131*Hs + 0.567*D_1 + 1.321*D_2 + 0.435*D_3 + 0.528*D_4 + 0.375*Inc + 0.216*SWv \tag{Eq. 5}$$

**Table 5** Results of linear regression model of WTP

	Bien Hoa City				My Tho City			
	B	Beta	Sig.	VIF	B	Beta	Sig.	VIF
<b>Const</b>	-0.986		0.040		0.795		0.043	
<b>Gen</b>	-0.017	-0.015	0.053	2.561	-0.022	-0.016	0.061	2.379
<b>Ag</b>	0.041	0.058	0.031	3.450	0.032	0.039	0.043	2.376
<b>Edu</b>	0.263	0.377	0.043	3.246	0.249	0.347	0.044	2.376
<b>Hs</b>	0.135	0.209	0.028	2.169	0.131	0.163	0.038	2.072
<b>D<sub>1</sub></b>	0.748	0.216	0.084	3.779	0.567	0.147	0.035	3.124
<b>D<sub>2</sub></b>	1.025	0.348	0.009	4.184	1.321	0.254	0.034	2.435
<b>D<sub>3</sub></b>	0.317	0.321	0.027	3.321	0.435	0.268	0.053	2.431
<b>D<sub>4</sub></b>	0.627	0.187	0.042	2.786	0.528	0.230	0.012	2.419
<b>Inc</b>	0.510	0.342	0.000	1.713	0.375	0.458	0.001	2.448
<b>SWv</b>	0.147	0.235	0.019	2.382	0.216	0.184	0.041	2.085
F = 17.522; Sig.<0.001; R <sup>2</sup> = 0.637; Adjusted R <sup>2</sup> = 0.600				F = 17.599; Sig.<0.001; R <sup>2</sup> = 0.664; Adjusted R <sup>2</sup> = 0.626				

In My Tho City, the regression coefficient on the age variable had a positive sign, which means that WTP increases with age of the respondent. This result is not consistent with the previous findings by [28, 37], which showed a negative relationship between age of respondent and WTP for solid waste management. The results of this study showed that the respondents who had many years of schooling were more likely to pay for the solid waste management. Similar to the results reported in other study by [33, 40], the findings in this study presented that the more people in the household, the more willing the household will appreciate an environmental protection. Regarding household size, results illustrated significant and positive influences ( $p = 0.038 < 0.05$ ) the household WTP with  $\beta_3 = 0.163$ . From the above model, we can see that the significant variables such as household income (Inc) and age (Ag) with regression coefficient ( $\beta$ ) were 0.458 and 0.039, respectively. In addition, they indicate that education level

was statistically significant at the 5% significant level. In some previous studies, income and education had a positive effect on WTP in several studies [10, 29, 56–58]. Concerning other variables, for example as respondents' occupations (D<sub>3</sub>: Worker) was not statistically significant. Results of regression model of solid waste volume obtained statistically significant with  $p = 0.041 (< 0.05)$  and regression coefficient was 0.184 and showed their positive impact.

Thus, based on linear regression model showed education level was highest effect on WTP in Bien Hoa City with  $\beta = 0.377$ . Concerning variables including solid waste volume, occupation and education levels also strongly affected WTP. Meanwhile in My Tho City, the existence of impact following respectively age, education, occupation, solid waste volume and highest with income ( $p < 0.05$ ). It means that the community's income ability had strongest effects on selection and satisfaction with solid waste services.

#### 4) Estimates of household WTP with respondents characteristics

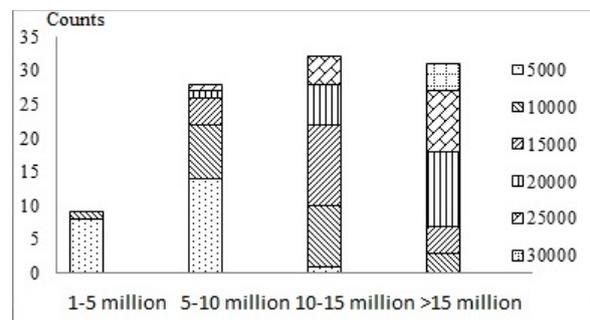
Figures 3 and Supplementary Material (SM) 1 depict the WTP at different income levels in Bien Hoa and My Tho Cities ( $p < 0.05$ ). According to the survey results, almost of households with highest per capita income of more than 5,000,000 VND per month were willing to pay at 15,000 to 25,000 VND per month. The income based WTP in Bien Hoa was calculated and illustrated in Figure 3.

Results of WTP analysis of income levels in My Tho City showed significant differences ( $p < 0.05$ ). In Bien Hoa, the household that had income that was less than 10 million VND have chosen WTP<sub>k</sub> at 5,000 to 10,000 VND. However, the household that had income sources of more than 10 million have chosen WTP<sub>k</sub> within value which was higher than 20,000 VND. Meanwhile in My Tho, almost of public chose WTP<sub>k</sub> at 15,000 VND and it was not by choice within WTP<sub>k</sub> at 30,000 VND. It means showed WTP in Bien Hoa is greater than that in My Tho City.

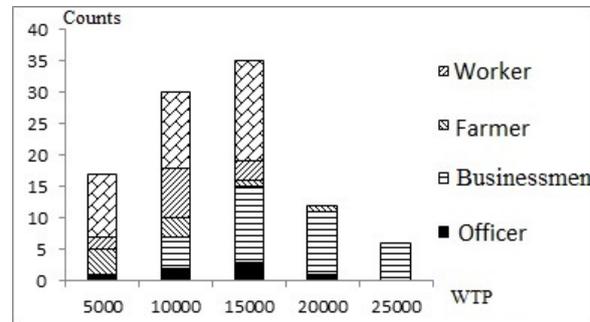
The different occupations were confirmed by their role to WTP in Bien Hoa City ( $p < 0.05$ ). In general, the WTP trend of the high income people was greater than the low income households. Especially, the businessmen in the community showed highest WTP as shown in SM 2. As the level of increasing income, so did the percentage of high WTP survey for the improved solid waste management system. In contrast, almost of farmer households in Bien Hoa City only chose WTP<sub>k</sub> at 5,000 VND.

In My Tho, variable of occupation had an important role in deciding WTP as shown in Figure 4. This means that WTP responses in relation to the households' occupation characteristic and there exists the significant differences ( $p < 0.05$ ). With reference to the relationship between occupation and WTP, most of the businessmen and workers showed higher WTP than other respondents such as farmers and officers. The survey conducted with 25,000 VND at WTP<sub>k</sub> was selected

only by businessmen. Respondents related to officer occupation who chose WTP<sub>k</sub> achieved highest value at 15,000 VND and varied from 5,000 to 20,000 VND but with low proportion. The farmer and worker's WTP<sub>k</sub> were less than other groups, ranging in 5,000 to 15,000 VND. In short, the results also have shown My Tho's WTP depended on the income and occupation of respondents. The findings from this study illustrate that the respondents were in support for improved the solid waste management [49].



**Figure 3** WTP analysis at different income levels in Bien Hoa City.



**Figure 4** Relationship between occupation and WTP in My Tho City.

#### Conclusions

The surveys with almost of respondents showed the high satisfaction levels of solid waste collection service in both of cities. Based on results showed that the most willing to pay were equal to 10,000 and 15,000 VND per month. The respondents were willing to pay in Bien Hoa and My Tho with an average of 14,450 VND (0.63 USD) and 13,000 VND (0.56 USD) per month, respectively. The linear regression model showed that adjusted R squared in Bien

Hoa and My Tho cities were 0.600 and 0.626, respectively. It can be explained about 60.0% and 62.6% of data variation related to satisfaction levels of solid waste collection service. Results from the linear regression models revealed that age, occupation, household size, income, education level and solid waste volume had significantly influence on household WTP for improved waste management systems. The study also provides contributions to the determinants of household WTP for solid waste collection services. In which, education and income of respondents are also strongest positive for amount of WTP in Bien Hoa and My Tho Cities, respectively.

Regarding to respondents characteristics, this study showed WTP at different occupation and income levels in Bien Hoa and My Tho cities was significant ( $p < 0.05$ ). The results of this study can be useful for understanding the status of the issue such as residents' awareness, WTP for household solid waste management, for the policy makers, and can be used to further promote the recycling of solid waste in Bien Hoa and My Tho Cities. However, the limitation of this study is composed of small sample size; therefore, the investigators need to consider the large sampling distribution aims to emphasize the population in the next studies. Future studies might also investigate applying the Ordinal Logistic to enhance the understanding of the determinants of WTP values for improving household solid waste management.

### Acknowledgements

The authors are grateful to Nong Lam University of Ho Chi Minh City (Vietnam) for providing relevant supports for this article. We are also thankful Dong Nai and Tien Giang Urban Environment Services Company Limited for providing data collection for the study.

### References

- [1] Bahauddin, K.M., Uddin, M.H. Prospect of solid waste situation and an approach of environmental management measure (EMM) model for sustainable solid waste management: Case study of Dhaka City. *Journal of Environmental Science and Natural Resources*, 2012, 5(1), 99–111.
- [2] Manuel, S.C., Juan, C.R.R., Alberto, L.T., Rafael, A.J. Stakeholder analysis of municipal solid waste companies - A first step towards successful corporate social responsibility. *Journal of Environmental Science and Management*, 2017, 20(2), 40–53.
- [3] Guerrero, L.A., Maas, G., Hogland, W. Solid waste management challenges for cities in developing countries. *Waste Management*, 2013, 33(1), 220–232.
- [4] United Nations Environment Program (UNEP). *The use of economic instruments in environmental policy: Opportunities and challenges*. Geneva: United Nations Publication, 2004a.
- [5] Afroz, R., Masud, M.M. Using contingent valuation approach for improved solid waste management facility: Evidence from Kuala Lumpur, Malaysia. *Waste Management*, 2011, 31, 800–808.
- [6] Addai, K.N., Danso-Abbeam, G. Determinants of willingness to pay for improved solid waste management in Dunkwa-on-Offin, Ghana. *Journal of Environmental and Agricultural Sciences*, 2014, 3, 1–9.
- [7] Afroz, R., Hanaki, K., Hasegawa-Kurusu, K. Willingness to pay for waste management improvement in Daka City, Bangladesh. *Journal of Environment Management*, 2009, 90, 492–502.
- [8] Banga, M., Razack, B.L., Adolf, F.M. Households' willingness to pay for improved solid waste collection services in Kampala City, Uganda. *Environment and Development*, 2011, 20(4), 53–62.

- [9] Rahji, M., Oloruntoba, E.O. Determinants of households' willingness to pay for private solid waste management services in Ibadan, Nigeria. *Waste Management and Research*, 2009, 27(12), 961–965.
- [10] Assa, M. Emerging solid waste market in Lilongwe urban, Malawi: Application of dichotomous choice contingent valuation method. *Journal of Sustainable Development in Africa*, 2013, 15(4), 56–65.
- [11] Monavari, S., Omrani, G., Karbassi, A., Raof, F. The effects of socioeconomic parameters on household solid-waste generation and composition in developing countries (a case study: Ahvaz, Iran). *Environmental Monitoring and Assessment*, 2012, 184(4), 1841–1846.
- [12] Menikpura, S., Gheewala, S., Bonnet, S. Framework for life cycle sustainability assessment of municipal solid waste management systems with an application to a case study in Thailand. *Waste Management and Research*, 2012, 30(7), 708–719.
- [13] United Nations Environment Programme (UNEP). *State of waste management in South East Asia*. New York, USA: United Nations Publication, 2004b.
- [14] Verma, R.L., Borongan, G., Memon, M. Municipal solid waste management in Ho Chi Minh City, Viet Nam, Current Practices and Future Recommendation. *Procedia Environmental Sciences*, 2016, 35, 127–139.
- [15] National Assembly of Vietnam. *Law on environmental protection 2014*. Hanoi: National Political Publishing House, 2014.
- [16] Dong Nai Urban Environment Services Company Limited. *A status report of household solid waste management in Bien Hoa*. Bien Hoa: DN.URENCO, 2016.
- [17] Tien Giang Urban Environment Services Company Limited. *A status report of household solid waste management in My Tho*. Tien Giang: TG.URENCO, 2016.
- [18] Chanhthamixay, B., Vassanadumrongdee, S., Kittipongvises, S. Assessing the sustainability level of municipal solid waste management in Bangkok, Thailand by wasteaware benchmarking indicators. *Applied Environmental Research*, 2017, 39(3), 49–61.
- [19] Ferronato, N., Torretta, V. Waste mismanagement in developing countries: A review of global issues. *International Journal of Environmental Research and Public Health*, 2019, 16(6), 1060.
- [20] Carson, R.T. *Contingent valuation: A user's guide*. *Environmental Science & Technology*, 2000, 34, 1413–1418.
- [21] Maler, K.-G., Vincent, J.R. *The Handbook of environmental economics: Valuing environmental changes*. Amsterdam, The Netherlands: Elsevier, 2005.
- [22] Hoehn, J.P., Randall, A. A satisfactory benefit cost indicator from contingent valuation. *Journal of Environmental Economics*, 1987, 14(3), 1226–1247.
- [23] Carson, R.T., Hanemann, W.M., Kopp, R.J., Krosnick, J.A., Mitchell, R.C., Presser, S., ..., Martin, K. Referendum design and contingent valuation: The NOAA panel's No-Vote recommendation. *Review of Economics and Statistics*, 1998, 80, 335–338.
- [24] Yamane, T. *Statistics, An introductory analysis*. New York: Harper and Row, 1967.
- [25] Maskey, B., Singh, M. Households' willingness to pay for improved waste collection service in Gorkha Municipality of Nepal. *Environments*, 2017, 4, 77.
- [26] Mulat, S., Worku W., Minyihun, A. Willingness to pay for improved solid waste management and associated factors among households in Injibara town,

- Northwest Ethiopia. BMC Research Notes, 2019, 12, 401.
- [27] Whittington, D. Improving the performance of contingent valuation studies in developing countries. *Environmental & Resource Economics*, 2002, 22, 323–367.
- [28] Aggrey, N., Douglasson, O.G. Determinants of willingness to pay for solid waste management in Kampala City. *Current Research Journal of Economic Theory*, 2010, 2, 119–122.
- [29] Bhattarai, K. Households' willingness to pay for improved solid waste management in Banepa municipality, Nepal. *Environment and Natural Resources Journal*, 2015, 13, 14–25.
- [30] Song, Q., Wang, Z., Li, J. Residents' attitudes and willingness to pay for solid waste management in Macau. *Procedia Environmental Sciences*, 2016, 31, 635–643.
- [31] Alhassan, M., Mohammed, J. Household's Demand for better solid waste disposal services: Case study of four communities in the New Juaben Municipality, Ghana. *Journal of Sustainable Development*, 2008, 6(11), 16–25.
- [32] Huang, C.J., Ho, Y.H. Willingness to pay for waste clearance and disposal: Result of the Taichung City Study. *The Business Review, Cambridge*, 2005, 4(2), 136–141.
- [33] Chuen-Khee, P., Othman, J. Household demand for solid waste disposal options in Malaysia. *World Academy of Science, Engineering and Technology*, 2010, 42(6), 1139–1144.
- [34] Adebo, G.M., Ajewole, O.C. Gender and the urban environment: analysis of willingness to pay for waste management Disposal in Ekiti-State, Nigeria. *American International Journal of Contemporary Research*, 2012, 2(5), 228–236.
- [35] Barmon, B.K., Mohiuddin, K., Islam, G.E., Laila, N. Willingness to pay for Solid waste management system in Dhaka City, Bangladesh: A socio-economic Analysis. *East West Journal of Business and Social Studies*, 2015, 4(2), 29–52.
- [36] Sujitra, V., Suthirat, K. Factors influencing source separation intention and willingness to pay for improving waste management in Bangkok, Thailand. *Sustainable Environment Research*, 2018, 28(2), 90–99.
- [37] Altaf, M.A., Deshazo, J.R. Household demand for improved solid waste management: A case study of Gujranwala, Pakistan. *World Development*, 1996, 24, 857–868.
- [38] Niringiye, A., Omotor, D.G. Determinants of willingness to pay for solid waste management in Kampala City. *Current Research Journal of Economic Theory*, 2010, 2(3), 119–122.
- [39] Muhdin, M.B., Ermyas, A., Fikadu, T. Determinants of households' willingness to pay for improved solid waste management in Ethiopia: The case study of Jimma Town. *Journal of Environment and Earth Science*, 2016, 6(7), 64–77.
- [40] Yusuf, S.A., Salimonu, K.K., Ojo, O.T. Determinants of willingness to pay for improved household waste management in Oyo State, Nigeria. *Research Journal of Applied Sciences*, 2007, 2(3), 233–239.
- [41] Tietenberg, T., Lewis, L. *Environmental economics and policy*. Pearson, New York, 2010.
- [42] Awunyo-Vitor, D., Ishak, S., Jasaw, G.S. Urban households' willingness to pay for improved solid waste disposal services in Kumasi Metropolis, Ghana. *Urban Studies Research*, 2013, 659425.
- [43] Thai, N.T.K. Municipal Solid Waste management in Vietnam challenges and solutions. In: Pariatamby, A., Tanaka, M. (ed.), *Municipal solid waste management in Asia and the Pacific Islands*. Singapore:

- Environmental Science and Engineering Springer, 2014.
- [44] Ferreira, S. Marques, R.C. Contingent valuation method applied to waste management. *Resources, Conservation and Recycling*, 2015, 99, 111–117.
- [45] Hair, J.F.Jr., Anderson, R.E., Tatham, R.L., Black, W.C. *Multivariate data analysis*. 3<sup>rd</sup> edition. New York: Macmillan, 1995.
- [46] Kim, J.H. Multicollinearity and misleading statistical results. *Korean Journal of Anesthesiology*, 2019, 72(6), 558–569.
- [47] Ashish, T.R., Uttam, D. Household willingness to pay for improved waste management in municipal area: A case study in Cachar District, Assam. *IOSR Journal of Humanities and Social Science*, 2013, 6(5), 21–31.
- [48] Tariq, M., Rashid, M. Solid wastes management and its willingness to pay in Mingora, Swat. *Civil and Environmental Research*, 2014, 6(8), 1–9.
- [49] Ezebilo, E.E. Willingness to pay for improved residential waste management in a developing country. *International Journal of Environmental Science and Technology*, 2013, 10(3), 413–422.
- [50] Seth, K., Samuel, C.J., Asare, W., Duwiejuah, A.B. Household demand and willingness to pay for solid waste management service in Tuobodom, Techiman-North District, Ghana. *American Journal of Environmental Protection*, 2014, 2(4), 74–78.
- [51] Tanrivermis, H. Willingness to pay (WTP) and willingness to accept (WTA) measures in Turkey: May WTP and WTA be indicators to share the environmental damage burdens: A case study. *Journal of Economic Cooperation Among Islamic Countries*, 1998, 19(3), 67–93.
- [52] Sumukwo, J., Kiptui, M., Cheserek, G.J. Economic valuation of improved solid waste management in Eldoret municipality. *Journal of Emerging Trends in Economics and Management Sciences*, 2012, 3, 962–970.
- [53] Mary, O., Adelayo, A. Household willingness to pay for improved solid waste management in Akinyelelocal government area. *Journal of Biology, Agriculture and Healthcare*, 2014, 4, 76–82.
- [54] Fonta, W.M., Ichoku, H.E., Ogujiuba, K.K., Chukwu, O.J. Using a contingent valuation approach for improved solid waste management facility: Evidence from Enugu State, Nigeria. *Journal of African Economies*, 2008, 17, 277–304.
- [55] Jin, J., Wang, Z., Ran, S. Comparison of contingent valuation and choice experiment in solid waste management programs in Macao. *Ecological Economics*, 2006, 57, 430–441.
- [56] Caplan, A.J., Grijalva, T.C., Jakus, P.M. Waste not or want not? A contingent ranking analysis of curbside waste disposal options. *Ecological Economics*, 2002, 43, 185–197.
- [57] Danso, G., Drechsel, P., Failor, S., Giordan, M. Estimating the demand for municipal waste compost via farmers' willingness to pay in Ghana. *Waste Management*, 2006, 26, 1400–1409.
- [58] Basli, M., Matteo, M.D., Ferrini, S. Analyzing demand for environmental quality: a willingness to pay/accept study in the province of Siena (Italy). *Waste Management*, 2006, 26, 209–219.