Urban Households' Willingness to Pay to Improve Municipal Solid Waste Collection Services and Associated Factors: A Double-Bounded Contingent Valuation Study in Harar City, Ethiopia

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Haileyesus Girma[1,2], Abraham Geremew[1], Molla Alemayehu[3], Gutema Mulatu[1], Mesfin Gebrehiwot[4,5] and Bart Defloor[2]

[1]Department of Environmental Health Science, Haramaya University, Harar, Ethiopia. [2]Department of Economics, Ghent University, Ghent, Belgium. [3]Department of Economics, Haramaya University, Dire Dawa, Ethiopia. [4]Department of Environmental Health Science, Wollo University, Dessie, Ethiopia. [5]Ethiopian Environment and Forest Research Institute, Addis Ababa, Ethiopia.

ABSTRACT: Municipal solid waste collection (MSWC) service financing is a challenge for governments in developing countries, with little or no contribution from the service users. In most Ethiopian cities, residents do not pay for MSWC. This study aims to estimate households' willingness to pay (WTP) for improved municipal solid waste collection service in Harar city. A cross-sectional study was conducted among 331 households employing the contingent valuation method with a double-bounded dichotomous choice format. The hypothetical program works to collect solid waste twice a week, house-to-house, and safely dispose of it to reduce environmental and health impacts. The Tobit regression model was used to account for the determinants of households' WTP. Findings showed that 89% (95% CI: 85.4, 92.5) of households were WTP for the improved waste collection program, with an average yearly amount of US$12. The Tobit model shows that being married (β = 6.9, 95% CI: 1.2, 13.7), having a monthly household income of >8000 ETB (β = 31.9, 95% CI: 22.1, 41.7), attending education about MSWM (β = 11.8, 95% CI: 5.6, 18.1), having temporary storage at household level (β = 15.3, 95% CI: 9.5, 21.2), and recycling practices (β = 5.5, 95% CI: 1.2, 10.8) positively influenced the WTP. Interventions like providing educational programs about waste handling and recycling and providing or encouraging households to have temporary storage at the household level are needed to enhance users' WTP. The policy implication of the finding is that community contribution through service fees could be a strategy for sustainable financing.

KEYWORDS: Solid waste collection, contingent valuation, willingness to pay, service fees, Tobit model

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CORRESPONDING AUTHOR: Haileyesus Girma, Department of Environmental Health Science, Haramaya University, P.O. Box 235, Harar, Ethiopia. Email: hailejesus22@gmail.com

Introduction

In Ethiopia, inappropriate handling and disposal of solid waste are common in major cities where waste is dumped in unauthorized sites like roadsides, drainage systems, and open spaces.[1,2] These practices seriously endanger the population's health and the environment, as only 2% receive solid waste collection services.[3] Because of the existing poor waste management system, such as a traditional mode of waste collection and poorly planned and operated landfills, cities have neither adequate nor acceptable levels of practice in solid waste collection and disposal.[4] The main challenge in the waste management sector is that the municipality has the only responsibility (including financial and resources).[5]

In Harar city, this study's focus, residents currently do not pay for municipal solid waste collection (MSWC) services. The Harari region municipality is the only budget source for MSWC and disposal. As a result, solid waste management services such as waste collection and disposal are ineffective and inefficient. Only two-fifths of the municipal solid waste was collected and disposed of properly from the daily waste generated, 39 tons.[6] The current MSWC scheme includes curbside collection (people gather the waste in the designated place, mostly on the ground for collection by truck), and a few door-to-door collections were implemented. In addition, the amount of solid waste generated in the city is increasing, exerting great pressure on waste management systems within Harar's limited land area. The commonly generated and disposed of waste in the residential areas were biodegradable wastes like *Catha edulis* (Khat) (ie, a plant mostly grown in the eastern part of Africa where people chew the leaves for stimulant action) and non-biodegradable wastes, such as plastic bottles and plastic bags. Moreover, the landfill site, the only waste disposal site in the area, is poorly operated and is criticized due to location suitability, design, and local community acceptance.[7] Furthermore, the city lacks the implementation of waste reduction schemes. This implies that small proportions of the urban dwellers are served, and a large quantity of solid waste is left uncollected.[8]

Municipal solid waste management (MSWM) continues to be a major environmental and public health concern in urban areas, particularly in low- and middle-income countries.[9] Improper solid waste disposal practices have several implications for the environment, public safety, and health.[10] In developing nations, especially sub-Saharan Africa, waste generation is gradually increasing. Over two-thirds are disposed of in open dumps,

Table 1. Examples of commonly used elicitation formats for willingness to pay estimation.

FORMATS	DESCRIPTIONS	REMARKS
Open-ended	*". . .What is the maximum amount you would pay per year, through a tax surcharge, to improve MSWM in Baher Dar city, Ethiopia. . .?"*	Likely to have a high zero response
Bidding game	*". . .Would you pay 'A' ETB every year, through a tax surcharge, to improve MSWM in Baher Dar city, Ethiopia . . .?"*	The estimate influenced by starting-point used
Payment card	*". . .Which of the amounts listed below best describe your WTP every year, through a tax surcharge, to improve MSWM in Baher Dar city, Ethiopia. . .?" 0, A ETB, and B ETB, etc.*	The amount influences the final estimate on the card
Single-bound dichotomous choice	*". . .Would you pay 'B' ETB every year, through a tax surcharge, to improve MSWM in Baher Dar city, Ethiopia. . .? (the price is varied across the sample)"*	Higher estimate than other formats
Double-bound dichotomous choices	*Would you pay 15 ETB monthly through a tax surcharge to improve MSWM in Baher Dar city, Ethiopia? I have just described (the price is varied randomly across the sample)* *If Yes: Would you pay 20 ETB?* *If No: Would you pay 10 ETB?*	Easier for respondents than other methods

Source: David et al[43] and. Tassie and Endalew[32]

which block drains, resulting in stagnant water for vector breeding and flooding during the rainy seasons.[11] Studies report that open dumping and open burning can cause all types of environmental pollution, such as air, soil, and water (both surface and groundwater).[12,13] It also contributes to the global warming effect from greenhouse gas (GHG) emissions (methane, CO_2, etc.) and other pollutants released into the atmosphere.[14] If properly managed, waste management sectors can reduce global greenhouse gas emissions from 10% to 15% and substantially increase to 20% if waste prevention is applied.[15]

An increase in the generation rate and types of solid waste directly relates to lifestyle change, technological development, and industrialization.[13,16] The high population growth rate and urbanization also became the main driving force that generated a huge volume and diverse types of solid wastes (non-biodegradable and e-wastes). This huge volume and various types of waste, together with limited resources and lack of financial support, create a challenge for the local governments to provide adequate MSWM services.[17,18]

It is essential to consider service users' preferences to enhance the waste collection service since the waste collection practice links the service recipients (waste generators) and the service providers.[19] Users' positive attitudes and willingness to pay for waste management can ensure the sustainability of service provision.[20] Ferrara and Missios[21] reported that asking for service fees improves users' waste management behavior, like recycling and waste reduction and segregation at the household level. Household waste segregation to collection frequency and WTP for waste management services depends on users' preference and participation.[22] Thus, the formation and implementation of relevant waste management interventions and policies should consider the local communities' behavior and readiness to contribute. The scientific community has executed several techniques to scrutinize users' attitudes, preferences, and willingness to contribute to various environmental issues.[23-25]

Willingness to pay for solid waste collection service improvements can be accessed via non-market valuation methods. The most commonly used non-market valuation method is the Contingent Valuation Method (CVM), which is validated for its application in developing countries.[26] The CVM estimates the value of a good/service not in the market by employing a survey-based approach.[27] Several elicitation formats were used to estimate the value of environmental goods and services (Table 1). CVM has been frequently used in waste management sectors, among others, in food waste management,[28] photovoltaic waste recycling and management,[29] private SWM,[30] and municipal SWM.[31,32]

Previous studies in developing countries employed a WTP approach for assessing residents' preference to improve SWM services. For example, a study in Nepal examined residents' WTP for a regular solid waste collection service, where the existing waste collection service is irregular and is provided only in a few areas.[33] The authors report that about three-fifths of the households were WTP, with an average amount of 0.72 US$ per month.[34] Boateng et al[33]also utilized the contingent valuation method to elicit households' WTP in 4 metropolitan cities in Ghana. They found that about half of the respondents' were WTP additional service charges (1.3 US$). The authors also state that having higher education and working in the private sector positively affect WTP. Similarly, a study in Nigeria used a dichotomous choice CVM to estimate residents' WTP for higher solid waste collection service fees than the current one.[35] The author report that older respondents had a lower WTP than the younger ones. They state that this was probably the younger respondents were likely to be more familiar to cost sharing, such as for education and health services rather than free government services.

Moreover, a study in Ethiopia used a Tobit model to analyze factors associated with WTP. They found that an individual was willing to pay about 1.07 US$ per month. The authors

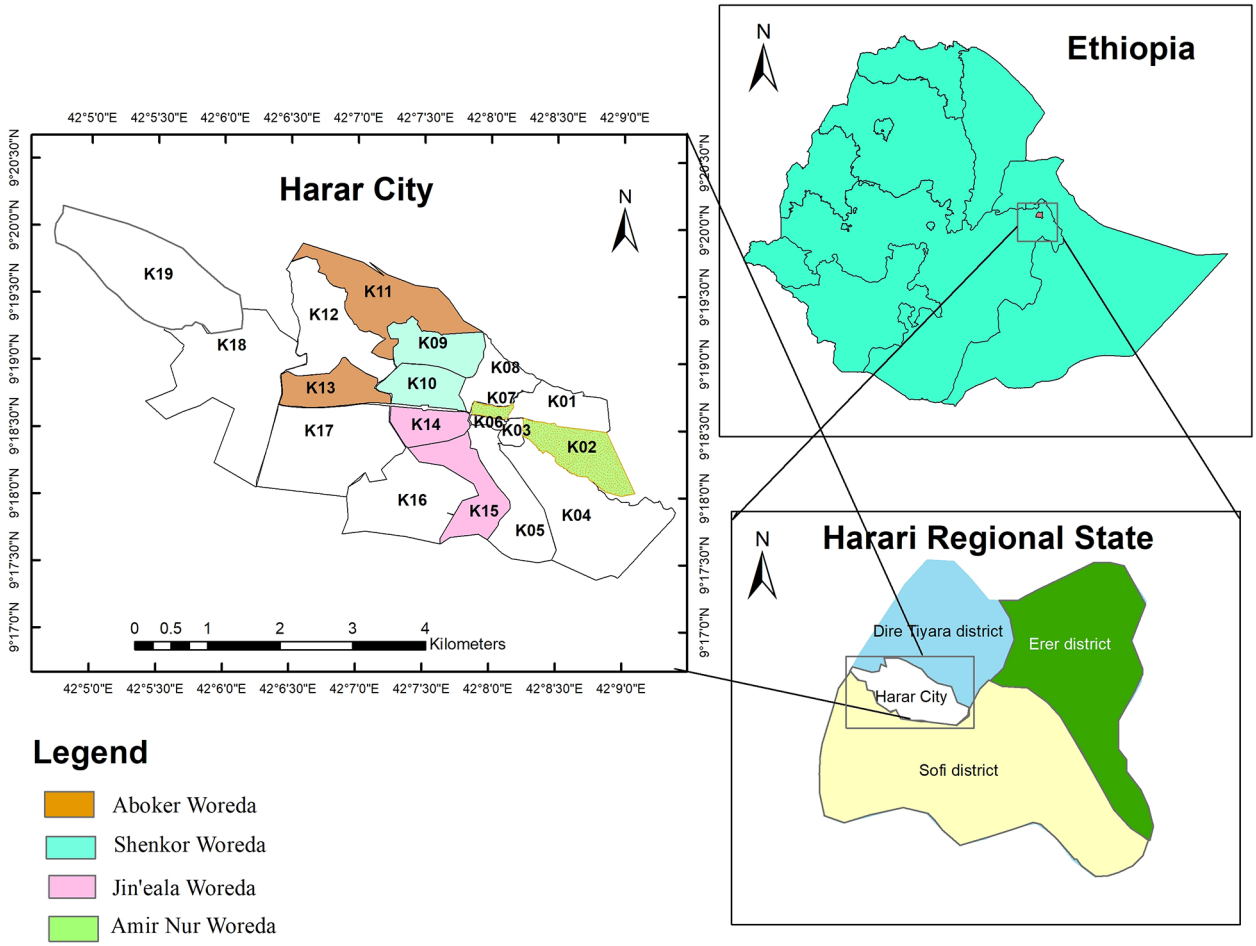

Figure 1. Map showing the study area, Harar city, and the study woredas (coded in color).

revealed that richer households, satisfied by the service and generating a higher amount of solid waste, had statistically significant positive effects on households' WTP.[36] Furthermore, a study done in Malaysia evaluated the economic value of MSWM using the CVM. They found that satisfaction with MSWM service affected the WTP amount, apart from socioeconomic factors such as educational level, house type, occupation, and household income.[37] The most stated variables in prior studies are age, gender, educational level, and income. However, the previous studies barely studied aspects like residents' experience of solid waste-related health hazards, attending education about MSWM, and recycling practices.

Scientific findings on service recipient preferences and WTP to improve the solid waste collection service are limited in Ethiopia. The coordination of concerned bodies (such as municipalities and NGOs) in identifying and considering the local communities' attitudes and preferences toward MSWM has received insufficient attention. Moreover, to the best level of the authors' knowledge, no evidence reported the proportion of urban residents' contribution to SWCS in cities with no service fees in Ethiopia. Therefore, the main purpose of the current study is to assess households' willingness to pay and its determinants to improve municipal solid waste collection service among Harar city residents, where partial and inconsistent waste collection service is currently implemented.

Materials and Methods

Description of the study area

The study was conducted in Harar city, Harari regional state, eastern Ethiopia from May 25 to June 08, 2021. The Harari region is divided into 6 urban and 3 rural administrative Woredas (third-level administrative division in Ethiopia). According to the Central Statistical Agency (CSA) projection, the region has a total population of 270 031 in 2020.[38] Harar city is located between 42°4′30″ to 42°9′30″ N latitude and 9°17′30″ to 9°20′10″ E longitude (Figure 1). Unlike most other regions in Ethiopia, most of the population (56%) lives in urban areas.[39]

Study design and study population

This study utilized a cross-sectional design to estimate respondents' willingness to improve the solid waste management service. The study unit was household, as most service fees, such as water supply and electricity service, are paid at the household level. The study population consisted of households

in the selected kebeles (the smallest administrative division in Ethiopia).

Sample size and sampling procedure

The sample size was calculated using the single population proportion equation, with the assumption of a 95% confidence level, a 5.5% margin of error, a 5% non-response rate, and a sample proportion of 50% (since in the study area, the estimated value residents' willingness to contribute for MSWM was unknown). The final sample size was 331 households, and the number of households surveyed in each kebele was determined by proportional allocation (Supplemental Figure 1).

This study employed a multistage sampling technique. Harar city has one of the highest solid waste generation rates next to Jimma, Bahir Dar, and Addis Ababa (the uppermost).[6] Simple random sampling was used to select 4 woredas from a total of 6, and from each woreda, 2 kebeles were selected similarly using a lottery method. Lastly, the study households were selected using the systematic sampling technique, with the first household selected randomly. The sampling interval (*K*-value) was determined for each study area by dividing each kebele's total household (N') by its sample size (n') ($K = N'/n'$).

Data collection methods

Data were collected using a structured questionnaire through a face-to-face interview. Carson and Hanemann[40] encourage face-to-face interviews due to their reliability and advantages over other approaches, such as online, mail, and telephone surveys. The advantages are that respondents can ask for clarity, keeping the interviewee focused on the valuation exercise. It also reduces the non-response rate and incompleteness of data.

The questionnaire has 4 sections. The first section includes socioeconomic and demographic questions. The second part includes questions about the respondents' general knowledge and attitudes about solid waste management. The third part contains questions related to MSWM practice and access to services. This includes the practice of segregation, recycling, and disposal. The final part includes the valuation exercise. A contingent valuation method (CVM) using a double-bounded dichotomous choice format was used to elicit respondents' willingness to pay under a hypothetical scenario of improving the solid waste management system, particularly the collection service.

The CVM typically consists of a series of steps. First, the current state of waste management was described. Second, a scenario for a hypothetical market was formulated. The scenario includes describing the baseline (or status quo) condition (s), as well as the proposed change (s), in a simple, meaningful, and understandable way.[41] In this study, we formulated a hypothetical scenario called "*Harar City solid waste management improvement program*" in the future that could be implemented by Harar city municipality or other concerned bodies. The hypothetical program intends to increase the waste collection frequency and improve the waste disposal system from the current condition (status quo). And respondents were informed by stating, "*. . .the program would work to collect solid waste two times a week (House-to-house) and safely dispose it into a waste disposal site outside the city to reduce health impacts related to poor MSWM.*" The payment vehicle is a service fee for solid waste collection services. The hypothetical market assumes that each response to hypothetically stated questions is comparable to the individual response to the actual market.[27] The valuation exercise starts by asking respondents whether they are willing to pay or not by using a dichotomies question (Yes/No). Then, the double-bounded choice format was followed for those who answered "Yes" by asking how much they were willing to pay for the scenarios described in the hypothetical market.[42] Respondents who answered "No" were then asked to explain why in a follow-up question.

Before the data collection, the questionnaire was pretested on 15 households in Hakim woreda, Harari region, to determine the initial bid value and check the study material's appropriateness and ambiguities. In addition, the initial English version of the questionnaire was translated into local languages (Amharic and Afaan Oromo) to correctly convey the intention of the questions to both enumerators and respondents.

Data analysis

Descriptive statistics and censored regression models were analyzed using STATA 14.2. The Tobit regression was used to estimate the maximum likelihood function and the mean WTP.

Regarding variable selection, a bivariate analysis was initially run for all variables. As a result, the variables (13 variables) with a *P*-value less than .25 (ie, as a rule of thumb) were considered to build the regression model and were subjected to multivariable censored regression. Then, the variable occupation of the household head was dropped from the model due to the detection of sample size insufficiency. A multicollinearity test was also conducted using a pairwise correlation test, and all the variables included in the model were not correlated. The final model was run by incorporating 12 independent variables: gender, marital status, family size, educational level, house ownership, monthly household income, attending education about MSWM, access to collection service, having temporary SW storage at the household level, experiencing MSWM-related health hazard, sell or exchange recyclable materials, and service satisfaction.

Econometric model

This study applied a double-bounded dichotomous choice format, as it efficiently elicits more information about respondents' WTP.[43,44] In a double-bounded dichotomous question, the individual was presented with a first bid and asked whether

Table 2. Double-bounded dichotomous choice format to elicit respondents' willingness to pay for solid waste management.

	BID PRICES	RESPONSE	DESCRIPTION	OUTCOMES
Initial bid price	35 ETB*	Yes—No	"Yes" for the initial bid but "No" to the higher bid price proposed.	$35 \leqslant WTP < 50$
Higher bid price	50 ETB	Yes—Yes	"Yes" for both the initial and higher bid prices.	$35 \leqslant WTP \geqslant 50$
Lower bid price	20 ETB	No—Yes	"No" for the initial price but "Yes" for the lower bid price.	$35 > WTP \geqslant 20$
	—	No—No	"No" for both initial and lower bid prices.	$35 > WTP < 20$

*One US$ = 43.5 Ethiopian Birr (ETB) on June 19, 2021 (https://www.combanketh.et/en/exchange-rate/).

they would pay this price for the new MSWM program when considering their maximum subjective value. If the answer was yes, then a second higher bid was presented. If the answer was no, then a lower second bid was presented. According to Entele[45] and Wegedie et al,[46] this method produces 4 possible outcomes (Table 2):

Tobit model. The Tobit model was used to evaluate factors influencing the maximum amount of money households are willing to pay as used by other similar studies.[36,47] The Tobit model is an alternative to other linear regression models like Ordinary Least Square (OLS) when the dependent variable is not fully observed, that is, if there are zero values for a substantial part of the sample, which is the case in this study.[48,49] This is because the OLS would give inefficient and inconsistent estimates.

The data have both left- and right-censored observations. The left-censored observation is from below 0 (ie, at $Y_i \leqslant 0$), households unwilling to pay any amount or are against the proposed improvement program, and their maximum WTP amount was reported as 0. In addition, since the proposed higher bid price was 50 ETB, we included the right-censored observation (ie, at $Y_i \geqslant 50$) to consider respondents who might have a higher contribution (ie, Yes—Yes). Therefore, the Tobit model can be stated as:

$$\boldsymbol{Y_i} = \boldsymbol{X_i}\boldsymbol{\beta} + \boldsymbol{\varepsilon_i} \quad {}_i \sim \mathbf{N}\left(\mathbf{0},\ \delta^2\right)$$

Where Y_i is the dependent variable, that is, the maximum amount of money the respondents are willing to pay; X_i is a set of explanatory variables, and ε_i is assumed to be normally distributed and independent of X_i with zero mean and constant variance (δ^2), that is, $N(0, \delta^2)$. The coefficient to be estimated is denoted by β.

$$\boldsymbol{Y_i} = \begin{cases} \boldsymbol{Y_i} = \boldsymbol{Y_i^*}\ if\ \boldsymbol{Y_i^*} > 0 \\ \boldsymbol{Y_i} = 0\ otherwise \end{cases}$$

Where Y_i^* is the unobserved latent variable or the threshold observed when Y_i or the amount of money households are willing to pay is positive. The observed Y_i counterpart of Y_i^* can be expressed as $Y_i = 1$ if $Y_i^* > 0$ for willingness to pay for improved SWCS, and $Y_i = 0$ if $Y_i^* \leqslant 0$ for not willing to pay for improved SWCS, and Y_i is a latent (unobservable) variable for WTP.

Data

Socioeconomic and demographic characteristics

A total of 301 households completed the questionnaire. One hundred sixty-one of the respondents were females with a mean age of 39.8 years (SD ± 9.9). More than half of the respondents were married, and the average family size of the households was 3.7 (SD ± 1.7). Nearly half attended college diplomas, and about half of the study households were privately owned. The mean annual household income was about 82 000 ETB (~1885 US$) (Table 3).

Solid waste management practice and access to service

Only about one-third of the sample respondents had a temporary solid waste storage bin in their houses. In contrast, more than half of them has designated place for solid waste handling at the household level. About three-fifths of the households received a solid waste collection service (ie, once per week) from the municipality. Most participants experienced health hazards such as vector breeding and odor nuisance. Regarding MSWM service satisfaction, nearly half of the households did not feel satisfied with the current service in the city (Supplemental Table 1).

Knowledge and attitude about MSWM

Study participants were asked knowledge and attitude questions. Of the total respondents, only 42.2% know the type of MSWM in Harar city, of which 70.9% said: "the waste is collected house-to-house and disposed of at landfill/open field." On the other hand, most participants (90%) know that improper handling and disposal of solid waste could cause health problems. For the knowledge question about problems related to poor MSWM, respondents mentioned that odor nuisance and vector breeding (65.4%) are major problems, environmental pollution like soil and water pollution, and poor esthetics (15.6%), and the remaining responded "do not know." Regarding MSWM education, only one-fourth of the participants were at least educated once about MSWM, including proper waste handling, segregation, reuse/recycling, and disposal.

Table 3. Socioeconomic and demographic characteristics of the study participants (n = 301).

VARIABLE	CATEGORY	FREQUENCY (%)
Gender	Male	140 (46.5)
	Female	161 (53.5)
Age	<30	71 (23.6)
	30-39	84 (27.9)
	40-49	78 (25.9)
	⩾50	68 (22.6)
Current marital status	Never married	45 (15.0)
	Married	178 (59.1)
	Divorced	44 (14.6)
	Widowed	34 (11.3)
Family size	1-4	210 (69.8)
	⩾5	91 (30.2)
Educational status	No formal education	17 (5.7)
	Attending primary and/or secondary school	128 (42.5)
	College diploma and above	156 (51.8)
Occupation	Government employee	89 (29.6)
	Private employee	71 (23.6)
	Housewife	52 (17.3)
	Merchant	76 (25.2)
	Others*	13 (4.3)
House ownership	Private housing	151 (50.2)
	Rented housing	125 (41.5)
	Subsidized/Kebele house	25 (8.3)
Aggregated household income	<50 000 ETB**	89 (29.6)
	50 000-100 000 ETB	150 (49.8)
	>100 000 ETB	62 (20.6)

*Others = farmer and unemployed.
**One US$ = 43.5 Ethiopian Birr (ETB) on June 19, 2021 (https://www.combanketh.et/en/exchange-rate/).

The study applied 5-point Likert scale questions to assess the attitude of respondents toward MSWM. The majority of the respondents agree on the main MSWM components, such as solid waste segregation (70.1%), waste reduction (56.1%), and recycling at the household level (47.1%). However, a greater number of them (44.5%) disagreed with the question they were asked about whether they believe Harar city has an effective MSWM system.

Table 4. Household responses to the hypothetical improved solid waste management program.

	RESPONSE	BID PRICE	FREQUENCY (%)
Willing to pay (n = 268)	Yes—Yes	50 ETB*	107 (35.6)
	Yes—No	35 ETB	100 (33.2)
	No—Yes	20 ETB	61 (20.2)
	No—No	0	
Not willing to pay (n = 33)		—	33 (11.0)

*One US$ = 43.5 Ethiopian Birr (ETB) on June 19, 2021 (https://www.combanketh.et/en/exchange-rate/).

Results

Willingness to pay to improve solid waste collection service

Of the total respondents, 89% (95% CI: 85.4, 92.5) were willing to pay for the improved municipal solid waste management program. The findings of the Tobit regression (ie, only households that are WTP, n = 268) showed that the households' mean monthly willingness to pay is about 41.8 ETB (~1 US$), ranging between 37.9 and 45.7 ETB with a 95% confidence interval. Furthermore, based on the double-bounded dichotomous choice format, about one-third of the households responded "Yes" for both the initial bid and the follow-up higher bid price, whereas no household refused to accept the stated bid prices (Table 4).

On the other hand, about 11% of the households were unwilling to pay for the solid waste management improvement program. Therefore, a follow-up question was asked to the respondents to state their reason for being against the program, and most of them stated they could not pay because of budget constraints (Figure 2).

Determinants of willingness to pay

The Tobit regression model was used to identify the factors influencing WTP. The model's findings show that 5 out of 12 variables significantly determined households' WTP. The variables marital status, monthly household income, education about MSWM, having temporary SW storage at the household level, and selling or exchanging recyclable material were significantly associated with households' WTP toward improved SW collection service. For instance, respondents who are married had 6.9 ETB (95% CI: 1.2, 13.7) higher WTP ($P < .05$) than other marital status categories (single, divorced, and widowed). Another statistically significant variable is monthly household income. The marginal effect shows that household heads with a monthly income of 4000 to 8000 ETB and greater than 8000 ETB were WTP 12.1 ETB (95% CI: 5.4, 16.2) and 31.9 ETB (95% CI: 22.1, 41.7), respectively more than those with lower monthly income (<4000 ETB).

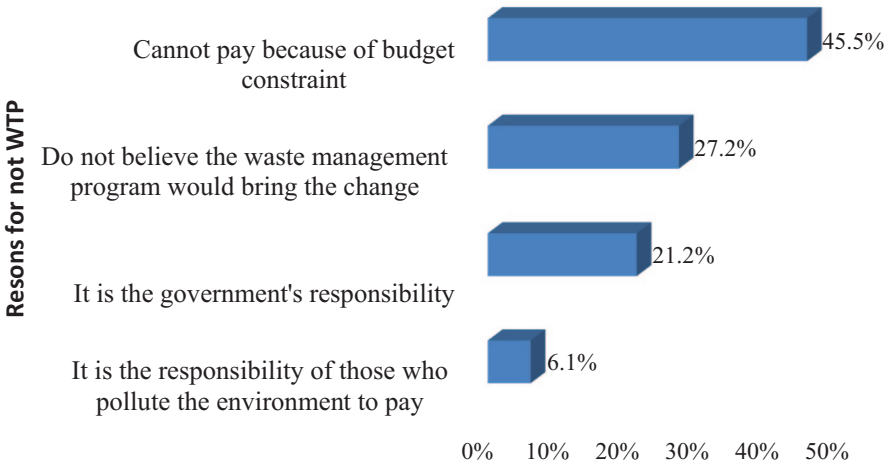

Figure 2. Participants' reasons for being against the waste management program (n = 33).

Household heads who attended an education about MSWM were also WTP (β = 11.8 ETB, 95% CI: 5.6, 18.1) more than those who did not attend. Furthermore, households with temporary solid waste storage and those who practice waste recycling through selling or exchanging material influence WTP positively at 0.05 significant levels, respectively. A positive effect implies that higher values of the variables increase the probability of WTP (Table 5).

Discussion

In the study area, there is no specific municipal solid waste collection fee imposed on the residents. Only about three-fifths of the households received MSWC service weekly from the municipality. The study revealed that 89% of households were willing to pay for the improved MSWC service. A household's average amount of money willing to pay was 41.8 ETB per month (~1 US$), ranging between 37.9 and 45.7 ETB, with a 95% confidence interval. The willingness to contribute shows the households are interested in improving the municipal solid waste collection service, even if there is no existing fee.

The current finding of 89% of households' WTP for improved MSWC service is comparable with the studies conducted in other parts of Ethiopia. For instance, studies conducted in Batu town, 89.5%[50]; Bahir Dar city, 86.3%[51]; and Debre Berhan town, 93.2%.[52] However, the result showed deviation from other studies, such as higher than studies done in Nepal 61%[34] and Nigeria 64.4%.[53] The plausible reason for the deviation might be the differences in study areas, settings, socioeconomic, and demographic conditions. On the other hand, the monthly household willingness to pay amount can be compared with other recent studies on solid waste collection services even though there is an expected difference in the socioeconomic conditions, study region, and period. For instance, this study was comparable with a study done in Hawassa City, Ethiopia (0.62 US$)[54] and Rwanda (1.5 US$).[55] However, the WTP is lower than a study done in Malaysia (2.87 US$).[56]

Based on the model estimation, the marital status of the respondents (being married) has a statistically significant association with WTP at a 5% probability level. Married household heads had 6.9 ETB higher WTP than those with single, widowed, or divorced marital status. The findings of this study corroborate with previous studies, for example, in Uganda[57] and Ghana.[33] This might be because married respondents are likely to have a high waste generation rate due to larger family sizes; thus, they face a higher risk of improper waste management than those not married.

The household's monthly income was found to have a statistically significant positive effect on WTP ($P < .001$). Households with a monthly income category of 4000 to 8000 ETB and greater than 8000 ETB have 12 and 31.9 ETB more contributions, respectively, than those with less than 4000 ETB. The result was checked for possible economic influence on WTP. As a result, about two-thirds of the households that refused to contribute were in the lower-income category (<4000 ETB). Thus, when the household income increases, respondents are more likely to pay for improved solid waste management (increased purchasing power). This finding was comparable with other studies in Nigeria,[53] Nepal,[34] Sri Lanka,[58] Ethiopia,[51] and Vietnam.[59] This proves that the high-income respondents were willing to pay more for environmental improvements than low-income respondents, who tend to dispose of solid waste in open spaces.[59,60]

Furthermore, attending education about MSWM has a statistically significant ($P < .001$) positive effect on households' willingness to pay. The possible explanation for this might be that as a person becomes trained or educated about proper waste management, such as waste segregation and recycling, it could bring positive perceptions and the ability to understand the consequences of improper solid waste management. In addition, education increases people's access to knowledge about the future benefits of improved waste management services. Therefore, the government may launch promotional and educational activities to disseminate knowledge on the MSWM to implement the household MSWC service successfully.

The households with temporary solid waste storage at the household level were more likely to pay for waste collection. A

Table 5. Tobit regression showing factors associated with respondents' willingness to pay for solid waste collection service (n = 301).

VARIABLE	CRUDE		ADJUSTED	
	β (95% CI)	*P*-VALUE	β (SE)	95% CI
Gender (Reference = male)				
Female	−12.1 (−18.8, −5.3)	.01	−1.87 (2.6)	(−6.9, 3.3)
Marital status (Ref. = otherwise[a])				
Married	24.3 (17.8, 30.1)	.001	6.9 (3.4)**	(1.2, 13.7)
Family size (continuous)				
	5.3 (2.9, 7.8)	.03	−0.05 (1.3)	(−2.5, 2.4)
Educational level (Ref. = no formal education)				
Attending primary and/or secondary school	16.7 (3.4, 31.2)	.03	8.28 (5.9)	(−3.4,19.9)
College diploma and above	30.3 (15.6, 45.3)	.01	9.6 (6.1)	(−2.3, 21.5)
House ownership (Ref. = rented/Subsidized housing)				
Private housing	17.9 (11.3, 24.6)	.02	1.5 (3.1)	(−4.5, 7.5)
Household income (monthly) (Ref. = <4000 ETB[b])				
4000-8000 ETB	21.9 (15.2, 28.6)	.001	12 (2.4)***	(5.4, 16.2)
>8000 ETB	46.7 (37.2, 56.1)	.001	31.9 (5.0)***	(22.1, 41.7)
Attended education about MSWM (Ref. = no)				
Yes	29.2 (20.6, 37.8)	.001	11.8 (3.2)***	(5.6, 18.1)
Get SW collection service (Ref. = no)				
Yes	19.2 (12.5, 25.9)	.01	−5.9 (3.5)	(−12.8, 0.9)
Having temporary SW storage at the household level (Ref. = no)				
Yes	23.8 (17.2, 30.3)	.001	15.3 (3.0)**	(9.5, 21.2)
Experience health hazards related to improper SW disposal (Ref. = no)				
Yes	17.9 (10.4, 25.5)	.001	4.43 (2.9)	(−1.3, 10.2)
Sell or exchange recyclable material (Ref. = no)				
Yes	16.4 (9.5, 23.3)	.01	5.53 (2.7)**	(1.2, 10.8)
Service satisfaction (Ref. = not satisfied				
Satisfied	19.3 (12.7, 25.8)	.04	1.42 (3.2)	(−4.9, 7.7)

[a]Otherwise = never married, widowed, and divorced.
[b]One US$ = 43.5 Ethiopian Birr (ETB) on June 19, 2021 (https://www.combanketh.et/en/exchange-rate/).
Significance level at **$P < .05$, ***$P < .001$.

possible explanation may be, first, the idea of having a place to gather the waste until disposal is possibly raised because of the awareness of the waste management system. Second, as wastes from residential areas decompose and produce odor, nuisance, and esthetic problems within a week, there is a need to regularly collect and transport waste to disposal sites like sanitary landfills. Both explanations could influence the respondents to agree and WTP more for the proposed waste collection program. Similarly, respondents who sell or exchange recyclable materials had higher WTP than those who do not practice. Therefore, it may be that the practice of waste reduction through recycling used materials possibly come from one's perception of proper waste management, which can influence the demand for improved services.

The study result can be extrapolated to all households in the studied Woredas. In the selected Woredas, there were about 21 844 households. The aggregate WTP was calculated by considering the present amount of willingness to pay. Extrapolating the values, the aggregated monthly WTP (89%) found to be 812 640.5 ETB (~18 681.4 US$). A recent report

revealed that only one-fourth of the generated waste was collected and disposed of, with a monthly budget of less than 200 000 Ethiopian birrs.[61] This implies that the aggregate WTP amount can significantly increase the coverage of solid waste collection services if well collected, organized, and implemented.

Strengths and limitations of the study: The study employed the Tobit model to reduce inconsistency in the model, like in the case of Ordinary Least Square (OLS), which gives inconsistent and biased estimates. The Tobit model is recommended when the outcome variable is not fully observed, that is, if there are zero values for a substantial part of the sample, which is the case in this study. The study also implemented a double-bounded dichotomous choice format, which is recommended and easier to understand by the respondents than other methods like single-bounded. On the other hand, the study failed to investigate the households' preferred charging methods, such as flat rate (ie, the same amount of money paid regardless of the quantity of waste generated), volume-based, and weight-based. Future studies might thus consider incorporating preferred charging methods. In addition, even though measures were taken to mitigate hypothetical bias (ie, respondents might not behave the same way as they stated in a hypothetical experiment), the study might be subjected to it. The measures were (ie, ex-ante approaches) informing the participants about the current service delivery and future improvements to reduce their uncertainty, pretests to reveal the truth in the proposed bid, and alternative bid prices based on the respondent's first choice.

Conclusions and Recommendations

The study area's municipal solid waste management system has no solid waste collection charge imposed on the inhabitants. Our findings revealed that about 89% of the respondents were willing to pay one of the proposed bids for MSWC services. This suggests that improved MSWC services are essential and are supported by the inhabitants. The user's willingness to pay was influenced by socioeconomic status and current solid waste management practices at the household level. Being married, having a higher household income, being educated about MSWM, having temporary storage at the household level, and selling or exchanging recyclable materials increase the likelihood of respondents' WTP.

Based on the present study, the following points were recommended. First, to enhance users' WTP, we recommend interventions like providing promotional and education programs about waste handling and recycling and providing or motivating households to have temporary storage in their houses or neighborhoods. The policy implication of the finding is that community participation in terms of service charges could be a means to sustainable financing. Thus, the local government must work on convincing and participating in the community to pay a service fee for house-to-house waste collection, which could support financial constraints. In addition, as households were not the only waste generators, other studies have to assess governmental organizations, institutions, and marketplaces' contributions to MSWM in the city. Finally, yet importantly, combining valuation methods could bring better WTP estimation; thus, further studies might consider using other methods, such as discrete choice experiments.

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Author Contributions

HG and AG contributed to the study conception, tool development, and design. AG and MA approved the proposal with some revisions, participated in data analysis, and revised subsequent drafts of the paper. HG, GM, and MG wrote the first draft of the manuscript and revised the following changes. BD critically revised the manuscript. All authors have read and approved the submitted version.

Data availability statement

Data available on request from the authors

Supplemental material

Supplemental material for this article is available online.

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