Willingness to pay for air quality improvement in Ho Chi Minh City, Vietnam

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ABSTRACT

This research aimed to estimate people's willingness to pay (WTP) to improve air quality in Ho Chi Minh City (HCMC), Vietnam. Contingent value method (CVM), the single bounded dichotomous choice question format, was employed. Five levels of bid were used, including 10,000; 20,000; 30,000; 40,000; 50,000 VND. A survey was conducted with 600 people, distributed in 8 districts. The results showed that people had limited perception on specific terms, but they understood the phenomenon and the consequence of air pollution. The mean willingness to pay (MWTP) for air quality improvement was 19,147.06 VND/person per month (0.83 USD/person per month) (with protesters) and 28,157.01 VND/person per month (1.22 USD/person per month) (without protesters). The total budget that would be used for air protection in HCMC was 86,927,652,400 VND/month (3,779,463.15 USD/month) (with protesters) and 127,832,825,400 VND/month (5,557,557.62 USD/month) (without protesters). The income, education level and bid level were the factors affecting their WTP.

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1. Introduction

Air pollution is a critical problem at urban area, especially at mega cities. Major sources of pollution are from the transportation and industrial activities. Ho Chi Minh City (HCMC) is the biggest city and the center of development in Vietnam. The economic and social development is obtained at the cost of environmental damage, especially air environment. The city air quality monitoring systems show that air is polluted by dust, noise, CO and NO_2. Transportation and industrial activities are the two main sources of air pollution in HCMC. Transportation contributes most to the pollution. The city has a total of 3,584 roads which are 3,670 km in length and spread over 36 million m^2; 7.1 millions of vehicles within the city; around 1 million of motorbikes and 60,000 cars and trucks moving in and out the city everyday (HDOEP, 2015). Monitoring data shows that 72.36% of monitored sites has an excessive concentration of dust (163.42 – 690.00 µg/m^3), 97.64% of them has excessive noise (> 70 dBA) as compared to the National Standards (HEPA, 2016). Traffic jam is another factor contributing to the consequences. In industrial area, there are 839 industrial sites, 32% of which does not have air treatment systems. Air pollution affects communities' health, especially, children health, and the number of patients related to respiratory diseases is increasing in the past 10 years (HDONRE, 2016).

In order to enhancing the air quality, there are many proposed solutions and all of them need the sustainable finance source. The more diverse financial sources are, the better the long air protection scheme is. In addition, research related to air valuation is limited and the value of environment factor is usually undervalued in making decision process.

Clean air is an environmental good which does not have price. In order to valuate this kind of resource, state preferences methodologies are used. In this group of methods, contingent valuation method (CVM) is the common one. The studies related to air evaluation are often conducted at the air polluted cities and can be divided into different categories. First, there were studies about a certain air pollution event, including WTP to reduce air pollution in Singapore caused by forest fire in Malaysia (Yuan et al., 2017), WTP to reduce smog in China (Chuanwang et al., 2016), WTP to avoid respiratory disease in Turkey (Shihomi & Cem, 2015) and WTP to enhance children health in China (Keran et al., 2015). Second, studies related to people's awareness on air pollution and WTP to reduce air pollution were also conducted (Tifanny et al., 2014; Yutao et al., 2015; Chuanwang et al., 2016). In this group of study, the authors not only used the social-economic characters as explained variables but also awareness variables to figure out the main factors affecting WTP decision. Third, there were studies on certain solutions to improve air quality such as using friendly environment energy instead of the old one (Abdullatif et al., 2016), or using public transport system rather than private vehicles (Nikolaos et al., 2010).

This research aimed to understand people's perception on air environment and their WTP for air quality improvement.

2. Materials and Methods

Clean air does not have the price on the market. In order to measure value of this good, stated preference method is usually used. The CVM belongs to this group. It is used to estimate the value of change in environment. It was developed based on the theory written by Cropper et al., Alberini et al. and Cropper and Freeman (Sarabdeen et al., 2012). As stated in the CVM in measuring the value of culture: The theory can be explained as follows: if initial utility (U_0) is a function of certain levels of income, prices, private goods and public goods, and an increase in the amount of public good supplied increases utility (U_1), then WTP is the difference between U0 and U_1, such that the final level of utility is unchanged.

This study used dichotomous question with 5 levels of price (bids). The survey was conducted by face to face interview at the respondent's house. It took 30-45 min to complete one questionnaire.

2.1. Questionnaire design

The questionnaire comprised 4 sections: introduction; interviewee's information; awareness of interviewee on air pollution; scenario and WTP question.

The designed scenario:

"HCMC is a developed city in Vietnam. Going along with the speedy development of the city is the decrease of its air quality. The main sources of air pollution are transportation and industrial activities. Air pollution is more severe in HCMC. In order to reduce pollution, comprehensive solutions are needed, including doing research, using alternative energy, planting trees, replacing the old-fashion technology, etc.

To implement these solutions, it requires a huge amount of money. Besides the government's budget, it is helpful with the contribution from community. Money generated for air protection fund will be used for reducing air pollution".

Currently, there are environment protection funds (EPF) in HCMC. This air protection fund is an assumed division under EPF management.

WTP question: Are you willing to pay «bid» VND/person per month to improve air quality? There are 5 levels of bid: 10,000; 20,000; 30,000; 40,000; 50,000 VND. These bids were recommended based on 1% of national basic salary of people.

2.2. Sample sites and size

Due to financial constraint, 600 households (HHs) in 8/24 districts of HCMC including Binh Thanh, Phu Nhuan, 1, 3, 5, Binh Chanh, Thu Duc and Hoc Mon (75 HHs/each district) were chosen by stratified random sampling. The distribution of bid levels is shown as Table 1.

Table 1. Distribution of questionnaire in sites and bid categories

Districts Name/WTP bid	10,000 VND	20,000 VND	30,000 VND	40,000 VND	50,000 VND	Total
Binh Thanh	15	15	15	15	15	75
Phu Nhuan	15	15	15	15	15	75
No.1	15	15	15	15	15	75
No.3	15	15	15	15	15	75
No.5	15	15	15	15	15	75
Binh Chanh	15	15	15	15	15	75
Thu Duc	15	15	15	15	15	75
Hoc Mon	15	15	15	15	15	75
Total	120	120	120	120	120	600

2.3. Data analysis

2.3.1. Turnbull estimation

According to Timothy & Kenneth (2002), if the answer is "Yes" to a certain price, the WTP 's respondent is equal to or higher than that price; if the answer is "No", then their WTP is less than that price.

In this study, five bid levels: t1, t2, t3, t4 and t5 were employed. From the number of respondents and the number of respondents answering "Yes" (P1, P2, P3, P4 and P5), WTP was calculated.

Then, we plotted a chart with the bids (tj) and the share of "Yes" answers (Pj) as shown in Figure 1 with tj as the horizontal axis and Pj as the vertical axis. The mean WTP is the area below the bold line in Figure 1.

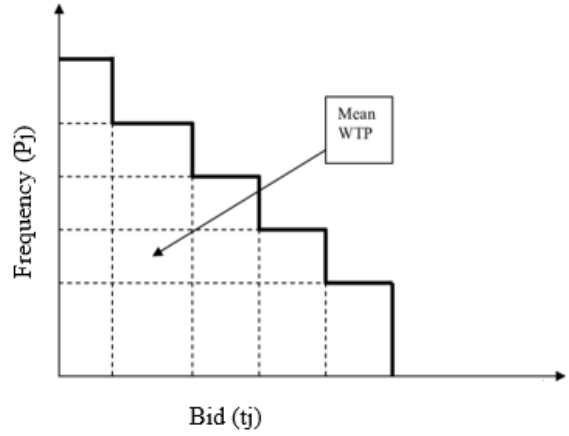

Figure 1. A Kaplan-Meier-Turnbull estimation chart.

2.3.2. Utility random model

The basic model to analyze the ditochomonous question in CVM is random utility model (Timothy & Kenneth, 2002). Basically, random utility model is used to describe an individual utility among the variety choice set. It is assumed that people will choose the alternative that brings more benefits or utility for them (Horowitz et al., 1994). In case of CVM, it will be two choices: agree or not agree to pay (Timothy & Kenneth, 2002). To estimate the random utility model with a linear utility function, a logit model was run with yes/no responses to the WTP question as the dependent variable, and bid and other respon-

Table 2. Variables explanation and expected signs

Variable	Meaning	Expected sign
Income	Monthly income (million VND/month) decides the ability to pay. People who earn more incomes, have more ability to pay	+
Education	Education level is presented by number of years they spend in school (years). The more years they spend in school, the more they want to pay for reducing air pollution	+
Number of year living in Ho Chi Minh City	The habitants who live for a long time in Ho Chi Minh City will have less intention to pay for air pollution as they are familiar with the surrounding. (Unit: Years)	-
Bid	The suggested amount of money: 10,000; 20,000; 30,000; 40,000; 50,000 VND. The higher the bid, the less people want to pay	-

dents' characteristics as the explanatory variables as follows:

$Pr(Yes_j) = a_0 + a_1 bid + \Sigma a_i X_i$

Where:

$Pr(Yes_j)$ is probability of answer "Yes"

a_n is the coefficient associated with the variables

bid is the bid level

X_i is the social-economic variables

2.3.3. Variables explanation and expected signs

Variables explanation and expected signs is shown as Table 2.

2.3.4. Eligible data

There is a question in CVM to distinguish respondents into 2 categories: support or not support for the study (i.e., protesters). This step aims to remove the protesters records which can affect the results.

The question is "Do you agree to contribute to Air Protection Fund?"

⋆ If they do not agree then they are asked for the reasons.

If the reasons for "No" response is any of following the respondents are considered as protesters:

- I don't support this project because environment protection is government duties;
- I don't support this project because the factories should be the ones who pay for the cost;
- I don't believe in this scenario;
- I have to pay many types of fees and taxes;
- I don't believe that the Fund will be used for the air protection;
- I don't know.

If the reason for "No" response is any of following the respondents are considered as supporters:

- I think reducing air pollution is important but I am not able to afford the price.
- I want to pay but the price is too high.

⋆ If they agree then they are asked for the reasons. If the response is "I don't know", then their records are removed from the computation in the case of without protesters.

In addition, this study removed the records of those who are younger than 15 years old to assure that all respondents are in their labor age (HDOS, 2018). Thus, the eligible records were 598/600 in case with protesters and 380/600 in case without protesters.

3. Results and Discussion

3.1. Respondents characteristics

Respondent's characteristics are presented in Table 3.

Table 3. Samples properties

No.	Parameters		Number of respondents (person)	Sharing (%)
1	Gender	Male	333	55.7
		Female	266	44.3
2	Ethic group	"Kinh"	578	96.3
		Others	22	3.7
3	Age	Under 18	12	2
		19 - 60	567	94.5
		Above 61	21	3.5
4	Education	Under High school	309	51.5
		Graduate	250	41.7
		Postgraduates	41	6.8
5	Main labor in households	Yes	329	54.8
		No	271	45.2
6	Career	Student	61	10.2
		Office staffs	110	18.3
		Business	180	30.0
		Homemaker	26	4.3
		Educational field	25	4.2
		Workers	58	9.7
		Others	140	23.3
7	Average income (monthly)	0-5 million VND	188	31.3
		6-10 million VND	286	47.7
		11-20 million VND	101	16.8
		21-30 million VND	15	2.5
		Greater than 31 million VND	10	1.7

Source: data analysis.

Table 4. Definition of air environment

Options	Number of respondents (person)	Sharing (%)
The air surrounding the Earth	426	71.0
The air which is 11-17 km in depth surrounding the Earth	142	23.7
There is no right answer	32	5.3
Total	600	100.0

Source: data analysis.

3.2. People awareness on air environment and air pollution

Air environment definition is not a common term to the community; the right answers occupy only 23.7% the total responses. Similarly, for air quality index (AQI), only 15.5% of respondents have heard about this term and 9.3% and 4% of them can choose the right color presented for best AQI and worst AQI, respectively. The results are shown from Tables 4 to 6.

Regarding to air pollutions consequences, 72.5% of respondents chose the right option, 21.7% chose the insufficient answer and the rest din't know the answer (Table 7).

Respondents were asked to name the air pollutants that they knew. There were 7 air pollutants mentioned, including particle, smoke, NO_x, CO_x, CFC, SO_x and natural substances (Table 8).

They were aware of the consequences of air pollution on human health, construction and vegetation as the results shown in Table 9.

Table 5. The color presented for the best air quality index

	Options	Number of respondents (person)	Sharing (%)
Valid	Don't know	36	6.0
	Green	56	9.3
	Yellow	1	0.2
	Total	93	15.5
Missing	99	507	84.5
	Total	600	100.0

Source: data analysis.

Table 6. The color presented for the worst air quality index

	Options	Number of respondents (person)	Sharing (%)
Valid	Don't know	43	7.2
	Yellow	1	0.2
	Orange	1	0.2
	Red	16	2.7
	Purple	8	1.3
	Brown	24	4.0
	Total	93	15.5
Missing	99	507	84.5
	Total	600	100.0

Source: data analysis.

Table 7. Definition of air pollution

	Options	Number of respondents (person)	Sharing (%)
Valid	Don't know	33	5.5
	The present of harmful substances in the air	130	21.7
	The change in air components	435	72.5
	There is no right options	2	0.3
	Total	600	100.0

Source: data analysis.

Table 8. Air pollutants

		Particle	Smoke	NO_x	CO_x	CFC	SO_x	Natural substances
Valid	Yes	330	335	130	257	59	39	7
Missing	99	270	265	470	343	541	561	593
Total		600	600	600	600	600	600	600

Source: data analysis.

They were asked to list the source of air pollution. Table 10 shows that transportation and industrial sources were mentioned the most.

3.3. People WTP for air quality improvement

3.3.1. Average WTP in case of protest votes

The average willingness to pay (MWTP) for air quality improvement was MWTP = $\Sigma t_j(P_j - P_{j+1})$ = 19,147.06 VND/person per month (0.83 USD/person per month) (with t_j is bid j level and P_j is frequency of bid j) (Table 11).

3.3.2. Average WTP in case without protest votes

The average willingness to pay (MWTP) for air quality improvement in case without protesters was MWTP = $\Sigma t_j(P_j - P_{j+1})$ = 28,157.01

Table 9. Consequences of air pollution

		Respiratory	Skin	Buildings	Vegetation
Valid	Yes	596	398	254	290
Missing	99	4	202	346	310
Total		600	600	600	600

Source: data analysis.

Table 10. Sources of air pollution in Ho Chi Minh City

			Transportation	Industry	Agriculture services	Natural origin
Valid	Yes	588	551	292	311	270
Missing	99	12	49	308	289	330
Total		600	600	600	600	600

Source: data analysis.

Table 11. Turnbull estimation with protest votes

Bid (VND)	Number of respondents (person)	Number of respondents who agree to pay (person)	Sharing %
10,000	119	75	63.0
20,000	120	61	50.8
30,000	120	49	40.8
40,000	120	28	23.3
50,000	119	16	13.4

Source: data analysis.

Table 12. Turnbull estimation without protest votes

Bid (VND)	Number of respondents (person)	Number of respondents who agree to pay (person)	Sharing %
10,000	79	71	89.9
20,000	87	59	67.8
30,000	84	48	57.1
40,000	63	27	42.9
50,000	67	16	23.9

Source: data analysis.

VND/person per month (1.22 USD/person per month) (Table 12).

The reasons of not willing or willing to pay are presented as Tables 13 and 14, respectively. They don't have willingness to pay because they think that government or factories should be the one in charge (14%); they don't believe in the scenario/transparent (12.5%); they have to pay many types of tax (7.5%) and they are not able to afford the bid (26.7%).

Respondents are willing to pay for the reason "it's good for them and their family's health" accounting for 35.8%; 1.2% of respondents agree to pay because the payment will be good for the community in general. Other 0.8% of them are not sure or don't know why they agree to pay.

With the population of 4,540,000 persons in the labor age in Ho Chi Minh City (HDOS, 2018), the total amount of money for air protection that can be collected is 86,927,652,400 VND/month (3,779,463.15 USD/month) (with protester) or 127,832,825,400 VND/month (5,557,948.93 USD/month) (without protester).

3.4. The relations between social-economic variable and WTP

3.4.1. With protes votes

The regression result (with protest votes) and the prediction ability are presented in Tables 15 and 16, respectively. The education, number of years living in Ho Chi Minh City and bid are

Table 13. Reasons of not willing to pay

	Reasons of not willing to pay	Number of respondents (person)	Sharing (%)
Valid	Air protection is government's duty	39	6.5
	Factories should pay for the air pollution	45	7.5
	Don't believe in the scenario	18	3.0
	Already have to pay many types of fee/tax	45	7.5
	Are not able to afford the bid	160	26.7
	Don't believe in the transparent	57	9.5
	I don't know	6	1.0
	Others	3	0.5
	Total	373	62.2
Missing	99	227	37.8
	Total	600	100.0

Source: data analysis.

Table 14. Reasons of willing to pay

	Reasons of willing to pay	Number of respondents (person)	Sharing (%)
Valid	I don't know	5	0.8
	Good for individual and family's health	215	35.8
	Other: good for community	7	1.2
	Total	227	37.8
Missing	99	373	62.2
	Total	600	100.0

Source: data analysis.

Table 15. Regression model with protest votes

	B	S.E.	Wald	df	Sig.	Exp(B)
Education	0.072	0.025	8.080	1	0.004	1.074
Income	0.009	0.010	0.843	1	0.359	1.009
Number of year living in Ho Chi Minh City	-0.012	0.006	4.504	1	0.034	0.988
Bid	-0.558	0.069	66.008	1	0.000	0.572
Constant	0.387	0.397	0.955	1	0.329	1.473

Variable(s): education, income, number of year living in Ho Chi Minh City, bid. R^2 = .193.

the variables affecting people WTP. In particular, people who spend more years in school are more willing to pay for air protection; the less years they live in HCM city, the more they intend to pay; the lower the bid is, the more they want to pay. R^2 is 0.193 meaning that there are more other variables that need to be considered in further research. However, this model can predict the probability of payment up to 68.2%.

3.4.2. Without protest votes

The regression result (without protest votes) and the prediction ability are presented in Tables 17 and 18, respectively. The variables affecting people WTP are education, income and bid. In particular, people who spend more years in school have more willingness to pay for air protection; people who earn more will have the intention to pay; the lower the bid is, the more they want to pay. Table 18 shows that the model can predict decision of payment up to 76.6%.

3.5. Payment collection means and frequency

Table 19 shows that people prefer to pay monthly (51.6%) rather than others. Many of them want to pay directly to air protection fund (51.6%) as presented in Table 20.

Table 16. Predict the decision of payment

	Actual data		Prediction		
			Willing to pay		Accurate prediction (%)
			No	Yes	
Step 1	Willing to pay	No	303	68	81.7
		Yes	122	105	46.3
	Average				68.2
a. The cut value is 0.500					

Source: data analysis.

Table 17. Regression model without protest votes

	B	S.E.	Wald	df	Sig.	Exp(B)
Education	0.101	0.034	8.736	1	0.003	1.106
Income	0.181	0.033	29.912	1	0.000	1.199
Number of year living in Ho Chi Minh City	-0.011	0.008	1.811	1	0.178	0.989
Bid	-0.852	0.105	65.413	1	0.000	0.426
Constant	0.487	0.527	0.854	1	0.355	1.627

Variable(s): education, income, number of year living in Ho Chi Minh City, bid. $R^2 = 0.395$.

Table 18. Predict the decision of payment

	Actual data		Prediction		
			Willing to pay		Accurate prediction (%)
			No	Yes	
Step 1	Willing to pay	No	105	54	66.0
		Yes	35	186	84.2
	Average				76.6
a. The cut value is 0.500					

Source: data analysis.

Table 19. Payment collection means

	Options	Number of respondents (person)	Sharing (%)
Valid	Monthly	114	51.6
	Quarterly	52	23.5
	Annually	55	24.9
	Total	221	100.0

Source: data analysis.

Table 20. Payment collection frequency

	Options	Number of respondents (person)	Sharing (%)
Valid	Attach the bid with electricity bill	86	38.9
	Attach the bid with water bill	15	6.8
	Pay directly to the air protection fund	114	51.6
	Others	6	2.7
	Total	221	100.0

Source: data analysis.

4. Conclusions

People do not know exactly about the specific definitions, but they have awareness on air pollution impacts, air pollutants, etc. The average WTP is 19,147.06 VND/person per month (0.83 USD/person per month) and 28,157.01 VND/person per month (1.22 USD/person per month) in case of with and without protesters. Thus, the city might

have 86,927,652,400 VND/month (3,779,463.15 USD/month) and 127,823,825,400 VND/month (5,557,948.93 USD/month) in case of with and without protesters. People want to pay monthly and directly to Air Protection Fund. The variables which affect people WTP for air protection are education, income and bid. Some concerns arise for further related research, including considering the difference in WTP for different target groups and policy assessment on people who do not agree with the added fee for air environment, especially, people who can not afford to make payments.

Conflict of Interest

All authors have no conflict of interest of this report.

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