JASEM ISSN 1119-8362

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://ww.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 22 (7) 1037 –1041 July 2018

Establishment of a New Urban Solid Waste Management Programs in Mazandaran Province, North of Iran

AMIRNEJAD, H; *JAHANIFAR, K; SHAHPORI, A; ESHGHI, F

Department of Agricultural Economics, Sari University of Agricultural Sciences and Natural Resources, Sari, Iran
Email: k_jahanifar@yahoo.com

ABSTARCT: This study reports residents' preferences to establish a new urban solid waste management programs results from a double-bounded dichotomous choice contingent valuation method and choice experiment in Mazandaran province, north of Iran. In order to analysis the residents' preferences, a dichotomous hypothetical market and a choice sets with different attributes and options were used For estimation of two mentioned methods, the normal logit and conditional logit were applied. In addition, an empirical comparison of the welfare measures derived from the double-bounded DC-CVM and CE is conducted. The main results show that there is no significant difference between the values derived from the two methods. The mean of WTP to establish a new solid waste management programs in CV and CE were estimated 2.45 and 2.61 US$, respectively, per a person per a month. Also the estimated marginal WTP for all attributes in CE was 8.1 US$ per a month. The results suggest that both double-bounded DC-CVM and CE can be successfully stablished for improvement environmental level quality in Mazandaran province. This paper could provide the basis for further development of other new programs on sustainable urban management of solid waste in Mazandaran province.

DOI: https://dx.doi.org/10.4314/jasem.v22i7.7

Dates: Received: 09 April 2018; Revised: 30 May: 2018; Accepted: 11 June 2018

***Keywords*:** Dichotomous choice, Willingness to pay, Solid waste management, Mazandaran province, Iran

INTRODUCTION

The management of solid waste is a main problem in urban areas throughout the world but particularly in the quickly growing cities and towns in the developing world (Guerrero-Baena *et al*., 2015). A high rate of population growth and increasing per capita income have resulted in the generation high amount of solid waste posing a serious threat to environmental quality and human health (Snigdha, 2003; Liu *et al*., 2014a). From an economic aspect, optimal solid waste management systems would be those that stabilize that a community gains the maximum benefit from the disposal of its waste (Laforest *et al*., 2013). Because solid waste collection and disposal services are often underpriced or non-priced, it is difficult to derive their economic benefits from ordinary market prices (Willson *et al*., 2013). Stated preference (SP) methods such as contingent valuation method (CVM) and choice experiment (CE) are the primary means of valuing non-market benefits as they can develop hypothetical markets to elicit residents' willingness to pay (WTP) for changes of non-market goods to institute the benefits (Midzic *et al*., 2013). The CVM has been the most commonly used non-market valuation method for estimating the benefits of environmental goods and services, but this method is viewed with some doubt, especially in situations where multiple options and several attributes are being considered. Researchers have got positive consequences using CE for valuing the benefits of nonmarket environmental goods or services (Hanley *et al*., 2002; Carlsson *et al*., 2003; Sasao, 2004). Early examples of comparisons between these two different non-market valuation methods applied to the same or similar problem include on recreational moose hunting, on preserving caribou habitat in Alberta, Christie and Azevedo (2002) on lake's water quality, Lehtonen et al. (2003) on forest conservation in Finland, Hala (2003) on water quality in Cairo and Christie et al. (2004) on biodiversity in UK. In this, one aim of this study is to compare the results of double-bounded DC-CVM and CE with respect to solid waste management programs in Mazandaran province (MP). Since MP is a special ecological region in Iran with a complex political, institutional, cultural and socioeconomic background, a related objective is to learn if CVM and CE can be applied in MP. Hence, the objective of this paper is to investigate the establishment of a new urban solid waste management programs results from a double-bounded dichotomous choice contingent valuation method and choice experiment in Mazandaran province, north of Iran.

MATERIALS AND METHODS

*Corresponding Author Email: k_jahanifar@yahoo.com

Mazandaran province (MP) with an area of 23,833 square kilometers with a population of 3 million consists of 16 cities (Statistical center of Iran, 2015b) . The province with a variety of appropriate ecosystem conducive to human life is one of the most important areas of high population attraction in the country. Population growth and increasing urbanization in the last three decades have increased the amount of solid waste in cities. A quick glance at solid waste management situation in most cities of the province suggests that solid waste management has still many shortcomings (Akhani *et al*., 2010) this not only caused the environmental pollution but also brought waste of energy, waste of resources and capital and eventually citizen's dissatisfaction .According to the studies carried out in Mazandaran, every day over 3,150 tons of waste is produced and 1,450 tones belong to rural area to 1700 tones to the metropolitan area. Of the total waste produced in the province, 68 %is the wet waste and the rest includes 9% of waste paper, 5 %of glass, 7 %of plastic, 3 %of metal, 3 %of wood. Theoretical model: Both choice experiment (CE) and dichotomous choice contingent valuation method (DC-CVM) are based on random utility theory, which assumes that choices are relied on utility comparisons between the available alternatives, and the alternative providing the highest utility will be the preferred choice.

Empirical design and data collection: In order to develop the CV and CE methodology for monetary valuation of solid waste management programs in MP, this study conducted a CV and CE survey. The questionnaires used in this study were based on five focus group discussions among the agencies involved in waste collection, waste transportation and treatment services, municipality, some environment experts, as well as some local residents. Then a pretest study was conducted on 45 residents in 3 main city (Sari, Babol and Amol) in MP for both CV and CE in order to reveal misinterpretations of the questions and the difficulty of the choice tasks. The final survey was conducted face-to-face by 5 well-trained MSc and Ph.D students from the department of Agricultural Economics, Sari Agricultural Sciences and Natural Resources University. The sample contained 414 household heads (male or female) aged 18 – 65 years old. All of respondents received the CV and CE questionnaires, but the socioeconomic characteristics were the same in CV and CE questionnaires. The respondents were selected by stratified random sampling based on the parameters of age, sex and population published by official statistics (Statistical center of Iran, 2015a). As a result, the enumerators were instructed to address their questions directly to the heads of the household who are permanent residents of MP.

RESULTS AND DISCUSSION

Socioeconomic characteristics of respondents: A total of 414 samples were collected from September to November in 2016. Table 2 presents the descriptive statistics of the main socioeconomic characteristics of respondents. The mean age of the respondents was 0.6943. About 42.32% had completed a university degree in CV and CE. The mean household size was around 3.85 with a mean of 0.72 persons under 15 years of age. The average household income was around 15,000.000.00 IR Rials/month (562.53 US$/month). Attitudes of respondents to waste segregation and recycling: In CV, among 207 valid questionnaires, there were 156 (65.52%) respondents who would be willing to pay different amounts of money for the new solid waste management program and only 51 (34.48%) respondents who select the status quo option and gave zero WTP. In CE, among 207 questionnaires, only 68 (33.7%) of the respondents select the current conservation level in all eight choice tasks, indicating zero WTP. On the level of notification and the feasible practice to be undertaken by the households themselves regarding waste segregation at origin, the majority (78.98% and 83.27% in CV and CE, respectively) stated that they had heard of waste segregation at origin and 54.23% of the CV respondents (63.16% in CE) thought that it was necessary to performance waste segregation at origin

Estimation results from double-bounded DC-CVM: In this method, the individual is stated with a first bid (BID_I) and asked whether she or he would pay this price for the new program when thinking about her or his maximum subjective value. If the answer is yes, then a second higher bid (BID_U) is offered. If the answer is no, then a lower second bid (BID_L) is asked. The respondent then chooses between two alternatives: an improved state with three potential costs (BID_I, BID_U and BID_L) that derive a utility U^1, and the status quo U^0 yielding no betterment in environmental conditions and no increase in cost. Four possible outcomes get with different probabilities of (i) both answers are "yes"; (ii) a "yes" pursued by a "no"; (iii) a "no" followed by a "yes"; and (iv) both answers are "no". Assuming each random term is Type I extreme value distributed, the following response probabilities are derived for research model: Where BID_I is the initial bid; BID_U is the higher bid; BID_L is the lower bid; are parameters; is the socioeconomic characteristics of respondent.

Table 1: Attributes and their levels used in CE

Levels	Attribute	
Once a day, irregular; twice a day, regular	Collection frequency	1
No change; less noise up to 50%	Noise reduction in waste collection and transportation process	2
Wash and disinfect garbage containers with warm water 1 per month; ; twice a month	Attention to health	3
No need; need and multiple color free containers provided by Municipality	Waste segregation and recycling at source	4
60,000, 120,000 IR Rials	Monthly garbage fee per person	5

Table 2: Main socioeconomic variables of the respondents in CV and CE

Variables	Description	Mean	Standard deviation
Observations		414	-
GENDER	1= Male, 0 = Female	0.4239	0.4792
AGE	Age of respondents (1=18–39, 0 = 40 – 65)	0.6943	0.3973
EDUCATE	Education of respondents (1= above diploma level, 0 = below diploma level)	0.3874	0.4198
HOLIVING	Number of household members living together	3.8527	2.9326
HO15	Number of household members less than 15 years old	0.7192	0.8527
HOEARN	Number of household members earning income	1.923	0.8942
INCOME	Total household income (US$/month)	562.53	382.73

Table 3: Variables included in the logit analysis

Variables	Definition	Mean	Standard deviation
BID	Bid used in WTP questions (US$)	-	-
GENDER	1=male, 0=female	0.4283	0.5928
EDUCATE	Education level of respondents (1=above diploma level, 0=below diploma level)	0.4283	0.5237
CONSWM	Dummy variable denoting respondents' concern about solid waste management (1=concerned, 0 = not concerned)	0.5729	0.5932
HO_{15}	Number of children (below 15 years old) living in the household	0.4839	0.5382
INCOME	Total household income (US$/month)	1250.53	980. 53

The results are presented in Table 4. Almost all explanatory variables have expected signs and are significant. The coefficient of EDUCATE is positive and significant at the 1% level, which indicates that a respondent with a higher education level would be willing to pay more for any better solid waste management program.

Table 4: The factors influencing respondents' choices

Variables	Coefficient	Standard error	t-value	p-value
Constant	0.3829	0.4293	0.872	0.5372
BID	-0.1573	0.1728	9.839	0.0000***
GENDER	0.7392	0.2692	3.253	0.0149**
EDUCATE	1.2831	0.3829	4.936	0.000***
CONSWM	1.7291	0.3845	4.283	0.000***
HO_{15}	-0.3729	0.2012	-1.923	0.3829
INCOME	0.0982	0.0538	4.738	0.0000***

*** Significant at P-value = 0.05; *** Significant at P-value = 0.01.*

In addition, the coefficient for the attitudinal variable CONSWM is positive and significant, which supports the hypothesis that the respondents who are more interested about the current solid waste management in MP would have more WTP for this new solid waste management program. The coefficient for HO_{15} is negative, which points that WTP is forced out by the costs of caring for increasing the family.

Estimation results from CE: Conditional logit (CL) models were estimated using the data derived from CE questionnaires with Stata v.13.0 (Greene, 2002). The definitions of the variables used and their main statistics are introduced in Table 5. The first model, called model 1, is a basic specification which presents the importance of the choice attributes in explaining respondents' preferences of the different management program options. The second model, called model 2, discussed both socioeconomic and attitudinal variables in addition to the attributes in the choice sets.

The estimation results of these models are presented in Table 6.

The coefficients of all attributes in both model 1 and model 2 have the expected signs. The coefficients of almost all attributes in the choice sets both in model 1 and model 2 are significant at the1% level with the exception of FRQ (waste collection frequency).

Table 5: Variables included in CL model analysis

Variables	Definition	Mean	Standard deviation
C_1, C_2	Alternative specific constants for options B and "none" choice	-	-
INCOME	Total household income (US$/month)	1025.34	863. 88
EDUCATE	Education level of respondents (1=above diploma level, 0=below diploma level)	0.4283	0.5018
HOEARN	Number of household members earning income	3.8236	0.9823
CONSWM	Dummy variable denoting respondents' concern about solid waste management (1=concerned, 0=not concerned)	0.3845	0.4787
AGE	Age of respondents (1=18–39, 0=40–65)	0.4335	0.4956
WSEPAR	Dummy variable denoting supporting waste segregation; "1" for supporting, and "0" otherwise	0.5862	0.4538
ENVICA	Dummy variable denoting participation in environmental conservation activities; "1" for participation, and "0" otherwise	0.3684	0.4277
HO_{15}	Number of children (below 15 years old) living in the household	0.4915	0.4638

Table 6: The estimation results of model 1 and model 2

Variables	Model 1			Model 2		
	Coefficient	Standard error	p-value	Coefficient	Standard error	p-value
B_SEPR	0.5684	0.2157	0.0000***	0.7624	0.1937	0.0000***
B_FRQ	0.0853	0.1143	0.4125	0.0953	0.1253	0.4928
B_NOISE	0.5982	0.1294	0.0000***	0.5389	0.1193	0.0000***
B_COST	-0.1253	0.0063	0.0000***	-0.1163	0.0065	0.0000***
C_1	0.9836	0.1273	0.0000***	0.8638	1.5037	0.0000***
C_1*INCOME				0.0001	0.0001	0.0073***
C_1*EDUCATE				0.7382	0.1738	0.0000***
C_1*HOEARN				-0.2038	0.1082	0.0026***
C_1*CONSWM				0.2834	0.0382	0.0202**
C_2	-2.2153	0.2517	0.0000***	-2.5377	0.2972	0.0000***
C_2*AGE				-0.8721	0.3921	0.0023***
C_2*WSEPAR				0.6829	0.3173	0.0036***
C_2*ENVICA				0.7183	0.2482	0.0072***
C_2*HO_{15}				-0.9263	0.4321	0.0053***
Summary statistics						
Log likelihood	-1236.97			-1182.92		
Chi-squared	452.63***			563.53***		
Pseudo-R^2	0. 2033			0.2739		
Iterations completed	6			8		

** Significant at P-value ≤ 0.05, *** Significant at P-value ≤ 0.01

Both model 1 and model 2 are significant at the 1% level, as presented by the chi-square statistic. The larger the value of the Log likelihood is, the better the fit of the model to the observed samples are (Sasao, 2004). The pseudo-R^2 also lets us to compare the fit of different models. The larger the value of the pseudo-R^2 is, the better the fit of the model to the observed data is (Christie et al., 2004). As shown in Table 6, model 2 has a larger value of the Log likelihood and a larger pseudo-R^2, which is near to the 20% level offered as informing a very appropriate fit in this kind of data. Therefore, model 2 with covariates is assumed the superior model, and the marginal WTP from this are applied in the following part.

Table 7: Marginal WTP for each attribute in choice sets when using model 2

Attributes	WTP IR Rials (US$)	(%)
SEPR	73160 (2.3)	95.2
FRQ	34500 (1.7)	44.9
NOISE	76830 (2.4)	100
HYGIENE	74830 (2.3)	97.4
TOTAL	257320 (8.1)	-

Welfare analysis: However two different methods were applied, comparison of welfare estimates is still practical because CE and double-bounded DC-CVM share a common theoretical base. As for CVM only one change can be examined where the suggested improvement is waste segregation and recycling at origin, a development in waste collection frequency and attention to health, reduction in noise during waste collection and transportation, while the CE technique allows estimation of welfare impacts. Thus, in order to compare welfare measures from CE and DC-CVM, the CE is limited to estimate the welfare impact of the same reform suggested in CVM. For the CE the change of a proposed solid waste management program was valued using the following expression:

Table 8: Marginal WTP for each attribute in choice sets when using model 2

Methods	WTP IR Rials (US$)	95% CI IR Rials[a] (US$)
CVM	68800 (2.15)[b]	58240 to 78400 (1.82 to 2.45)
	78400 (2.45)[c]	67840 to 88000 (2.12 to 2.75)
CE	81920 (2.61)[d]	71040 to 92800 (2.22 to 2.90)

[a] 95% confidential intervals are obtained by the so-called delta method (Greene, 2000).

[b] WTP is obtained with covariates and with all respondents indicating zero WTP included.

[c] WTP is obtained with covariates but with all respondents indicating zero WTP excluded.

[d] WTP is obtained using model 2 with covariates.

This paper introduces a comparison between resulting welfare measures determined by two different stated choice methods: the double-bounded dichotomous choice contingent valuation method (DCCVM) and choice experiment (CE). The application involved the values of alternative solid waste management policy changes in MP. There is no significant difference found between the estimated values of the changes in solid waste management programs derived from these two methods. But the results of the analysis have stated that the benefits of the CVM approach are that it can instantly estimate the economic values for a particular condition (specific change in an environmental good or service) and statistical estimation is relatively simple.

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