Non-Market Pricing for an Improved Solid Waste Management System in Arba Minch Town, Ethiopia

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Abstract

Uncontrolled damping of solid waste has long been a major Source of concern for the public in Arba Minch, a tourist hub and one of the rapidly growing towns in Ethiopia. This study was conducted with a primary motive of initiating an improved system of solid waste management (SWM) in the town. For this purpose, the contingent valuation method (CVM) was employed to establish hypothetical grounds for eliciting the willingness-to-pay (WTP) of the residents for improved solid waste management services. Besides, the paper used maximum likelihood and multivariate estimation techniques to investigate the main factors influencing household's decision to pay for the specified project. From the results of the maximum likelihood estimation, the mean WTP of households for 'madaberiya' of solid waste per month is derived to be 9.025 Birr. The results of the multivariate regression reveal that residents' WTP for improved solid waste management is significantly related to age of the respondent, education level, income of the household head, amount of solid waste disposal, among other factors. The mean WTP estimated in this survey can serve as a guide for municipal officials in setting a more appropriate fee that can finance the specified improvement in SWM in Arba Minch town. Finally, the results of this study have an implication on the need to carry out research on the feasibility (both technical and economic) of the specified improved solid waste management system in the context of Arba Minch town to make the project come true.

Keywords: *Contingent valuation method, willingness-to-pay, solid waste, Arba Minch town*

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Introduction

Management of solid waste resulting from rapid urbanisation has generated a lot of concern in most developing countries (Kwabena and Gideon 2014). Population expansion and economic growth are often considered to be the two main drivers for the increasing waste generation in the world (US-EPA 2002; Rathi *et al.* 2007; Birol *et al.* 2008 and Dagnaw *et al.* 2012).Improperly-managed solid waste poses a risk to human health and the environment (NEERI 1994; Beede *et al.* 1995; CPCB 2000; and UN 2000).Uncontrolled dumping and improper waste handling causes a variety of problems, including contaminating water, attracting insects and rodents, and increasing flooding due to blocked drainage canals or gullies. In addition, it may result in safety hazards from fires or explosions. Improper waste management also increases greenhouse gas (GHG) emissions, which contribute to climate change (US-EPA 2002). Hence, elimination of these problems requires an integrated approach for waste collection, transport, and disposal along with activities to prevent or recycle waste.

In many rapidly growing cities, solid waste is a major Source of public health concern. This is partly due to the financial constraints within which the municipalities operate and partly due to lower standards of living of the people as well as the limited public perception about the health hazards posed by the deteriorating environmental conditions (Gupta *et al.* 1998; Buenrostro *et al.* 2001).As a result, many of the cities in the less developed world lack the required level of waste disposal systems. Likewise, solid

waste management hardly exists in Arba Minch town, one of the major tourist destinations in Ethiopia.

The population of Arba Minch town is increasing alarmingly over the years. According to the Ethiopian Central Statistical Authority (CSA), the population of the town has almost doubled in the last 15 years. As environmental theories contend, more population is associated with more consumption of goods and services, which originate directly or indirectly from the environment, and thus creating more stress on the environment. On the other hand, more population also generates more waste and hence stifles the assimilative capacity of the environment. Therefore, as a major attraction and tourist destination in the country, the town administration needs to work vigorously on reducing the impact of environmental stress, which arises due to population pressure and growing consumption, by establishing an improved waste management system in the town. This study was set out to come up with an improved solid wastemanagement system.

Cost recovery of solid waste management in Ethiopia is a serious problem in many towns as it is financed by government and there is no proper mechanism of waste management charges and its collection from the residents. To improve this pressing problem, according to Anjum (2013), the government and other stakeholders have to put maximum efforts to look for the possibility of cost-sharing by households. For this, we need to analyse the demand side for improved solid waste management. Therefore, this study was designed to generate demand side information by eliciting the WTP of households for a certain specified improvement in solid waste

management in Arba Minch town[1], which is vital for the planning process. The study also tries to scrutinise the major factors determining the decision of households to pay for this improvement.

The rest of the paper is organised as follows. It starts with a brief introduction of the study site. In Section 2, data Sources and survey administration techniques were presented. The methodology used for the analysis in this study is explained in Section 3. Section 4 is devoted to the presentation of the results of the paper. Finally, conclusion and implications are briefly included in the fourth section of this article.

Study Area

Arba Minch, located adjacent to two rift valley lakes, is one of the few tourist attraction cites in Ethiopia. It is located 505 kms to the south-west of Addis Ababa, the capital of Ethiopia. According toCSA (2008), Arba Minch had an estimated total population of 74,879, of whom 39,208 were males and 35,671 were females. According to the 1994 census, it had a population of 40,020.

Arba Minch (meaning "forty springs" in Amharic) received its name for the abundant local springs which produce a groundwaterforest. Located at the base of the western side of the Great Rift Valley, Arba Minch consists of the uptown administrative centre of Shecha and, 4km away the downtown, commercial and residential areas of Sikela, which are connected by a paved road. On the eastern side of Sikela is the gate to Nechi Sar National Park, which covers the isthmus between Lake Abaya to the north and Lake Chamo to the south. The area is also known for wildlife, including crocodiles and hippopotamuses.[2]

The town also serves as a spring board for tourists to discover big national parks, such as Nechi Sar, Mago and Omo national parks in addition to huge wealth of languages and cultures of diverse nationalities of the region. Promoting tourism requires conservation of environmental amenities both in quantities and qualities. Thus, a concerted effort on improving solid waste management should be a priority in the town.

Data and Survey Design

The data Sources used inthis paper are mainly primary Sources. An equal number of households were sampled purposively and interviewed in all four sub-towns of Arba Minch town. Within each sub-town, randomly sampling method was employed to generate a total of 300 samples in the town. From which 280 samples were approved for analysis as the rest were found to be protest zeros, incomplete ones, and other practical errors.

However, preceding the main survey, a pre-test questionnaire (with open-ended format was administered to 40 households randomly distributed in the four sub-towns) and was used to determine the starting prices (bid levels) as a reference for eliciting the mean WTP of households under the dichotomous choice format. From this pilot survey, the starting prices were found to be ranging from 0 to 20. From the distribution of starting prices sorted in ascending order, the 25^{th}, 50^{th} and 75^{th} prices were taken as starting prices for the main survey. This is primarily based on the judgment of the researcher and to select representative central values and avoid choosing extreme values from the gathered starting prices. Besides, it is in line with the practice of most empirical works undertaken under contingent valuation approaches. Accordingly, we have chosen 4, 8 and 12 Birr per

madaberiya[3] of solid waste disposal per month as starting bids to be offered to 300 sample respondents for the main survey.

The questionnaire for the main survey has three sections: current situations of solid waste management, households' willingness-to-pay for improved solid waste management, and household characteristics. In the survey, both close-ended (dichotomous choice format) and open-ended question formats were used to elicit the maximum willingness-to-pay (WTP) of households.[4]

Methodology

This research was conducted using the predominant survey method for non-marketed goods in developing countries called the Contingent Valuation Method (CVM). CVM is a survey method to elicit consumers' valuation of goods and services not sold in the market place, by calculating their WTP. The method has extensively been used in the valuation of non-market reSources, such as recreation, wildlife and environmental quality. In this method, the researcher creates a hypothetical market in a non-market or new good, invites a group of subjects (survey respondents or experimental subjects) to operate in that market, and records the results. The values generated through the use of the hypothetical market are treated as estimates of the hypothetical market.

Within this framework, the research basically selected the single-bounded dichotomous choice format for eliciting the WTP of respondents. Besides, the closed-ended question format was used for finding the maximum WTP of respondents for a specified improvement in solid waste management in Arba Minch town. The principal regression model employed in this survey

was the Probit Model. The Logit and linear probability (LPM) models were also run for comparison purposes.

In this study, the respondents were asked single-bound close-ended 'yes' or 'no' questions followed by open-ended questions to elicit households' willingness-to-pay for the improved solid waste management. The analysis of survey responses obtained from single bound and open-ended questions formats requires different models. Thus, to analyse survey responses, two different econometric models were specified: one for the single-bound and the other for the open-ended survey responses.

Econometric Model for the Single-Bounded CV Question

Econometric model for the single-bounded close-ended survey response can be modelled either as dichotomous variable as in random utility framework used in the utility differential model (RUM) constructed by Hanemann (1984) or as censored econometric model proposed by Cameron (1988). In this paper, using the Hanemann approach, we start by specifying the indirect utility function.

From empirical research studies and theoretical expositions, households' preference for improved solid waste management system is affected by income, socio-economic and demographic characteristics, characteristics of existing solid waste management practices, and attributes towards the improved solid waste management,among other factors. Let us denote household incomeY_i, and all factors that influence household's WTP for improved services by vectorX_i and the existing level of solid waste disposal service by $W^0$and after the improvement level by W^1. Then,

household utility functions for the existing and improved solid waste disposal services can be framed, respectively as follows:

$$U^0 = U(W^0, Y_i, X_i) - (1)$$

$$U^1 = U(W^1, Y_i, X_i) - (2)$$

In Random Utility Model (RUM), it is assumed that each individual knows his/her utility function or preferences with certainty, and there are some components that cannot be observed by the researcher and treated as random variable (Hanemann and Kanninen 1998). Designating the random error term byε, and the household indirect utility functions for the existing solid waste disposal by $V(W^0, Y_i, X_i)$ and after the improvement level by $V(W^1, Y_i, X_i)$, the household utility functions for solid waste disposal services at the status quo level and after improvement can be written respectively as:

$$U(W^0, Y_i, X_i) = V(W^0, Y_i, X_i) + \varepsilon_0 - - - - - - - - - - - - - - - (3)$$

$$U(W^1, Y_i, X_i) = V(W^1, Y_i, X_i) + \varepsilon_1 - - - - - - - - - - - - - - - (4)$$

Where, the random terms $\varepsilon_0$and$\varepsilon_1$are assumed to be independently and identically distributed with zero means. Households were confronted with two options: either to keep the existing level of service, W^0 or to get an improved service, W^1, which would cost them some additional amount of money equivalent to, let's say,M_i. Hence, households would go for the new scheme if the utility they expect from it (net of its additional cost) is higher than the utility they get from the existing scheme. That is,

$$V(W^1, Y_i - M_i, X_i) + \varepsilon_1 > V(W^0, Y_i, X_i) + \varepsilon_0 - - - - - - - - (5)$$

In a RUM model, it is assumed that, while the individual knows his/her preferences with certainty and does not consider them stochastic, they contain some components which are unobservable to the econometric

investigator and are treated by the investigator as random (Hanemann 1984). The researcher only observes 'yes' or 'no' responses and these responses are treated as random variable with probability distribution given by:

$$Prob.(yes) = Prob.\ \{V(W^1, Y_i - M_i, X_i) + \varepsilon_1 > V(W^0, Y_i, X_i) + \varepsilon_0\} \quad (6)$$

$$= Prob.\ \{V(W^1, Y_i - M_i, X_i) - V(U^0, Y_i, X_i)\}$$

$$> \varepsilon_0 - \varepsilon_1 \quad (7)$$

And,

$$Prob(No) = 1 - Prob(Yes) \quad (8)$$

Let us define $\omega = \varepsilon_0 - \varepsilon_1$ and $F_\omega(.)$ be cumulative distribution function. In the Probit model, $F_\omega(.)$ follows the normal cumulative distribution function, while in Logit model $F_\omega(.)$ follows the logistic cumulative distribution function. Both the Probit and the Logit models give similar parameter estimates. The choice between the Probit and the Logit model is only for mathematical convenience. Assuming the normal cumulative distribution, the Probit model can be expressed as follows:

$$Y^* = F(X\beta + U_i) \quad (9)$$

Where Y^* is unobserved latent variable =1, if the response is yes, =0 if the response is no, X is the explanatory variable, β is unknown regression parameters and U is the random error term.

In a single-bounded dichotomous choice, respondents indicate their WTP by answering 'yes' or 'no' to a set of offered prices. The respondents respond 'yes' if he/she accepts the proposed bid price and respond 'no' if he/she refuses to pay the proposed bid price. In both cases, the respondents' actual WTP for the improved solid waste disposal service is

not observable. The 'yes' or 'no' responses obtained from the single bound survey responses are estimated by the maximum likelihood procedure. Hence, following the work of Hanemann (1984), the response probabilities related to the underlying WTP distribution is given by:

$$P^Y = Prob\{Yesto\beta_i^*\} \equiv Prob\{\beta_i^* \leq T_i\}$$
$$= G(\beta_i^*; \theta) - - - - - - - - - - - - (10)$$
$$P^N = Prob\{Noto\beta_i^*\} \equiv Prob\{\beta_i^* > T_i\}$$
$$= 1 - G(\beta_i^*; \theta) - - - - - - - - - - - -(11)$$

In the above configuration, β_i^* is the offered initial (bid) price to respondents, T_i is unobservable households' actual WTP for improved solid waste management service and it is a latent variable with a given cumulative distribution $G(\beta_i^*; \theta)$ where θ represents the parameters of this distribution, which are to be estimated on the basis of the responses to the CV survey.

The resulting log-likelihood function for the responses to a CV survey using the single-bounded format is

$$\ln L(\theta) = \sum \{d_i^Y \ln G(\beta_i^*; \theta) + d_i^N [1 - G(\beta_i^*; \theta)]\} - - - - - -(12)$$

Where, $d_i^Y = 1$ if the i^{th} response is yes and 0 otherwise, while if the $d_i^Y = 1$ if the i^{th} response is no and 0 otherwise.

Based on the above justification, we specify the Probit model for households' preferences for the improved solid waste management services as follows:

$$WTP_i = \gamma_0 + \gamma_1 X_i + \gamma_2 BID_i + \varepsilon_i - - - - - - - - - - - - - - - (13)$$

Where WTP_i is a binary indicator variable and hence, $WTP_i = \begin{cases} 0 \; if \; WTP_i < bid \; offered \\ 1 \; if \; WTP_i > bid \; offered \end{cases}$.

X_is are set of household characteristics, BID_i is the initial bid offered and ε_i is the stochastic term. The regression parameters are estimated by Maximum likelihood techniques.

Econometric Model for Open-ended CV Questions

When dichotomous choice format is followed by open-ended question format, it finally produces open value of the respondent. In this case, the use of binary response models, such as the Probit or the Logit is not appropriate. The respondents' willingness to pay survey response from the open-ended are estimated as censored model such as the Tobit model if the dependent variable takes non-negative values with some zeros or by using linear regression model if the dependent variable takes none zero positive numbers (Siglman and Zeng 1999).

The results of this survey showed that all the respondents in Arba Minch town expressed their willingness to pay some amount of money that exceeds zero for the specified improved solid waste management service. Therefore, the ordinary least squares (OLS) model was the appropriate model for analysing the determinants of households' willingness to pay for the improved solid waste management services for our open-ended survey responses. Based on this theoretical exposition, we specify the linear regression model for the improved water services empirically as follows:

$$MWTP_i = \gamma_0 + \gamma_1 X_i + \gamma_2 BID_i + \varepsilon_i \; ---------- (14)$$

Where, $MWTP_i$ is the maximum WTP of the i^{th} respondent, X_is are set of household characteristics and BID_i is the initial bid offered.

Results

From a total of 300 samples, 280 (93.3%) of the respondentswere used for the analysis of this research while the rest were rejected due to protest zeros, incomplete questionnaires and other related problems.

We started with descriptive results and then proceeded to the econometric ones, where the single dichotomous choice format responses were analysed mainly based on Probit model and a comparison was made with Logit and

LPM results.

Descriptive Results

Looking at the existing system of solid waste disposal in Arba Minch town,few of the respondents of the survey, 4.47%, were found to be getting solid waste disposal services from the municipality; and among them, only 12% were satisfied with the service. Moreover, the researchers were able to assess the disposal of solid waste in the town in terms of size as measured by the common receptacle used in Ethiopia, *madaberiya,* and whether households have solid waste storage receptacle or not.

Table 1. Some descriptive statistics of the existing solid waste disposal system

Do you have a storage receptacle for solid waste in	**Frequency**	**%**	**Cumulative**
Yes	187	66.79	66.79
No	93	33.21	100
Total	280	100	
How many '*Madaberiyas*' of solid waste are generated in your household per month?	**Frequency**	**%**	**Cumulative**
<1	59	21.07	21.07
$1 \leq x \leq 2.5$	193	68.93	90
>2.5	28	9.89	10
Total	280	100	
How do you dispose off your solid waste?	**Freq.**	**%**	**Cumulative%**
Take it to a nearby secondary storage receptacle	6	2.19	2.19
Bury or burn it digging a hole around the house	184	67.15	69.34
Throw it into a nearby river	24	8.76	78.10
Private collectors take it	35	12.77	90.88
Any other (specify)	25	9.12	100.00
Total	274	100	

Source: Computed from the survey data

It is promising to see at least two-thirds of the sample respondents have storage receptacle. However, most of the receptacles in use by households were not good enough to handle the wastes until they are disposed. Hence, a large task remains to be done in creating awareness for the households at large to prepare their own solid waste storage receptacles from strong materials. The other question extended to households was regarding the

size and composition of solid wastes generated from households on monthly basis. Most of the sampled households were found to produce fewer *madaberiyas* of solid waste per month. Only about 10 percent of the households generated more than 2.5 *madaberiyas* of solid waste monthly. Moreover, from the discussion part of the interview, it was identified that the most common types of solid wastes are: ashes, food remains, plastics, glasses and papers, which are suitable for composting and recycling purposes.

Arba Minch town is one of the leading tourist destinations in Ethiopia. The population of the town is rapidly increasing in the last few decades. However, the town does not have a structured solid waste management system up until now. Yet, most (67.15%) of the interviewees said they have healthy ways of disposing their solid waste. Though this may seem to be a solution at the present, it is not a sustainable one. Only 2.19% of the respondents take their solid waste to a nearby storage receptacle, which is found to be the best way of doing it as far as there is someone who takes the collected waste to the right disposal site. At the time of the data collection, private collectors were covering 12.77% of the sample households as their means for solid waste disposal. However, unless private collectors are actively working with the municipality, they may end up in creating hazardous waste damping areas. Finally, less than 10% of the respondents specified other methods of solid waste disposal than the already stated ways. Nevertheless, many of these methods were found to be hazardous for life in the town.

In regards to the impact of inefficient solid waste management system, respondents were asked if any family member(s) had been affected by diseases related to sanitation -problems. More than 58% of the sample respondents reported that at least one of their family member(s) hadsuffered from diseases related to sanitation problems. Even if it is difficult to attribute such problems completely to lack of solid waste management systems, it is evident that it significantly contributes to the problem.

Respondents were also asked to suggest the best candidate they think will best handle solid waste management system in Arba Minch. About 56% of the respondents thought that the Municipality is responsible for handling the system; 30% assigned the responsibility to households; 8%to private companies; and 5% to other institutions.

WTP Estimation

Based on the open-ended question format, households were asked how much they would pay at maximum for one *madaberiya* of solid waste to be disposed once per month. The results from 280 sample responses were analysed based on a simple average formula as follows:

$$MMWTP = \frac{\sum_{i=1}^{i=n} MWTP_i}{n}$$

Where, MMWTP is the mean maximum willingness-to-pay of households, MWTP denotes maximum willingness-to-pay of households and n is the sample size. From the survey, the mean maximum WTP of households for improved solid waste management was found to be:

$MWTP = {}^{2470.323}/_{280} = 8.822582$ Birr.

The MMWTP result from the open-ended question format could be anchored in the single dichotomous question as the latter was forwarded to respondents right before the former. However, it gives some insight regarding the value households attach to the new improved services of solid waste management.

Econometric Results

The major regression results derived from the single dichotomous closed-ended and open-ended CV question formats designed for eliciting the WTP of respondents for improved solid waste management system in Arba Minch town are presented in the subsequent sub-section of this paper.

Regression Results for the Single Dichotomous Closed-Ended CV Questions

As already explained in the methodology part of this paper, some of the questions posited for respondents were closed-ended types. Particularly, respondents were randomly forwarded three different bidding prices, which were found from the pilot survey, and the respondents gave their acceptance/rejection for launching an improved system of solid waste management in Arba Minch town.

On the basis of theoretical exposition and data, the Probit model was employed to derive the mean WTP of respondents and investigate determinants of respondents' WTP for improved solid waste management in Arba Minch town.

Table 2. A maximum likelihood estimates of the determinants of households' positive WTP (Probit Model)

Variables	Coefficients	Marginal effects	Standard errors
Age of the respondent	-.0188720	-.0072262	(.0038)*
Marital status of the respondent	.1021775	.0390471	.099700
Education level of the respondent (Base: No schooling)			
Primary education level	.8669512	.2842993	(.1323)**
Secondary education level	1.3559650	.4752465	(.1516)***
Tertiary education level	1.7526390	.5624597	(.1206)***
Monthly income of the household head	.0002030	.0000777	.0001
Number of 'madaberiyas' of solid waste disposed by the household per month	-1.1554590	-.4424337	(.0568)***
Availability of receptacle for solid waste storage	.0960217	.0369196	.0752
Starting bid level	-.1552329	-.0594398	(.0125)***
Type of ownership of the house	.1933328	.0749118	.0850
Nature of the job of the household head	.0534732	.0205910	.1191
Respondents' judgment of the seriousness of solid waste	.1388328	.0536848	.0968

management in Arba Minch town			
Constant	1.4009450		
Log likelihood	-126.8917600		
Restricted Log likelihood	-186.2289600		
Wald chi2(12)	83.7600000		
Prob > chi2	0.0000000		
Pseudo R-Squared	0.3186000		

*10% level of significance, **5% level of significance, *** 1% level of significance. The robust standard errors are for the marginal effects.

Source: Estimation Based on Survey Data

The Probit regression gave some interesting results. The goodness of fit measured by Pseudo R-squared from the output of the Probit model was 0.32, which is relatively low. However, this result does not affect the relevance of the model as goodness of fit is of secondary importance in binary regressand models. What matter in limited dependent variable models are the expected signs of the regression coefficients and their statistical and/or practical significances. In binary regressand models, Count R-Squared is commonly used as a comparatively simple measurement for the goodness-of-fit of the model. It is calculated as follows:

$$Count\ R^2 = \frac{number\ of\ correct\ predictions}{total\ number\ of\ observations}$$

Since the regressand in the Probit model takes a value of 1 or 0, if the predicted probability is greater than or equal to 0.5, we take it a correct prediction for 1, but if it is less than 0.5, we take it as correct prediction for 0. We then count the number of correct predictions and compute the R^2 based on the prediction of our model as follows:

$$\text{Count } R^2 = \frac{228}{280} = 0.81$$

Hence, almost 81% of the variations in the dependent variable were explained by our model, which simply means that our model is robust.

From the regression results, age of the respondent was found to be negatively related to the regressand as expected and significant at 10%. This result is in line with Niringiye and Omortor (2010) but in contrast with other earlier findings by Alta and Dehazo (1996); Cairncross (1990); World Bank (1995). This is probably due to the fact that younger respondents are more concerned and informed about the dangers of solid waste management problems so that they are likely to accept bids extended

to them in conjunction to a specified change in solid waste management facility. Besides, younger respondents are likely to be familiar with cost-sharing arrangements whereas elderly ones tend to be accustomed with free public services.

Another interesting result is that the more educated the respondents are, the higher was their probability of accepting the starting bid forwarded to them. Considering no schooling as a base category, having attended tertiary education was found to have a positive impact on respondents' decision to accept the starting bid at 1% level of significance. Similarly, having had secondary and primary education has positive and significant impact at 5% and 10%significance levels. Moreover, as shown in Column 3 of Table 2, higher level of education was associated with positive and higher marginal effects on accepting the bid. This might have emanated from the fact that education creates awareness and concern on the problems of reckless damping of wastes and enables households to give more value to services that help to mitigate the problems than were they not educated.

Contrary to the researchers' expectation, the number of *madaberiyas* of solid waste disposed by households per month was found to be significant and negatively impacting the probability of respondents accepting the bid. As it is evident from the data, this result was not triggered because of the existence of higher pair-wise correlations with other variables. It might have occurred because of the fact that households disposing larger amounts of solid waste have come up with their own cheap and locally-efficient (but perhaps not environmentally sound) systems of disposing solid wastes and

may not be that much interested in another system of solid waste management, which could charge them higher fees.

Finally, it was found that starting bid level has a significant negative coefficient at 1% level. This result is plausible as respondents tend to reject higher starting prices as compared to lower ones. The rest of the explanatory variables were not significant and hence they do not have applicable policy implications.

Another important alternative approach for calculating the mean WTP of households for improved solid waste management was using the results of the Probit regression. The mean WTP for the single dichotomous closed-ended CV question format can be computed by dividing the Probit regression constant (intercept) by the negative of the bid coefficient. Thus, the mean willingness to pay was found to be:

$$Mean\ WTP = \frac{\beta_0}{-Bid\ Coefficient} = \frac{1.400945}{-(-0.15522329)}$$

This figure is very close to (not statistically different from) the mean WTP of respondents for improved solid waste management problem calculated from the open-ended CV question format in the descriptive section of this article. However, it is not directly comparable with the mean WTP from the open-ended format as the latter is anchored in the single-bounded dichotomous questions, whereon the computation of the former is based.

More importantly, the average number of *madaberiyas* of solid waste from the survey was found to be 1.45 per household per month. Accordingly, an average household in Arba Minch town offered a WTP of 13.05 Birr per month for the would-be improved SWMservices. According to Tadesse (2004), private solid waste collectors in Addis Ababa charge 10–12 Birr per household/month even though they operate predominantly in the

middle and high income areas. Hence, the resulting mean WTP of Arba Minch residents (regardless of their standard of living) is promising to launch an improved solid waste management services in the town,in collaboration with the public, governmental and non-governmental organisations.

Table 3. Comparison of the determinants of respondents' willingness-to-pay for improved solid waste management using LPM, Probit and Logit Estimation Models[5]

Variables	LPM	Probit	Logit
Age of the respondent	-.007 (.003)**	-.007 (.004)*	-.008 (.004)**
Marital status of the respondent	.053 (.068)	.039 (.100)	.052 (.111)
Education level of the respondent			
Primary education level	.184 (.133)	.284 (.132)**	.278 (.117)**
Secondary education level	.345 - (.130)***	.475 (.152)***	.488 (.141)***
Tertiary education level	.426 (.128)***	.563 (.121)***	.562 (.111)***
Monthly income of the household head	.000 (.000)	.000 (.000)	.000 (.000)
Number of '*madaberiyas*' of solid waste disposed by the household per month	-.225 (.040)***	-.442 (.057)***	-.469 (.066)***
Availability of receptacle for solid waste storage	.021 (.053)	.037 (.075)	.041 (.082)
Starting bid level	-.035 (.009)***	-.059 (.013)***	-.064 (.014)***
Type of ownership of the house	.041 (.060)	.075 (.085)	.084 (.095)
Nature of the job of the household head	.016 (.089)	.021 (.119)	.002 (.125)
Respondents' judgment of the seriousness of solid waste management in the town	-.025 (.066)	.054 (.097)	.037 (.108)
Constant	.901	1.401	2.611
Log Likelihood		-126.892	-126.696
Restricted Log Likelihood		-186.229	-186.229
Wald chi2(freedom=12) (prob>chi2)		83.76 (0.000)	68.02 (0.000)
(Pseudo) R-Squared	0.307	0.319	0.320
Count R^2	0.789	0.814	0.811

* 10% level of significance, **5% level of significance, *** 1% level of significance. The robust standard errors are for the marginal effects in logit and probit models and in the LPM model for the coefficients. Source: Estimation based on survey data

As shown in Table 3, the three models yielded interestingly very alike results. In the three models, having secondary and tertiary education was found to be significant at 5% and 1% levels of significance, respectively. Besides, both having secondary and tertiary education had positive sign as expected in all the models. Moreover, starting bid level had a negative coefficient and was found to be uniformly insignificant in all the three models. Finally, as it was expected, age of the respondents had negative coefficients in the three models; however, the level of significance was somewhat higher for the LPM. As it was true for the probit model, the number of *madaberiyas* of solid waste disposed by households per month also had a negative coefficient significant at 1% in the other two models. The remaining explanatory variables were all found to be insignificant in the three models. Overall, the outputs in the three models revealed some key variables that influence households' WTP for an improved SWM services in Arba Minch town.

Regression Result for Open Ended CV Questions

One of the question formats used for eliciting responses on the WTP of respondents for the specified improved system of waste management was open-ended format. Respondents were asked to give their maximum WTP for improved solid waste management services. Also the determinants of respondents' maximum WTP were studied.

As noted in the methodology part of this paper, the ordinary least squares (OLS) model was the preferred model for analysing the determinants of households' willingness to pay for the improved solid waste management services for our open-ended survey responses. The outputs are reported in Table 4.

Table 4. Determinants of MWTP using the Classical Linear Regression Model

Variables	Coefficients	Robust standard errors
Age of the respondent	-.0610644	0.0471247
Marital status of the respondent	.3201649	1.2973340
Education level of the respondent		
Primary education level	2.7365130	1.8749340
Secondary education level	4.2809410	(1.967075)**
Tertiary education level	5.2986570	(2.113583)**
Monthly income of the household head	0.0016095	(.0007633)**
Number of '*madaberiyas'* of solid waste disposed by the household per month	-3.6247940	(.7278219)***
Availability of receptacle for solid waste storage	0.5322376	0.9872564
Starting bid level	-1.065968	0.9098995
Type of ownership of the house	-.2692754	1.1349080
Nature of the job of the household head	.4764166	1.1307290
Respondents' judgment of the seriousness of solid waste management in Arba Minch town	-.1182397	1.0528470
Constant	9.3388390	
F(12, 267)	5.000000	
Prob >F	0.000000	
R-Squared	0.272000	
Number of Observations	280	

*10% level of significance, **5% level of significance, *** 1% level of significance.

Source: Estimation based on survey data

The OLS estimation resultsindicated that the goodness-of-fit was relatively a smaller one, i.e. 0.272.However, for cross-sectional survey, this doesn't write off the relevance of the model. This is strengthened by the fact that the overall significance of the regression is robust as found by the F-test above. The p-value of obtaining an F-value of as much as 5.0 or greater is almost zero, leading to the rejection of the hypothesis that together the regressors have no effect on the maximum willingness-to-pay of respondents to the specified improvement in solid waste management at all levels of significance.

Regarding the specific significance of the independent variables as given by the t-test, it was found that secondary education, tertiary education and the size of solid waste disposed per month are all significant and have similar signs of coefficients as found in the three models treated above. The difference lies in that age of the respondents was found to be insignificant and monthly income of household head was found to be significant and positive as expected, but contrary to what the three models above yielded. All the rest of the variables were insignificant and thus not important in explaining the model.

Conclusions and Policy Implications

As a rapidly growing town, Arba Minch needs an integrated and improved solid waste management system. However, as most of the towns in the country, the people of the town do not have such kinds of services and have still been vulnerable to diseases and problems caused by the inefficiency of the existing solid waste management system. From the results of the survey, it was found that only 4.47% of the respondents get solid waste disposal service from the municipality among which only

12.3% are satisfied with the service. Almost one third of the population does not have solid waste receptacle; and that indicates unsustainable management of solid waste and imminent hazardsthereof.

Most of the materials the receptacles made of, as explained by the respondents, are poor quality and would not lead to the desired level of solid waste disposal. Hence, the municipality needs to provide low-cost and durable types of receptacles for the residents at lower prices.

As evident from the commentary part of the questionnaire, the most common types of solid wastes are ashes, food remains, plastics, vegetables, and glasses, which are favourable for recycling and making of compost so that launching improved solid waste management services would benefit the public at large.

In general, Arba Minch town is not well served with sustainable solid waste management system. The people of the town have shown stronger desire and willingness-to-pay for improved solid waste management system envisaged by the contingent valuation scenario, both in the pre-test and main survey. From the Probit model, the mean WTP of households for a *madaberiya* of solid waste per month was found to be 9.025 Birr. Hence, the resulting mean WTP of Arba Minch residents is promising to launch improved solid waste management services in the town with the collaboration of the public, governmental and non-governmental organisations.

From the maximum likelihood regression estimates of the single dichotomous closed-ended CV questions, age of the respondent is found to negatively and significantly influence the decision of households to

accept/reject the forwarded bid prices consistent to theoretical and empirical expositions. More interestingly, the Probit regression result shows that the more educated respondents are, the higher is their probability of accepting the starting bid forwarded to them.This calls for the need to create knowledge and awareness to the residents about the detrimental effects of the current system and the need for launching an improved SWM system in the town. Effective management of solid waste requires the cooperation of the general public. Hence, training programmes, symposiums and other ways for creating the awareness of the decision-makers, as well as the public at large is indispensable. Once the interests of the public and decision-makers in improving solid waste management are created, the sustainability of solid waste management projects will be significantly improved.

The multivariate regression estimates for the open-ended CV questions further support the positive effect of education on households' maximum WTP for the specified improvement in solid waste management in Arba Minch town found in the maximum likelihood estimation. However, age of the respondents is found to be insignificant while monthly income of the household head is found to be positive and significant in the former model contrary to the results in the latter one. This evidently shows that income of the household head, the primary decision maker of the household, has more substantial effect on the maximum amount of WTP for improved SWM than simply on the decision to accept/reject the bidding prices.

Furthermore, both the mean WTP estimated from the maximum likelihood estimation and the mean maximum WTP calculated from the open-ended CV questions can serve as a guide for municipal officials in setting a more

appropriate fee that can finance the specified improvement in SWM in Arba Minch town. The result of this study indicates that there is a good chance of establishing and sustaining an improved SWM system in the town. For this purpose, the town administration should prepare compelling proposal for donors and non-governmental institutions to raise more funds for the project. Finally, this research is just a beginning and, based on its implications, responsible institutions should work hard to go further steps ahead, particularly conducting cost-benefit analysis, for this project to come true.

Endnotes

1. The level of environmental improvement is explained hypothetically to households and can be read from Appendix 1.
2. http://www.nationmaster.com/encyclopedia/Arba-Minch.
3. A medium-sized sack common in Ethiopia that can handle an average of 50kg of wheat grains.
4. Households were asked to give their maximum WTP after they were given ample explanation of the project intended for improved solid waste management system in the town. See Appendix 1.
5. The dependent variable in all the three models (LPM, Logit and Probit) is a binary indicator variable taking 0 when the respondent rejects the starting bid level and 1 when the respondent accepts the starting bid level for the specified improvement in solid waste management in Arba Minch town.

Appendix 1: Hypothetical Explanation of the Level of Environmental Improvement

The existing disorganised SWM service is causing serious human health and environmental problems. In order to overcome the current problems, there is an urgent need to launch sustainable SWM services. Hence, suppose that the municipality is planning to provide an improved solid waste management system in your area and this service involves door-to-door collection of your solid waste once every week using trucks of the municipality and transporting the waste safely to its final disposal site. Or, a door-to-door collection of your waste once a week by private waste collectors who dump the waste into temporary dumpsters of reasonable size located in the vicinity of your area by the municipality from which the municipality trucks transport the waste to the final disposal site. The disposal involves separating the decomposable solid waste from the indecomposable ones and making quality compost from the former that can be sold to users at a reasonable price. From the indecomposable wastes,those which can be recycled will be recycled and the rest will be land filled. The recycled materials will be reused and separation of decomposable and recyclable components involves creation of job opportunities for some members of the community.

However, implementing this program is very costly for the municipality and the users are required to share the cost of running the program by paying a user charge for the service per month.

1. Are you willing to participate in this project? A. Yes B. No

2. Would your household be willing to pay 4/8/12 Birr per total *'Madaberiya'* of solid waste generated in a month for this improved solid waste management service?

   A. Yes B. No If 'Yes' or 'No', go to question 3.

3. What is the maximum amount your household is willing to pay for all *'Madaberiya'* of solid waste you generate per month (in Birr)?

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