

## Demand for Improved Solid Waste Collection Services: A Survey in Mekelle City

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Tewodros Tadesse and Samson Hadgu. 2009. Demand for Improved Solid Waste Collection Services: A Survey in Mekelle City. *Journal of the Drylands* 2(1): 32-39.

Problems related to waste collection and demand for improved solid waste collection services are examined using a household survey in Mekelle city. The focus of the empirical analysis is largely to determine the factors that influence the willingness to pay for improved waste collection services. Results of household survey data analyzed using logit model are presented. The fact that households are dissatisfied with the current waste collection services shows about 90 percent of the households in the city are willing to pay a positive amount where the mean willingness to pay is 8.78 birr a month. Demographic features such as education, age, household size and gender are found to have insignificant impact on the demand for improved services of waste collection. Whereas, household income and current access to waste disposal containers have significant influence on the decision whether or not to purchase the new collection services. While demand for the services increases with income, showing that the services are normal goods, the willingness to pay decreases with the distance of (access to) communal waste disposal containers. One major area of intervention in order to improve solid waste management is ensuring adequate supply of waste collection services. In addition, cost sharing can be practiced through price discrimination for the collection services provided, which ultimately would help improve waste management.

**Key words:** waste collection services, willingness to pay, Contingent Valuation Method, households, Mekelle

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Received June 16, 2009, Accepted October 14, 2009.

### Introduction

The practice of solid waste management in cities of developing countries has been largely unsatisfactory, largely aggravated by the ever expanding dimension of cities and ever-growing population. “*Poor solid waste management is a threat to public health*” and reduces all sorts of environmental quality (Altaf and Deshazo, 1996 p. 857). Despite the fact that most municipalities in cities of developing countries allocate a good proportion of their budget to waste management, solid waste collection services are yet in low levels and final disposal of these solid wastes remains unsafe (Cointreau, 1982).

In cities where recycling and reuse is poorly practiced, solid wastes are best treated by good disposal practices. Similarly, in the city of Mekelle where reuse and recycling practice is poor, households mainly dispose their wastes to communal containers and open areas (Tadesse, 2006). While disposal is the cheapest and easily accessible alternative available, in relative terms, to the city’s household, the supply of disposal facilities in the city is meager (Tefay, 2004, Tadesse *et al.* 2008). Households unable to be served by waste collection services do adopt different mechanisms of their own, which largely are open dumping in unauthorized areas and to some extent burning (Tadesse *et al.* 2008). Despite the municipality acts as major

supplier of waste collection services, informal waste pickers (such as street boys, individual workers, etc) and formally established waste collection firms participate in primary collection of solid wastes (Tefay, 2004, Tadesse, 2006). While poorer households resort to the use of municipal waste facilities and unauthorized areas, higher income households primarily use individual workers and to a lesser extent formal<sup>a</sup> waste collection services (Tadesse, 2006).

In recent years, the city of Mekelle is growing in terms of population and area; the result of which is voluminous waste generation and inadequate collection and disposal services (Tadesse, 2006). At municipal level for example only 33.4 percent of the solid waste generated in the city of Mekelle is collected and disposed (Tefay, 2004). From household perspective, solid waste management as well is poor. Only few households recycle their wastes; separation at source is poorly practiced and there is widespread open dumping in unauthorized areas and final disposal is very poorly organized (Tadesse, 2006). The practice of poor solid waste disposal is attributed to various reasons. Among the major factors responsible for this is inadequate public (as a matter of fact, private as well) waste collection services. Despite this, studies in the city of Mekelle that attempt to contemplate households’

demand for more and improved solid waste collection services are non-existent to our knowledge. This paper aims to fill this gap by attempting to estimate the willingness to pay by households for improved solid waste collection and disposal services. It is therefore aimed at making significant contribution to analyze household demand for more and better solid waste collection and disposal services and elicit the willingness to pay for obtaining the services.

The paper is presented as follows. In section 2, the theoretical framework behind the demand for improved waste collection services is provided. It also discusses the logit model which underlies the econometric approach chosen for the empirical analysis. Section 3 provides a brief description of the study area and the data set. Analytical model results are presented and discussed in section 4. Section 5 summarizes the main results and formulates some conclusions and implications.

### Theory and Econometric Modelling

Environmental goods are the most notable resources which the price system fails to give market value. In such cases, economists try to apply 'implicit market' mechanisms which enable us to estimate economic value of these non-marketable (environmental) goods.

However, the value of other non-marketable goods (such as services of improved waste collection or waste management) can be estimated using any of the 'implicit market' mechanisms. Among these implicit market mechanisms are hedonic pricing, travel cost method and the contingent valuation method. The use of Contingent Valuation Method (CVM)<sup>b</sup> enables a researcher to elicit the *stated preference* of an economic agent (*households* in this paper) for obtaining more or better services or goods. The willingness to pay questions in CVM asks households to speculate on how much they would be willing to pay for a certain good or service (example, for waste collection services). Typical components of a contingent valuation method include the description of the improved service on offer and the mechanism to elicit household willingness to pay for the service. Different methods of collecting solid waste have different costs and require different levels of involvement from residents. We devised the following three different (alternative) waste collection services from which households can state their specific preference (Table 1). The alternative services were designed so as to elicit the willingness to pay of households in relation to current waste collection services and the fee paid for them.

**Table 1.** Household descriptive statistics

Household features	Percentage	Mean
Age of respondent		38.8
Gender of respondent		0.37
Household (family) size		5.2
Household Dependency composition		
≤18	5.0	17.7
18-64	87.6	38.1
≥64	5.7	72
Respondent's Education		
Education		9.78
Illiterate	6.4	0
Elementary	23.2	4.6
Junior and secondary	46.8	10.1
College education or more	21.6	16.6
Respondent's primary occupation		
Self-employed as labourer	9.9	
Self-employed as trader	38.9	
Self-employed as consultant or professional	1.7	
Employee of government or private organization	35.5	
Others	11.2	
Households' gross monthly Income		1544.7
≤500 birr <sup>1</sup>	6.3	306.4
500-1000 birr	12.5	847.1
1000-2000 birr	16.6	1588.7
2000-5000 birr	27.8	3810.8
5000-10000 birr	11.8	6630.5
≥10000 birr	24.8	15687.5

<sup>1</sup>Birr is the Ethiopian currency where 1€ at the time of data collection (November 2006) roughly equalled 10.5 birr.

### Description of alternative services: scenarios explored<sup>c</sup>

**A.** Low cost-Communal containers: more communal containers - with 8 cubic meters holding capacity of

solid wastes– (where this capacity is equal to the current carrying capacity of communal containers in the city) would be placed in households' neighbourhood at a central location and each household would be

expected to carry its refuse to empty it into the container. The container would have an attendant to sweep the area and keep it tidy. A vehicle would pick up the container and take it away to be emptied before it is completely full. The current waste container size is highly inadequate in which 810 households share only one communal container for waste disposal (Tadesse, 2006). This better scheme differs from the current service in that more communal containers will be made available in accessible positions. As such households will have bigger share of the waste containers.

**B.** Low cost-Tractor-trailers: more tractor trailers (or better vehicles) would go to the neighbourhood on a scheduled basis and park for a few minutes at each block or road junction to collect solid waste. When the vehicle parks, it would sound its horn or play a musical jingle to summon residents to bring their containers out to be emptied. All waste in the neighbourhood would be kept inside until the vehicle comes.

**C.** Medium cost system-Tractor-trailers or containers with workers: as with the first service option, a large communal container would be placed in households' neighbourhood or more tractor-trailers would go to the neighbourhood. However, instead of household members being required to carry waste to the communal container, households were informed that door-to-door collection would be arranged for an added fee. The door-to-door collection would be done by a worker using a push cart or donkey, depending on which would work better in the neighbourhood. The worker then takes the wastes to containers or tractor-trailers for disposal.

Household utility maximization depends on various household features as well as on other attributes related to the use of the service from which utility is derived. Therefore, the decision of a household whether to buy waste collection services is made based on the utility that the household derives from the particular service that it chooses to use (Devkota *et al.* 2004). The utility from the waste collection service chosen to be purchased is measured in terms of the supply of waste collection services coupled with other household characteristics such as income, education, and so on. The utility derived by a household from the choice of an alternative waste collection mechanism is specified to be the sum of a deterministic and random component (Devkota *et al.* 2004). In such cases, the deterministic part of the indirect utility for each waste collection alternative depends on observed attributes of the alternative services chosen, various household demographic, waste and environmental characteristics. To motivate our demand analysis, we based our analysis upon standard consumer theory, in which case demand is a function of prices, income, wealth, and other household characteristics such as education, age and others (Bennett and Blaney, 2003). For municipal waste collection services in the city of Mekelle, hypothesized relationships of the probability of a respondent willing and able to pay for the provision of an improved waste collection service are presented in Table 2. Household respondents were offered price premiums (bids) of the improved services from which they would select. These bids represent the price the respondent would be willing to pay for the improved waste collection service.

### The microeconomics of demand for waste collection Services

**Table 2.** Hypothesized relationship and demand for improved waste collection services (for the major covariates)

Key Variables	Hypothesized relationship	Rationale for proposed relationship
Household income	Positive	Households with higher income are able to pay more and thus will have the willingness to pay. Because waste collection services can be considered as 'normal goods', their demand increases with household income
Household size	Undetermined	As household size increases the opportunity cost of income increases, suggesting a negative correlation, while the size of the aggregate benefits are increasing in household size
Gender	Undetermined	Male and female respondents may have systematic differences in willingness to pay
Education	Positive	Better educated households have better understanding of the benefits improved services who would be encouraged to pay more
Concern for environment	Positive	Households with prior knowledge and concern for their surrounding environmental safety better understand the benefits of the improved collection services
Current payment	Undetermined	Households that currently pay for waste collection may be less inclined to pay more while others can be otherwise
Number of earners	Positive	The higher number of adult earners in the household the reduced is the cost of paying for the improved service (or the higher the capability to pay)
Access to containers	Negative	Households will not be willing to pay for services not used. Thus, their willingness to pay declines with the unavailability of waste disposal facilities near their houses (neighbourhood)

A representative individual household  $i$  willing to buy the waste collection service will have a utility function given by:

$$U_i = \theta x_i' + \varepsilon_i \quad (1)$$

Where,  $U_i$  is the utility derived by household  $i$

from purchasing the improved waste collection service,  $x_i'$  is the row vector of various household factors and characteristics of the alternatives that affect disposal,  $\varepsilon_i$  is the unobserved component, and  $\theta$  is the vector of parameters of the model. If we assume an individual household  $i$  has a willingness to pay (price for the improved waste collection service) represented by:

$$WTP_i = \beta x_i + \varepsilon_i \quad (2)$$

Where  $WTP_i$  is households' willingness to pay,  $x_i$  represents the vector of explanatory factors and  $\varepsilon_i$  signifies the systematic random error with zero mean and unit variance that arises from the unobserved factors about  $i$ 's WTP. Discrete dependent-variable models such as the logit model can be used to reflect the utility maximization process (Cramer, 1994, Greene 1997). Households may or may not be willing to pay for the service. In such cases, the dependent variable assumes a latent (unobserved) status as represented by the following equation:

$$y_i^* = x_i \beta + \varepsilon_i \quad (3)$$

in which  $y_i^*$  is the unobserved dependent variable. If an individual household  $i$  is willing to pay,  $y_i = 1$  and otherwise  $y_i = 0$  (zero). Mathematically, this is given by

$$y_i = \begin{cases} 1 & \text{if } y_i^* = 1 \text{ (household willing to pay)} \\ 0 & \text{otherwise} \end{cases} \quad (4)$$

When  $y_i^* = 1$ , then  $y_i = 1$  implying the specific household is willing to pay a positive price for the service. This probability that a household would be willing to pay is given by the following distributional function.

$$P(y_i = 1) = P\{x_i \beta + \varepsilon_i > 0\} = F(x_i \beta) \quad (5)$$

Where  $P$  represents the probability,  $F$  is the cumulative logistic distribution.

### Study Area and Data

The study area is the city of Mekelle located in northern Ethiopia (783 km away from Addis Ababa). The city is located between latitude of 13°32' north and longitude of 39°28'. In the last two decades, the city's spatial and population growth has been tremendous. While the spatial coverage expanded from 16 (in 1984) to 100 square kilometres by 2004, growing at a rate of 4.9

percent per annum the city's population grew to around 190000 by the same year (Tadesse, 2006). As a result of this growth, waste generation has been increasing, which waste collection and disposal services could not accommodate. The principal component of the study is therefore the designing, development and implementation of a household survey in an effort to analyze the demand for improved waste collection and disposal services. In line with the objectives set, this was intended to elicit three types of household information: the perceived level of existing public service problems; practices of waste collection and disposal at household level; and willingness to pay for improved collection services by the municipality.

For this purpose, a random sample of 300 households was drawn from residents of Mekelle. A roughly proportional number of sample households were selected from the eight administrative *tabias*<sup>d</sup> of the city. In selecting the sample households, a number of criteria were considered. Studies (such as Qdais, 1996) investigated and showed that socio-economic level of population (such as income, population density) significantly determines the type of waste generated and the way the wastes are primarily treated. Other factors such as geographical settlement (Tadesse, 2006) (where households could not be reached by current waste collection services) affect waste collection and disposal. Taking into account these influencing household features, structured questionnaire interviews were administered to collect information from sampled households. In November 2006, eight enumerators were sufficiently trained and collected data from 300 household members whose age is 18 years or older. In table 1, we describe several characteristics of our household sample. We see that the majority of the respondents are in the secondary (46.8%) and primary (23.2%) stage of their schooling. Moreover, a good proportion of the respondents have at least college diploma (21.6%). The average income amounts to birr 1544.7. Most of the respondents (44.4%) are in the 'middle' income class where they earn their income either as self-employed traders (38.9%) or by working in civil and private organizations (35.5%). Average household size is 5.2, slightly higher than that shown by previous studies, 4.93 (Hagos and Holden, 2002) and 4.47 (Tadesse, 2006).

### Shortage of Waste Collection Facilities as Major Public Service Problems

Of the various (public) service problems in cities of developing countries, this study attempted to identify the major ones. A wide variety of lingering problems in access and quality of drinking water, transport facilities, waste facilities, power supply and drainage problems are some of the major deficiencies in cities of developing countries. These deficiencies are exacerbated by the ever-growing population size of cities. In line with the theme of the paper, we explored

the extent of waste facilities such as inadequate collection services for solid waste, human excreta and residential waste water and issues related to illegal dumping. Survey results in the city of Mekelle show that inadequate collection services to household wastes is the prime problem resulting in a widespread illegal dumping in unauthorized areas. The majority of households use communal containers (as examined by other studies as well, such as Tesfay, 2004, Tadesse, 2006) to dispose their wastes. This however could not prevent households from dumping bulky waste in open areas and roadsides (which is illegal dumping). Figure 1

shows some of the major service problems that households encounter. It shows inadequate waste collection services and pervasive illegal dumping as the major (service) problems in the city. Flooding and inadequate drainage and inadequate disposal of residential waste water are also among the major problems. Households believe that the rest of major public services such as electricity supply and public transport are 'second batch' problems in the city of Mekelle, depicting that problems related to waste management are as severe as ever.

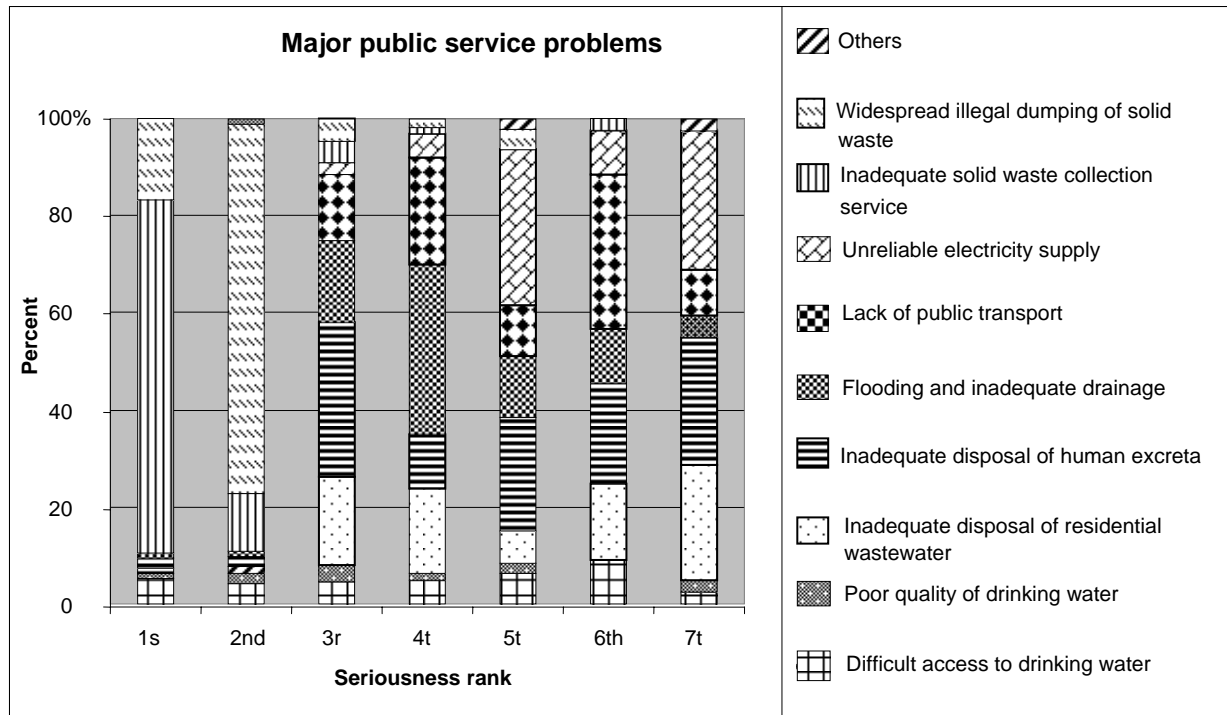


Figure 1. Extent of shortages in major public services.

### Results and Discussion

In this paper, we employed an iterative bidding elicitation module with follow-up questions, which were used to elicit a respondent's willingness to pay. The respondent was first asked if he or she would accept any one of the improved waste collection services offered at a given monthly fee. Based upon a YES or NO response in the previous question, the monthly fee was raised or lowered. Following the iterations, the elicitation procedure ended with an open-ended question enquiring the respondent to state his or her maximum willingness to pay for the preferred improved service. Those who were not interested or not willing to pay at all for the service were asked to justify their answer.

The willingness to pay responses of the households is stipulated in Table 3. For either of the improved solid waste collection services, the minimum willingness to

pay is birr zero while birr 30 is the maximum. Specifically, 95.6 percent of the respondents gave an amount between birr 0 and 30. Among these, 88.3 percent gave a positive amount for one of the improved waste collection services while 11.6 percent have a zero willingness to pay for the services. One percent of the respondents do not wish to participate in any of the new services and 3.4 percent are non responses. The mean willingness to pay is birr 8.78 a month and the median is birr 10. A large proportion of the respondents are willing to pay between birr 5 and 15 for the services. Overall, service C is the most preferred improved method of solid waste collection as can be seen from table 3. In the analysis of willingness to pay, different techniques are employed based on the type of data input, required output and the technique of estimation. In our study, the preferred elicitation CVM method is the iterative bidding. This method is prone to starting point bias, but we have tried to test the presence of this

bias using multivariate analysis. OLS regression of the willingness-to-pay bids of households who are interested in purchasing the improved waste collection service confirm that the bids are not random but are related to household socioeconomic features in line with expectations (table 4). The willingness to pay bids increase systematically with increases in average household income and access to waste containers (shorter distance of containers).

**Table 3.** Willingness to pay responses (frequency)

Bid amount (Birr)	Yes			No	Non-response
	Service A	Service B	Service C		
0	11	17	5		
2	4	5	2		
3	4	6	2		
5	18	23	27	3	10
10	13	42	34		
15	5	7	27		
20	4	1	23		
30	1	0	3		
Total	60	100	123		

The multivariate analysis of the bids shows (Table 4) that income is a significant positive determinant of willingness to pay suggesting that solid waste collection service is a normal economic good with implications for household welfare. OLS results of the willingness to pay depict that key household demographic features (such as gender, education, household size) do not have statistically significant influence over their willingness to pay. Nevertheless, the willingness to pay of households is largely affected by the income that the household earns. A number of interpretations may explain the insignificance of the variables in the multivariate results. First, respondents may not have believed the acceptance scenario presented to them. Second, they might not have associated externalities with the proportion of households accepting the service since this was not explicitly mentioned in order to avoid biased responses by providing leading information. However, the objective of the multivariate analysis

(OLS regression) is not to provide an explanation for the willingness-to-pay bids obtained, but simply to establish that bids are not random. Based on the results of logit estimation presented in Table 5, demographic variables such as education, number of earners in the household, age, and gender remained to have no statistical significance in the power to affect the willingness to pay by households for the improved waste collection services. Households' concern for environmental safety when household wastes are finally disposed of in open areas do not have that significant impact either in determining the willingness to pay by households for improved collection services. Current payments for municipal waste collection services by households do not have a significant influence on the demand for improved services. Household income and access to solid waste disposal containers are among the most important variables that determine demand for better waste collection services. In line with theory and causal empiricism, both of these variables are found to have significant impact on household willingness to pay. As expected, household income positively affects the demand for collection services. The higher the household income earnings the higher is the willingness to pay. This is in harmony with economic theory since waste collection services are normal goods where their demand increases with income (or at least, does not decline with increases in income). Access to solid waste disposal containers also has a significant impact on the demand for more collection services. As the distance of communal containers increases, households' willingness to pay for these services declines. It implies that households are willing to pay more the closer the waste containers are situated to their houses. Despite previous studies (such as Tadesse, 2006) revealed that many households are resistant to have waste containers near their houses, they would still be tempted to pay if these waste containers are not located far away from their houses (neighbourhoods). This is because there is unsatisfied demand for solid waste collection services among households in the city.

**Table 4.** Willingness to pay bid estimates for improved solid waste collection services (Ordinary Least Square)

(Dependent variable = Willingness to pay (WTP); 1= Yes, 0= No)	Parameter estimates	Standard error	T-values
Constant	5.51	2.51	2.20**
Household head (1= yes; 0= no)	-0.75	1.13	-0.66
Gender of respondent (1= male; 0= female)	1.44	1.17	1.23
Age of respondent (years)	-0.04	0.05	-0.92
Education of respondent (years of schooling)	-0.07	0.11	-0.69
Household size (family size)	0.29	0.29	1.01
Perception on current waste collection services (1= satisfied; 0= not satisfied)	-0.01	0.83	-0.2
Waste container distance (meters)	-0.004	0.002	-2.05**
Concern for environmental safety as a result of final waste disposal (1= concerned; 0= not concerned)	-0.96	0.98	-0.98
Current payment for waste collection services (1= yes; 0= no)	0.4	0.83	0.48
Number of earners in the household	-0.44	0.64	-0.7
Household monthly income (birr)	0.001	0.0005	1.12**

Number of observations = 250; Prob > chi<sup>2</sup> = 0.60; Log likelihood = -25.893422; R<sup>2</sup> = 0.16

Significance level: \*\* 5%

**Table 5.** Maximum likelihood logit estimation of the willingness to pay for improved services

(Dependent variable = Bid estimates or amount of bids)	Parameter estimates	Standard error	T-values
Constant	6.43	3.04	2.11**
Household head (1= yes; 0= no)	0.65	1.51	0.43
Gender of respondent (1= male; 0= female)	3.51	1.47	2.39**
Age of respondent (years)	-0.03	0.06	-0.45
Education of respondent (years of schooling)	0.10	0.15	0.60
Household size (family size)	0.25	0.26	0.96
Perception on current waste collection services (1= satisfied; 0= not satisfied)	-0.32	1.09	-0.29
Waste container distance (meters)	-0.005	0.003	-1.87*
Concern for environmental safety as a result of final waste disposal (1= concerned; 0= not concerned)	0.21	1.25	0.17
Current payment for waste collection services (1= yes; 0= no)	1.70	1.19	1.43
Number of earners in the household	-0.55	0.75	-0.74
Household monthly income (birr)	0.001	0.0004	3.54***

Number of observations = 250  
Significance level: \*\*\*1%, \*\* 5%, \*10%

## Conclusion

Previous studies (example Tesfay, 2004) and practical experience reveal that most of the solid waste generated in the city of Mekelle remains uncollected. Not surprisingly, households are overwhelmingly dissatisfied with existing solid waste collection and disposal services and a lot of them are willing to pay a specific positive amount in demanding for improved services. The positive and significant causal relationship among household income and access to containers with willingness to pay suggests that solid waste collection service is a normal 'economic' good, the demand of which increases with income. This demand for collection service is particularly varied according to spatial variations which could have a strong implication for those who are responsible for improving collection services. The limited waste collection budget the municipality has can be best allocated by considering the spatial variation in the demand and capability of paying for collection service. The results also indicate some prospects for limited collection cost recovery with households currently willing to pay a monthly average of birr 8.78 for the improved solid waste services. Application of price discrimination could be considered for example to extract the maximum possible waste collection revenue so as to improve the waste collection service. Such elements as distribution of waste collection and disposal facilities in a neighbourhood and household income can be considered for this.

However, households are currently paying some amount, which is higher or smaller than this figure, and policy makers can still have a good impression from this stipulated willingness to pay by households. Given that the valuation of waste collection and disposal services is important to improve waste management and environmental quality, further and rigorous study on the demand for improved waste collection services is warranted. Results of this study provide some very good implications, particularly with the effect of access

to waste facilities and income on willingness to pay; yet the interpretation with some of the other covariates should be considered with caution.

**Acknowledgement** - We appreciate the Young Researchers Fund of Mekelle University, NORAD II project, for the financial assistance provided to conduct the research. We are also grateful to two anonymous reviewers for their helpful comments and suggestions. The usual disclaimer applies.

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#### FOOTNOTES

<sup>a</sup> In this regard, those waste collection services provided by the municipality and private waste collection firms are considered 'formal'.

<sup>b</sup> For an extensive discussion (both introductory level and advanced) of the Contingent Valuation Method, readers are advised to consult, Whitehead (2000) and Whittington (1998).

<sup>c</sup> Of course, as in any willingness to pay study, services are provided publicly as those goods or services which are valued by WTP methods do not have market value and hence are not attractive to the private sector. Currently also, the municipality of the city of Mekelle provides the largest (more than 90%) household waste collection service where the private sector does not have the incentive to enter the market of providing household waste collection services.

<sup>d</sup> *Tabias* (*tabia* for one) are the lowest administrative units in the city. A group of *tabias* make up *Wereda* (District).