Full Length Research Paper

Household Willingness to Pay for Improved Solid Waste Management in Shashemene Town, Ethiopia

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This study tried to investigate urban community’s willingness to pay for improved solid waste management. Double Bounded Dichotomous Choice technique was used to examine household’s willingness to pay for improved solid waste management. The collected data further analyzed Bivariate probit and logistic regression models to investigate the mean and factors determining willingness to pay for solid waste management. A random sampling technique produced surveys from 190 households. Majority of the households indicated that the current solid wastes management is very poor. The econometric result showed that the mean and total willingness to pay from double bound elicitation method was 16US$/household/year and 590,473.22US$/year respectively, while the mean and total willingness to pay from open ended elicitation method were computed at 14US$/year and 524,306.8US$/year. The mean annual willingness to pay for solid waste management from double bound elicitation method was greater than from open ended elicitation method. Households’ age, size, income, education and amount of solid waste generated as well as bid value, were key determinants of solid waste management improvement. Hence, policy makers should target double bounded elicitation method than open ended elicitation method of eliciting the willingness to pay for solid waste management improvement.

Key words: Willing to pay, logistic regression, Bivariate profile, contingent valuation method (CVM), solid waste management (SWM).

INTRODUCTION

Cities in developing countries are facing increasing generation of waste (Begum et al., 2007) and accompanying problems associated with waste collection and disposal (Begum et al., 2007) resulting from urbanization process that brings a lot of problems in most third world countries (Kwabena and Danso-Abbeam 2014). In Africa, it is estimated that currently the rate at which solid waste is growing in urban areas is much...
faster than the urbanization itself (Hoornweg and Bhada-Tata, 2012). Likewise, according to UNESC (2009), urbanization with poor waste management practice, especially widespread disposal of waste water bodies dumping inside the road and uncontrolled dump site magnifies the problem of low sanitation level across the African countries. The problems are aggravated by high amount of waste generation, shortage of waste disposal sites, lack of waste collection by municipality offices, and less attention and poor disposal habits by dwellers (Bang et al., 2011). As evidences have shown that the global populations of urban residence continue to grow significantly within the last decades, it was reported that with about 30% of world population living in urban areas in 1950s, the figure is projected to reach 66% by year 2050 (United Nations, 2015).

In the last few years due to rapid natural population growth, high rural-urban migration and rising per capita incomes, cities in Ethiopia are growing fast (FDRE PCC, 2008). But the technology, technical knowhow, financial capacity, and understanding of the community required to properly manage solid wastes are not sufficiently available (Ali, 2001). As a result, most urban area in Ethiopia lack of financial resources and institutional power to supply basic infrastructures and services such as, the way how to manage solid wastes for the dwellers (Chakrabarti and Sarkhel, 2003). SWM is a daily routine that is continuous and never ends. As each day passes, it brings new task of streets to sweep, waste to collect, waste loads to haul and safely to dispose (Onukogu et al., 2017).

In order to ensure conducive urban environment for wellbeing of urban dwellers, a solid waste management services must be fulfilled (Muhdin et al., 2016). In Ethiopia, all urban level governmental bodies are taking the responsibility for SWM services (Muhdin et al., 2016), but these services are only focusing on collection of wastes from dumping areas (Muhdin et al., 2016). At present, Shashemene town municipality has a single truck and also allowing jobless youths to participate in waste management system via door to door collection by their push cart. Similarly, the households are expected to store wastes on their plastic bags or other temporary storage inside the home and hand over to these private waste collectors; (that is, community based approach). But what is actually observed is different; that is, there are wastes which are dumped on the road, burning inside the village and throwing in sewerages by the households. This implies that, solid wastes released from home are not properly managed by the households. Additionally, most municipalities have been disposes urban wastes improperly on open land near different agricultural lands. As a result, different waste debris has been carried away by the wind blown from the disposal sites and thereby trashes surrounding farms and homesteads.

Most studies are carried out on solid waste management practice improvement by given more focuses on waste generation rate of urban areas (Lemma, 2007; Melaku, 2008) and even special emphasis is given to the determinants of recycling of solid wastes; which is revolving on developed nations (Sterner and Bartelings, 1999). But such assessments do not guarantee to conclude about the factors affecting households’ willingness to pay for improved SWM. Likewise, previously some studies have been conducted on identifying SWM constraints and most of them reached different conclusions for the same research ideas (Tadesse, 2006; Dagnew et al., 2012; Amiga, 2002), that required further study. To this effect, it is impossible and does not guarantee to deal with the wide world urban areas by only taking the studies conducted in a certain specific area.

In addition, most of the studies have been conducted at the regional level and sub cities of Addis Ababa - Ethiopia. So, this work attempts to fill the research gap on SWM existing at zonal level and to identify factors mostly affecting this micro level. On top of these, this type of study has not been ever conducted in the selected area, and the municipality also has not filtered or proved information about the problem of SWM. Hence, this study is timely to find the real factors affecting households’ willingness to pay for improved SWM practice of the town and tries to provide feasible solution for the identified problems. For that reason, based on an in-person household survey, the objectives here are (i) to assess the existing situation of SWM, (ii) to estimate households’ WTP for improved SWM using the contingent valuation method (CVM) and (iii) to identify socioeconomic determinants of households’ WTP for improved SWM.

MATERIALS AND METHODS

Site description

This study was carried out in Shashemene town. Shashemene is the zonal city of west Arsi zone; geographically; the town is located at 7°11’10”N to 7°13’19” N latitude and 38°35’02” E to 38°37’05” E Longitude. It is located within the Great Rift Valley system and is close to the lake and holiday resorts of Hawassa town, Langoano and the Shala-Abiyata Park. Its altitude ranges from 1,672 - 2,722 m a.s.l. Mount Abaro is the highest point 2, 580 m a.s.l. The total population of Shashemene was estimated around 150,000 by 39,474 households (CSA, 2010). Figure 1

Data collection and sampling method

Multistage stage sampling technique was employed for sample household selection to collect the necessary data for the study. In the first stage, Shashemene town was purposively selected. The selection of the town was made on the account that it is the 2nd center of commercial area next to Addis Ababa. In the second stage, three peasant associations (PAs) namely Abosto, Arada and Didaboke were selected on the basis of population number and commercial activities. Lastly, random sampling method was employed to select the sample households. Total number of households (HHs) in the selected peasant association was 10,935. Using Equation 1 for sample size determination given by Israel
a sample size of 199HHs was obtained with a sample fraction (k) of 0.027 at 7% significant level.

\[ n = \frac{N}{1 + N \cdot e^2} \]  

Where: \( n \) is sample size, \( N \) is total households and \( e \) is the significance level.

A semi-structured questionnaire was prepared. The questionnaire was pre-tested in 2 households from each PA and 3 experts from Shashemene municipality workers and 6 from solid waste collector cooperatives, respectively. The questionnaire was amended based on the feedback from a pre-test. In the Double-bounded dichotomous choice elicitation format, a respondent was asked about his/her WTP of a pre-specified amount of initial bid during pilot survey for the proposed SWM practices.

Contingent valuation method (CVM) in the form of double-bounded dichotomous choice elicitation method (Haab and McConnell, 2002) with open ended follow up question was also employed to explore households’ WTP for improvement of SWM (Haab and McConnell, 2002). The double-bounded dichotomous choice format (yes-no, no-yes responses) (Arrow et al., 1993) makes clear bounds on unobservable true WTP and the yes-yes; no-no response sharpens the true WTP (Haab and McConnell, 2002). The double-bounded dichotomous choice format also helps to elicit more information about respondents’ WTP than single bounded format (Arrow et al., 1993; Hanemann et al., 1991).

Bid design scenario

The payment vehicle was monthly garbage fee to be paid to the service provider (Cameron et al., 2002). Based on the scoping survey and pilot survey, five different bid prices were determined as birr 30, 35, 40, 45 and 50. Using these initial bids, sets of bids were determined for follow up questions based on whether the response is “no” or “yes” for the initial bid (Table 1). If the respondents were willing to take the offered initial bid, the follow up bids were 35, 40, 45, 50 and 55 birr; in case of a “no” response to the initial bid; the follow up bids were 25, 30, 35, 40, and 45 birr respectively.

Given this, the actual survey was undertaken by dividing the total sampled households randomly into five groups. The survey was successfully completed with relatively small number of protest zeros (about 2%). These protesters provided wrong value and after checking for sample selection bias, they were excluded from the data set. The criteria for selecting protest zero were based on the report of the NOAA Panel on contingent valuation (Cameron et al., 2002). According to Cameron et al. (2002) suggestion, respondents are willing to pay the stated amount but if the respondent believes that the proposed scenarios were distributed unfairly; one can refuse to accept the hypothetical choice.

Data analysis

The survey data were analyzed using descriptive statistics and econometric models. The descriptive statistics includes mean, standard deviation, percentages, frequency distribution and graphs.

Econometric model specification

In this research the double-bounded value elicitation question format was chosen to elicit the WTP of respondents for the proposed change and for the purpose of statistical efficiency and consistency. The main advantage of double-bounded over single-bounded format is that it increases the statistical efficiency of CV.
The value \( VIF = \frac{1}{1 + R^2} \) indicates the degree of association between explanatory variables. Out of the considered 190 responses, 53 (27.87\%) households provided complete responses and were considered in the analysis. However, the remaining 94 (4.52\%) households gave incomplete responses or did not provide the required information, and thus were dropped from the analysis. Out of the considered 190 respondents, 45 (23.68\%) households were not willing to pay for improved waste management.

The logit (double log) linear regression model was used to obtain the willingness to pay of the households for improved waste management. The logit (double log) linear regression model was applied to test the multicollinearity between continuous explanatory variables (Appendix 1). It was computed as:

\[
P_i = \Phi \left( \frac{Y - 1}{\chi^2} \right) = \frac{1}{1 + e^{-\left(\beta_0 - \beta_1 x_i\right)}}
\]

Where \( P_i \) is a probability that \( Y_i = 1 \) (WTP for improved SWM), \( \chi^2 \) is a set of independent variables, \( Y \) is dependent variable (Responses of household to willingness to pay question which is either 1 if Yes or 0 if No), \( \beta_0 \) is the intercept which is constant, \( \beta_1 \) is the coefficient of the price that the households are willing to pay for improved solid waste management.

### Bivariate probit model

Bivariate normal probability density functions are among the familiar bivariate distributions employed commonly by statisticians; they allow for a non-zero correlation, whereas the standard logistic distribution does not (Cameron and Quiggin, 1994). Hence, the bivariate probit model is used in this study to estimate the mean WTP from the double bounded dichotomous choice. For estimation of WTP, the bivariate probit Model is used, that is, double bound Dichotomous choice model takes the following form (Haab and Mconnell, 2002).

The \( j^{th} \) contribution to the Likelihood function is given as,

\[
L_j (\mu / t) = Pr(\mu_1 + \epsilon_1 \geq t_1, \mu_2 + \epsilon_2 < t_2)^{YY} \cdot Pr(\mu_1 + \epsilon_1 > t_1, \mu_2 + \epsilon_2 \geq t_2)^{YY} \cdot Pr(\mu_1 + \epsilon_1 < t_1, \mu_2 + \epsilon_2 < t_2)^{YY} \cdot Pr(\mu_1 + \epsilon_1 > t_1, \mu_2 + \epsilon_2 \geq t_2)^{YY}
\]

This formulation is referred to as the bivariate discrete choice model.

Where \( \mu = \) mean value for willingness to pay, \( YY = 1 \) for a yes-yes answer, 0 otherwise, \( NY = 1 \) for a no-no answer, 0 otherwise, etc. and the \( j^{th} \) contribution to the bivariate probit likelihood function becomes.

\[
L_j (\mu / t) = \Phi_{1,2}(d_1 \cdot (t_1 - \mu_1) / \sigma_1, d_2 \cdot (t_2 - \mu_2) / \sigma_2, d_1 d_2 p).
\]

Where

- \( \Phi_{1,2} \) = Standardized bivariate normal distribution function with zero means
- \( Y_{1j} = 1 \) if the response to the first question is yes, and 0 otherwise
- \( Y_{2j} = 1 \) if the response to the second question is yes, 0 otherwise
- \( d_1 = 2y_1 - 1 \), and \( d_2 = 2y_2 - 1 \)
- \( p = \) correlation coefficient
- \( \sigma = \) standard deviation of the errors

---

<table>
<thead>
<tr>
<th>Table 1. Bid design.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lower second bid (LSB)</strong></td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>35</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>45</td>
</tr>
</tbody>
</table>
This general model is estimated using the standard bivariate probit algorithms. Finally, the mean willingness to pay (MWTP) from bivariate probit model was calculated using the formula specified by Haab and Mconnell (2002).

\[ MWTP(\mu) = - \frac{a}{\beta} \]  

Where \( a \) = coefficient for the constant term, \( \beta \) = coefficient offered bids to the respondent

The data were analyzed using STATA version 11.0 and SPSS version 16.0.

RESULT AND DISCUSSION

Existing situation of solid waste management

As a result of rapid population growth and city's expansion, there are multiple issues of sanitary situation and waste management systems. Even though there have been newly constructed vacuum tankers, wells and garbage containers in the city, sanitary and waste management related issues still remain critical problems. As a result, currently liquid and solid wastes are being disposed in open space without any treatment involvements (Shashemene City Administration, 2016, unpublished). To minimize this problem, the municipality is applying different interventions like employing full time and part time sanitary staffs, giving permission to door to door solid waste collector cooperative members, transporting disposal of solid wastes and putting containers in different areas to improve SWM and creating awareness on environmental cleanliness and public health. Besides, 3 vehicles have been pressed into service: one mini truck, one tipper, one tractor trailer, one J.C.B for lifting of solid waste and carrying of the waste disposal point. According to the respondents, the municipality provides these services but the problem is not solved. Since households were dumping wastes from central bins, dust has been placed in residential, market and commercial areas. In addition the container is not placed on time. Only cooperative members take the waste of households since they make payments. However, poor households not able to pay dump the waste nearby river, open space, street, drain and/or burn openly.

According to the Federal Democratic Republic of Ethiopian SWM proclamation no. 513/2007, environmental cleanliness and public health responsibility relied on the shoulder of urban municipality. However, rapid growth of population, urbanization, economic expansion, lack of proper awareness on SWM of households, lack of infrastructures, lake of investors participate in waste management system via door to door collection, financial problems were the main challenging problems in SWM in Shashemene town. The study is also related with what has been found by Solomon (2006) and Dagnaw et al. (2012) in Mekelle city; Ashenafi (2011) in Ambo town; Begum et al. (2007) in Malaysia and Banga et al. (2011) in Kampala City, Uganda. Urbanization, economic expansion, lack of proper awareness and generation rate and type of solid wastes are determined by the consumption habits and living condition of each household.

Estimation results from double bounded dichotomous choice

In this double bounded dichotomous choice method, the respondents were subjected to choose between two alternatives: an improved SWM situation with three potential costs (FB, LSB, and SUB) that derive a utility \( U_1 \) and the status quo \( U_0 \) yielding no improvement in environmental conditions and no increase in cost. Four possible outcomes arise with different probabilities of: (i) both answers are ‘yes’; (ii) a ‘yes’ followed by a ‘no’; (iii) a ‘no’ followed by a ‘yes’; and (iv) both answers are ‘no’. Assuming that each random term is distributed as a Type I extreme value, then following Hanemann (1991), the following response probabilities are obtained for our model:

\[
P(\text{yes} - \text{yes}) = Pn(YY) = 1 - \frac{1}{1 + e^{(x+\beta_{SUB} + \epsilon_{YN})}}
\]

\[
P(\text{yes} - \text{no}) = Pn(YN) = 1 - \frac{1}{1 + e^{(x+\beta_{SUB} + \epsilon_{YN})}}
\]

\[
P(\text{no} - \text{yes}) = Pn(NY) = 1 - \frac{1}{1 + e^{(x+\beta_{FB} + \epsilon_{YN})}}
\]

\[
P(\text{no} - \text{no}) = Pn(NN) = 1 - \frac{1}{1 + e^{(x+\beta_{LSB} + \epsilon_{YN})}}
\]

Where \( \beta \) is the initial bid, LSB is the second lower bid, SUB Upper second bid; \( \alpha, \beta, and \gamma \) are parameters and \( \epsilon \) is the socio-economic characteristics of the respondent being analyzed (Table 2).

Households’ WTP for solid waste management

The respondents were asked subjective questions like what is the maximum amount of money that each household WTP each month for the wastes generated from their home. Accordingly, the mean WTP of the respondents is 31.30 Birr per month per bag. The mean WTP is efficient and valid measure (Bateman et al., 2002). The total WTP of 190 sample respondents was also estimated to be birr 3,728.19 per year with minimum 0 and maximum 85 birr (Table 3). Furthermore, lower numbers of respondents were recorded in the higher bids (Figure 2). Whereas, 26.63% of the respondents were
Table 2. Response of respondents.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Freq</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes -yes</td>
<td>96</td>
<td>50.53</td>
</tr>
<tr>
<td>Yes -no</td>
<td>21</td>
<td>11.05</td>
</tr>
<tr>
<td>No -no</td>
<td>58</td>
<td>30.53</td>
</tr>
<tr>
<td>No -yes</td>
<td>15</td>
<td>7.89</td>
</tr>
<tr>
<td>Total</td>
<td>190</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 3. Non-parametric estimation of WTP for SWM.

<table>
<thead>
<tr>
<th>Range number</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 -26.66</td>
<td>68</td>
<td>35.79</td>
</tr>
<tr>
<td>26.67-43.33</td>
<td>57</td>
<td>30.00</td>
</tr>
<tr>
<td>33.34-59.94</td>
<td>46</td>
<td>24.21</td>
</tr>
<tr>
<td>59.95-76.55</td>
<td>14</td>
<td>7.37</td>
</tr>
<tr>
<td>76.56-93.16</td>
<td>5</td>
<td>2.63</td>
</tr>
<tr>
<td>Number of households</td>
<td>190</td>
<td>100</td>
</tr>
<tr>
<td>Min</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Max</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>31.30</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2. Frequency curve of 190 households' WTP.

given the reasons for not willing to pay for the proposed project (Table 4).

Determinants of households' willingness to pay

Binary choice modeling (logit model) was projected to identify factors affecting households' WTP for SWM and their relationship. Maximum Likelihood (ML) method was employed to estimate the parameters in logistic regression model. Likelihood ratio index has been measured as an indicator of goodness of fit for the logistic regression model. Dependent variable is designed as a dichotomous dummy because of assuming whether the respondent is willing to pay or not. The model is,

\[ \log \frac{p_i}{1 - p_i} = z_i = \beta_0 + \beta_1 X_1 + \ldots + \varepsilon \]

Where,

\[ P = 1 \] if the respondent is willing to pay for improved
Table 4. Reasons for non-willingness to pay by respondents.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Freq.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive willingness to pay</td>
<td>133</td>
<td>66.84</td>
</tr>
<tr>
<td>Valid zero bidder</td>
<td>53</td>
<td>26.63</td>
</tr>
<tr>
<td>(i) Have no extra income but otherwise would contribute</td>
<td>24</td>
<td>12.06</td>
</tr>
<tr>
<td>(ii) Don’t believe that the SWM improvement programs would bring the changes</td>
<td>29</td>
<td>14.57</td>
</tr>
<tr>
<td>(iii) Protest Zero bidder (Rejection of contingent market)</td>
<td>9</td>
<td>3.52</td>
</tr>
<tr>
<td>(iv) It is the government’s responsibility</td>
<td>5</td>
<td>2.51</td>
</tr>
<tr>
<td>(v) Waste management improvement is not important</td>
<td>2</td>
<td>1.005</td>
</tr>
<tr>
<td>(vi) It is the responsibility of those who pollute the environment to pay for it</td>
<td>2</td>
<td>1.005</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>199</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 5. logistic model regression result.

| WTP (independent variables)                  | Coef.  | Std.Err | z       | P>|Z|/ | dy/dx  |
|---------------------------------------------|--------|---------|---------|------|--------|
| Age                                         | -0.035 | 0.0155  | -2.29   | 0.022** | -0.0059|
| Sex                                         | 0.386  | 0.5150  | 0.75    | 0.453 | 0.0670 |
| Household Size                              | -0.618 | 0.1826  | 3.38    | 0.001*** | -0.0747|
| Income                                      | 0.0006 | 0.0002  | 2.50    | 0.012** | 0.0001 |
| Marital status                              | -1.3543| 0.5588  | -2.42   | 0.150 | -0.1831|
| Education level                             | 0.1195624 | 0.0521 | 2.29    | 0.022** | 0.0197 |
| Awareness                                   | 1.550271 | 1.892 | 0.82    | 0.413 | 0.0313 |
| Current waste Collection service            | -0.3184| 0.4971  | -0.64   | 0.522 | -0.0498|
| Amount of waste generated                   | 0.6182 | 0.1826  | 3.38    | 0.001*** | 0.1020 |
| Type of solid waste service                 | 0.2017 | 0.5873  | 0.34    | 0.731 | 0.0346 |
| BID                                         | -0.1148| 0.0337  | -3.40   | 0.001*** | -0.0189|
| Cons                                        | 0.1857 | 0.4550  | 0.41    | 0.683 |                 |

Number of observation = 190
LR chi2(11) = 109.41
Prob > chi2 = 0.0000
Log likelihood = -61.357634
Pseudo R2 = 0.4713

Note: ***, ** and * significant at 1, 5 and 10% probability levels, respectively

Age has a negative significant (p<0.05) effect on respondents’ willingness to pay for improved SWM (Table 5). Marginal effect also shows that while the ages of the respondents increase by 1%, willingness to pay is reduced by 0.59%. This implies that younger respondents would know and appreciate the value of SWM than the older ones about the negative impacts of solid wastes (Afroz et al., 2006; Afroz and Keisuke, 2009). Household size has also negatively significant (p<0.5) effect on WTP. Similarly, marginal effect indicates that all factors keeping constant, at 1% increase of the household size of the respondents; their willingness to pay is reduced by 7.47% because waste management activities are handled by the members of the family and lack of money to outsource such services (Anjum, 2013; Othman, 2002; Jin et al., 2006).

Income

Income has a positive relationship with the households’ WTP (p<0.05). This indicates that improved SWM is a normal good since its demand increases with income. This implies households with high income are more WTP for the SWM than households with low incomes. Marginal effect indicates while household income increases by 1 Ethiopian birr, WTP for SWM improvement increases by
Table 6. Bivariate probit model result.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bid1</td>
<td>-0.075</td>
<td>0.0045</td>
<td>4.43</td>
</tr>
<tr>
<td>Constant</td>
<td>3.371</td>
<td>0.1609</td>
<td>3.21</td>
</tr>
<tr>
<td>Bid 2</td>
<td>-0.008</td>
<td>0.0044</td>
<td>-1.95</td>
</tr>
<tr>
<td>Constant</td>
<td>0.298</td>
<td>0.1519</td>
<td>1.94</td>
</tr>
<tr>
<td>ρ*</td>
<td>0.9829</td>
<td>0.0238</td>
<td></td>
</tr>
</tbody>
</table>

Log-likelihood=-177.69
Likelihood-ratio test of rho=0:
Wald χ²(2)= 21.59
χ²(1)=33.26
Prob > χ² = 0.000
Prob> χ²=0.000

0.01% (Afroz and Keisuke, 2009; Bamlaku et al., 2015; Dagnew et al., 2012). While Johnson and Baltodano (2004) studies reported that income did not have an effect on the households’ WTP for improved water quality improvement.

**Education**

Education has positive coefficients and significance at p < 0.05. An increase in the respondents’ year of schooling by 1% will increase their willingness to pay for improved SWM services by 18.31% (Zerbock, 2003; Dadson et al., 2013).

**Amount of solid waste generated**

Amount of solid waste generated per month per households is a positively significant at P <0.01. Marginal effect estimates show that, by keeping the influences of other factors constant, a one sack solid waste amount increases in the probability of households’ willingness to pay by 10.20% (Dagnew et al., 2012).

**Bid values**

Bid values have negative coefficient and are significant at p <0.01 for the follow up question. As the bid amount increases, willingness of respondents to accept the scenario is low and that is consistent with the law of demand. Likewise, as one more “yes” response given for the second bid, it results in a decrease of WTP by -0.0189 marginal effects.

**Bivariate probit model**

The analysis was conducted using seemingly unrelated bivariate probit model. The result revealed that the initial bid and the second bid have the negative signs and statistically significant which is expected. This implies that higher initial bid and second bid lead to lower probability of accepting the bid offered. In this fitted seemingly unrelated bivariate model, the coefficient of correlation (ρ) of the error terms is positive and significant (p <0.01) for both payment vehicles. Besides, the correlation coefficient of the error term is less than one which implies that the random component of WTP for the first question has no perfect correlation with the random component from the follow-up question (Table 6).

Double-bounded contingent valuation model is used to estimate the mean WTP and its determinants. There are two options of independent models which can be used to estimate mean WTP. The models are bivariate model with no covariates (WTP checked against the offered amount) and bivariate model with covariates (WTP for SWM against socio-economic factors). Thus, before deciding on which model to apply, it seems important to compare the results which would help to capture the true behavior of people that is expressed through their preferences. Cameron et al. (2002) indicated that, the model which runs with determinant factors to estimate mean WTP are more preferred for its high marginal value accuracy estimation for environmental changes. As a result the mean WTP value of improved SWM ranged from 44.95 to 35.25 ETB per household per month, for the initial bid (Fbid) and the follow up bid (Sbid), respectively. In order to choose the appropriate mean WTP among the two bivariate estimates, it was looked into the data and the total amount for the YY and NN responses accounted for about 81.06 % of the total responses. This means that the 2nd bid amount was closer to the unobserved true value of the individual. For example, if the first random bid for the individual was 30 ETB and the respondents accept the first bid then the 2nd bid becomes 35 ETB; again, if the respondents accept the second bid. This indicates that the respondents’ true WTP is greater than or equal to 35 ETB so the 2nd bid will be a better estimate than the 1st one. The same is true for NN answer. Even for the rest 18.94% of the NY and YN responses, both the first and the second bid amounts will have equal chances to be closer estimates of the true value; hence, using the second estimate of the double bounded bivariate model to calculate as mean willingness
to pay for SWM improvement.

Aggregate WTP for improved solid waste management

As it is indicated in Table 7, the aggregate WTP was calculated by multiplying the mean WTP by the total number of households who were expected to have a valid response in the study area. Following this, in this study the aggregate WTP for improvement of SWM practices was computed at 1,328,564.75 ETB/month.

<table>
<thead>
<tr>
<th>Total HHsY</th>
<th>Expected HHs to have a protest zero (A)</th>
<th>Expected HHs' with Valid Responses (B)</th>
<th>Mean WTP (C)</th>
<th>Mean WTP per year</th>
<th>Aggregate Benefit Per year (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>39474</td>
<td>1784.22</td>
<td>37689.78</td>
<td>35.25</td>
<td>423</td>
<td>15,942,776.94</td>
</tr>
</tbody>
</table>

1 (A) 9(4.52 %) of our 199 sampled households were protest zeros. We excluded those protest zeros from further analysis after we have tested for sample selection bias. So A is the expected number of households which are expected to protest for the proposed project. It is calculated by multiplying the percentage of sampled protest zeros (4.52 %) with the total population 39474.

2 (B) Is Y-A which is the total households in the study area which are expected to have a valid response

3 The mean WTP calculated from the maximum amount of Birr that a household could pay for SWM

4 Is mean multiplied by the number of total households which are expected to have valid response (B *Mean WTP)

CONCLUSION AND POLICY IMPLICATION

In rapidly growing cities in developing countries, solid waste is a major source of concern due to lack of appropriate planning, inadequate governance, resource constraint, and ineffective SWM. According to UNEP (2004), particularly in developing countries solid wastes generated by cities have become an environmental and public health problem everywhere in the world. This research was conducted on randomly selected sample of 190 households, and used eleven explanatory variables in the regression models based on the degree of theoretical importance and their impact on WTP. Logit and seemingly bivariate probit models were used to identify the determinants and mean willingness of households for improved SWM system using CVM. To improve solid waste collection system of the town, on average the households are willing to pay 1,328,564.75 ETB per month for wastes collection service.

A key policy implication of the results of this study is that policy makers can choose from a set of scenarios, which include different levels of attributes and WTP estimates for each attribute, to design an improved solid waste management project for Shashemene town. Policymakers have to consider the investments required, the service outcomes and the amount households are willing to pay for improved services. In addition, policymakers need to be aware that socio-economic characteristics and quality of waste collection services will influence the willingness to pay for better waste management. Without knowing the costs of providing various service improvements, we cannot recommend specific improvement measures. What we can state with clarity, nonetheless, is that survey households express a clear preference for improvements in waste management services and have a considerable willingness to pay for SWM practices.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES


