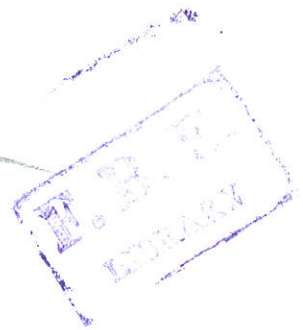


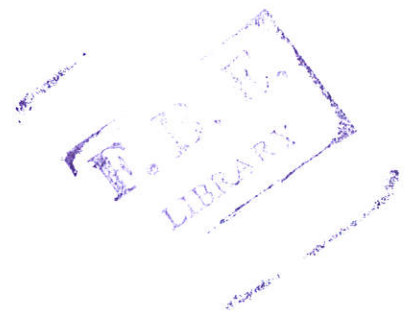
**ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
FACULTY OF BUSINESS AND ECONOMICS**

**HOUSEHOLDS' WILLINGNESS TO PAY FOR IMPROVED SOLID WASTE
MANAGEMENT: THE CASE OF ADAMA**

BY: TOLINA TIRUNEH



**A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF
ADDIS ABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN
ECONOMICS
(ECONOMIC POLICY ANALYSIS)**



JULY 2006

**Addis Ababa University
School of Graduate Studies**

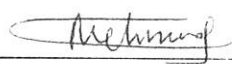
**Households' Willingness to pay for Improved Solid Waste Management:
The Case of Adama**

By

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Declaration

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university, and that all source of materials used for the thesis have been duly acknowledged.

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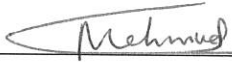
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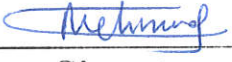
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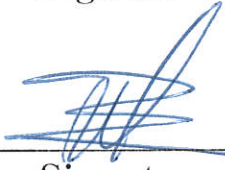
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ACRONYMS

ANOVA = Analysis of Variance
CAC = Command and Control
CS = Compensating Surplus
CSA = Central Statistical Authority
CVM = Contingent Valuation Method
E.C. = Ethiopian Calendar
EI = Economic Instrument
ES = Equivalent Surplus
FAO = Food and Agricultural Organization
GDP = Gross Domestic Product
LRI = Likelihood Ratio Index
NBE = National Bank of Ethiopia
NGOs = Non-Governmental Organizations
OLS = Ordinary Least Squares
SWM = Solid Waste Management
UNEP = United Nations Environment Program
USD = United States Dollar
WCED = World Commission of Economic Development
WTA = Willingness To Accept
WTP = Willingness To Pay

Abstract

With continuous urbanization and population growth and the resulting increase in solid waste generation, solid waste management is becoming a major health and environmental concern in major urban areas of Ethiopia, including Adama. Adama is situated 100kms away from Addis Ababa with a total population of 200,000 and with population growth rate of 5.1% per year. Management of solid waste in a sustainable manner requires cooperation among municipalities, the community, NGOs and the private sector. The limited capacity of the municipal government calls for a cost sharing by inhabitants of Adama based on their ability and willingness to pay.

The aim of this study is to determine the willingness of dwellers of Adama to pay for an improvement in environmental quality due to improved solid waste management. The central hypothesis is that willingness to pay should reflect the value to the community of having a better environmental quality, according to the contingent valuation literature. A contingent valuation survey is conducted to get information on households' willingness to pay a fee that covers some proportion of the cost of properly handling the solid waste. In the survey 250 randomly selected households from all kebeles are interviewed based on a well designed questionnaire. Three different enforcement mechanisms are provided to respondents under which they give their maximum willingness to pay for improved solid waste management to evaluate the impact of enforcement mechanism on willingness to pay values. Tobit and Probit models are used for the empirical analysis.

The study result shows that only 55.8% of the households are getting solid waste collection services and 55.2% of the households have some primary waste storage receptacles. Most of the households (96.8%) are not satisfied with the current services provided by the city administration. 92% of the households are willing to cooperate with the city government to improve the service in all aspects, including cost sharing. The mean willingness to pay, calculated from the open-ended responses, is 8.26, 8.66, and 8.41 Birr/month per household under the existence of no, strong and weak enforcement mechanisms, respectively. The F-test shows that there is no significant difference among these mean WTP values and hence enforcement does not matter. This may be due to lack of commitment from the side of the city administration in implementing existing rules pertinent to illegal dumping and the concern of well informed households to pay a fee irrespective of whether or not there is enforcement mechanism.

The Tobit model shows that income, education, marital status, time spent in the area, quantity of solid waste generated, house ownership and age(with negative sign) have positive and significant effects on the willingness to pay amount under the three cases. Results of the Probit model indicate that income, house ownership and status of respondent in the household (all with positive signs), sex, age, and waste receptacle (all with negative signs) have significant effects on the probability of having a positive willingness to pay.

The result of this study suggests that for improvement in solid waste management, the city administration should enforce existing rules, improve its service efficiency and encourage private sector participation; service charges based on ability and willingness to pay of households and quantity of waste they generate should be introduced; there should be continuous awareness creation programs and promotion of reuse and recycle of wastes; and there should be provision of standard primary waste storage receptacles at fair prices.



1. INTRODUCTION

1.1 Background

Ethiopia is amongst the least developed nations in the world with the real GDP per capita of 93.9 USD in 2002/03 and 112.4 USD in 2003/04 (NBE, Annual Report, 2004/05). Poverty is rampant, and in relative terms more severe in urban centers. The total population of the country for the year 2005 is estimated at 73.04 million of which 11.68 million (about 16%) lives in urban areas (CSA, 2004). The country has one of the fastest growing populations in the world (2.9% per year) (Ibid). There is also a significant influx of people from rural areas to urban areas of the country. The annual rate of urban population growth is around 5.4%. According to estimates of CSA (1999), the urban population will reach 16 million in 2013 and almost double (21 million) in 2020. The country is also characterized by very low life expectancy, being 53 years for males and 55 years for females for the year 2003/04 (NBE, Annual Report, 2004/05).

Rapid urbanization and the associated growth of industries, services and consumption activities is a key feature of economic and demographic development in many developing countries. The urban centers absorb the majority of the total population increase (UN commission on sustainable Development, 1999). With this the quantities of wastes generated increase as wastes arise from a multitude of industrial, commercial, agricultural and household services.

With continuous urbanization and population growth and the concomitant increase in waste

generation, solid waste management¹ is becoming a major public health and environmental concern in urban areas of many developing countries. The situation in Africa is more severe (Kenya country report, 2002). The major reasons mentioned by Kenya country report (2002) include poor capacity of the public sector to deliver effective services, limited regulation of the private sector, and the illegal dumping practice of domestic and industrial wastes by citizens.

As in other developing countries, the urban centers of Ethiopia are also characterized by poor solid waste management practices. The major reasons, in addition to those mentioned for developing countries in general, include the un-planned nature of urban development, a very slow urban economic dynamism and a huge influx of people, particularly the relatively poor, in the town every year (Tedla, 1997 cited in Yoseph, 2004). In fact, the degree and extent of the problem varies from one town to another. Adama, a town located 100 kms away from the capital, Addis Ababa, with a population of 200,000 and annual population growth rate of 5.1%, is one of the major towns where the problem is getting more severe (CSA, Adama Branch, 2005). Currently, the City Administration, health bureau of the City and few private micro enterprises are making some efforts to handle the problem but is insignificant as compared to extent of the problem.

The ever increasing quantity of solid waste disposal in urban centers of Ethiopia is imposing various health, environmental and aesthetic risks to urban dwellers. This calls for proper handling of the solid wastes through a coordinated effort by all

¹ According to Fossberg (1999), solid waste management is defined as the selection and application of appropriate techniques, technologies, and management programs to achieve specific waste management objectives and goals (Quoted in Yoseph, 2004).

stakeholders. Municipalities of urban centers of Ethiopia, including Adama, allocate a small proportion of their already scarce financial resources, as there are many ends towards which the budget should be allocated, indicating that the responsibility over solid waste collection and disposal is well beyond the capacity of municipalities (Adama Master Plan Revision Project, 2004).

One potential way of dealing with, or minimizing the problem is through adoption of cost sharing mechanism by inhabitants of the urban centers based on their willingness to pay for a better and cleaner environment. In the absence of a market for this environmental service, we ask people what they do in a hypothetical situation. This method, which is known as contingent valuation, involves obtaining direct information from individuals about their willingness to pay for changes in environmental quality.

This work, therefore, tries to evaluate demand for improved solid waste management by inhabitants of Adama.

1.2 Existing solid waste management systems in Adama

Adama is an old town established in 1917 (Anteneh and Associates, 2003). It is one of the fast growing towns of the country and strategically located being only 100 kms from Addis Ababa; lying on the Djibouti-Addis Ababa railway line and the major traffic route to eastern part of the country. Within the town, there are lots of light industries, service establishments and educational institutions. It is a thriving urban center whose population had been growing at an average rate of 4.7% per year till 2001 and at 5.1% per year since then (CSA, Adama Branch, 2006). The current

total population of the town is estimated at 200,000, almost equally divided between females and males (50.01% females and 49.98% males (Ibid).

With fast growth of the urban population, mainly due to migration from other areas, and increase in production and consumption activities in the town solid waste generation is ever increasing. The per capita solid waste generation rate for Adama was estimated as 267 gram/day (0.267 kg/day) for 2004 and 271 gram/day (0.271kg/day) for 2005 and the waste density as 375kg/m³. Applying these parameters to the population of the town for the years 2004 and 2005, the generated solid waste is estimated at 131.27 m³/day and 47915m³/year for 2004 and 144.5m³/day and 52755m³/year² for the year 2005 including the domestic and non-domestic solid wastes(Adama Master Plan Revision project,2004 and own calculation). The non-domestic wastes include market waste, street sweepings, commercial and industrial waste and garbage occasionally removed from drains. According to Adama City Administration(2005), domestic wastes account for the lion's share(76%) of the total solid waste where as commercial, street, industrial wastes, wastes from hotels and hospitals account for the remaining 9%, 6%, 5%, 3%, and 1%, respectively. A major constituent of domestic solid wastes in Adama is dead animal and vegetable matter, mainly in the form of kitchen wastes and garden wastes, as in the case of urban areas of developing countries.

The City Administration is the single body to finally dispose solid waste in Adama. The collection modalities are door-to-door collection by the City Administration and by private micro

² $0.267 \times 184374 / 375 \times 365 = 47915 \text{ m}^3/\text{year}$ for 2004
 $0.271 \times 200000 / 375 \times 365 = 52755 \text{ m}^3/\text{year}$ for 2005.



enterprises who dispose the waste in refuse containers located at accessible sites in the city and communal collection (container system).

In the case of door-to-door collection by the City Administration, upon notice of arrival of trucks residents bring out and dump the waste on municipality trucks. There are two trucks that provide this service with a carrying capacity of 6m^3 and 7m^3 and transport the waste to the final disposal site two to three times a day each. Currently, these trucks dispose 27m^3 solid waste per day, although they can dispose up to 39m^3 per day, as they do not wait till the maximum amount is loaded. The city administration charges households 12 Birr, 6 Birr, and 3 Birr per year as hygiene fee for high, middle, and low income earners, respectively.

There are three private micro enterprises; namely, 'Yenege Tesfa', 'Beza', and 'Hope' that give door-to-door waste collection service to business firms and households in Adama, since 2003/04 (1995 E.C). They have created job opportunities for 80 people (38, 17, and 25, respectively) and give the service to 260, 370, and 174 households, respectively, a total of 804 households (2.15% of the total households in the city), once every week charging 10 Birr each per month. These private firms currently use ten carts with different capacity to collect the waste from its source and dump it into refuse containers located at different sites in the town by the city administration.

The city administration has 30 garbage collection bins with a carrying capacity of 7m^3 each, out of which 25 are located at accessible sites throughout the city. The remaining 5 that are not in use, at the time of the study, would be located in appropriate sites once the identification of the sites is completed, according to head of Environmental and sanitation Section of the City Administration. The private waste collectors, households and commercial establishments dump

solid wastes in these bins. There are two dumping trucks with a carrying capacity of eight full containers each to the dumping site every day. The two dumping trucks dispose only around 63 m³ per day due to poor culture of residents of the city in disposing wastes in the containers and transporting of bins that are not full.

Therefore, only 90 m³ of solid waste is collected per day. That is, 21600m³ of solid waste is collected per year from the town, which covered about 41% of the total estimated Solid waste generated in 2005-52755m³. The percentage of non-domestic wastes collected is relatively larger because the markets are served and main streets are swept. Many households either bury or burn their wastes, or throw it away in a nearby vacant plot of land or ditch. Moreover, the solid waste brought by trucks from the town is indiscriminately disposed in open field located 8 kms away from the center of the town towards west on the road from Adama to Addis Ababa in a place called 'Qobbo Luxo' without taking any sanitary measures to safeguard the local environment. According to Hygiene department of Health bureau of the city, occasionally awareness creation programs are organized in social gatherings and health centers but are insignificant as compared to severity of the problem.

A study has been conducted by Adama city solid waste disposal site feasibility study team to select solid waste disposal site and two additional sites are already identified. These sites are located 13.5 kms and 15 kms away from the center of the town towards east in 'Hofi' and Hidha Jiru', respectively. The other feasible disposal site is the previously existing one (Adama Master Plan Revision Project, 2004).

³ 90 m³/day*240 working days=21,600m³ per year is collected.

1.3 Statement of the problem

As in other developing countries, the sources of urban population growth in Ethiopia are natural increase, the growth of small rural settlements into towns, and migration of people, particularly the relatively poor, from rural areas into towns. There is also flow of people into big towns from less privileged towns of the country in search of better living conditions. As a result, there is a high concentration of the poor in major towns of the country, where Adama is one. These major urban centers of the country are also characterized by poor planning. The continuous expansion of production and consumption activities in these major urban centers of Ethiopia, coupled with the above mentioned facts, is causing ever increasing environmental damages. Of the outstanding environmental problems, poor solid waste management is recognized as one of the most important concerns by both professionals and municipalities (Yoseph, 2004).

Solid waste arises from human activities-domestic, commercial, industrial, wastes from public sites and others, all of which increase with urbanization. Domestic sources constitute the major sources of solid waste in urban Ethiopia, including Adama. According to Fossberg (1999), there is a positive correlation between the level of development of a country and its waste generation rate. Amiga quotes Cointreau (1999) as having calculated solid waste generation per capita per day for low income countries in general to be in the range of 0.4-0.6 kg. According to Yoseph (2004), the figure for Addis Ababa lies in the interval [0.1-0.4kg]. According to Adama City Administration (2005), the solid waste generation per capita per day for Adama is 0.271 kg.

As discussed under 1.2, only 41% of the total solid waste generated in Adama per year was collected in 2005. That is, 59% remained uncollected. A significant proportion of inhabitants of Adama practice illegal dumping to drainage canals, empty sites, streets while the city

administration is dumping the waste to an open dumping site in the outskirts of the city, in an environmentally harmful manner.

As a result of this inappropriate dumping, there are increasing cases of patients visiting hospitals and health centers in Adama. According to Adama City Administration Health Bureau (2005), number of patients due to solid waste related diseases (diseases spread by insects and rodents attracted by garbage heaps, and diseases associated with different forms of pollution) is continuously increasing in hospitals and health centers.

Table 1.1 Ten Top Diagnoses (Diseases) of Adama Health Bureau for the Years 2004/05 (1996 EC) and 2005/06 (1997 E.C)

Serial No.	Type of Diagnosis	No. of Patients (Cases)	
		1996 E.C.	1997 E.C.
1	Acute Respiratory Tract Infection	9659	7268
2	Diarrheal Diseases	2764	2124
3	Intestinal Parasites	1784	1709
4	Skin Infection	1675	1594
5	Fever of Unknown Origin	1380	233
6	Urinary Tract Infection	1064	663
7	Gastritis & Doudenitis	998	755
8	Rheumatism	940	579
9	Ear Infection	668	262
10*	Malaria	295	-
10*	Eye Infection	-	350
	Total	21227	15537

* Malaria is not within the top ten in 1997 E.C. where as Eye Infection is not within the top ten in 1996E.C.

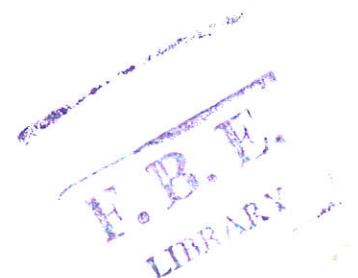
Source: Adama City Administration Health Bureau, 2006

From the ten top diseases most of them are either directly (especially diarrheal diseases, intestinal parasites and malaria) or indirectly related to poor solid waste handling. The number of cases is a good indicator of severity of the problem. The problem is more severe as a significant number of patients visit traditional healers and reports from all health institutions are not collected timely. In addition to the health risks related to poor solid waste handling, there are also pollution of air, ground and surface water(environmental risks) and bad odour, unpleasant vision and litter(aesthetic risks) that negatively affect welfare of the community.

The risks related to poor solid waste management result in few working hours of workers, less productivity and hence fall in income of inhabitants of Adama and loss of life in worst case.

The environmental and human health impacts of improper elimination of waste call for an efficient collection system and an environmentally sound sanitary landfill. These require a partnership amongst the government institutions (like municipalities), the community, the private sector and NGOs. It is when both the supply-side (like institutional arrangements for service delivery, enforcing existing environmental legislation and others) and demand-side (like participation of the community through cost sharing) information are employed that planning leads to sustainable solid waste management within the broader urban environmental management.

However, very few works are done in the area of solid waste management in urban centers of Ethiopia with main emphasis on supply-side information. Most of these very few works are concentrated in Addis Ababa. Adama City Administration is now making some efforts to improve the supply of solid waste management services. This effort of the city administration can



result in sustained and habitable urban environment if and only if the demand side information is also taken into account.

In connection with this, the study tried to investigate the demand for improved solid waste management by inhabitants of Adama. An attempt is also made to compare the amount households are willing to pay for improved solid waste management under different enforcement mechanisms. The results of the study may be used as an input in formulation of a strategy for sustainable solid waste management by the concerned body.

1.4 Objectives of the study

The general objective of the study is to determine the willingness of households to Pay for an improvement in environmental quality due to improved solid waste management for the inhabitants of Adama. The study also tests the impact of different enforcement mechanisms on households' maximum willingness to pay. Included in the general objectives are the following specific objectives:

1. Examine households' attitude towards refuse and the current collection system used;
2. Evaluate if and how much households are willing to pay for improved solid waste management and identify factors that affect it;
3. Compare the willingness to pay values under different enforcement mechanisms;
4. Use the willingness to pay responses to calculate aggregate benefits.

1.5 Significance of the study

In Adama, solid waste generation is ever increasing and very small proportion of it is collected due to limited capacity of the City Administration. As a result, its negative impact on human

health and public welfare is increasing, calling for all stakeholders to join hand to hand to sustainably manage it. One of the potential ways to mitigate the problem is to make the households, the major generators and victims of poor solid waste management, share the cost of properly handling the waste with the City Administration. This study is, therefore, significant as it examines the willingness to pay for improved solid waste management of dwellers of Adama, on which almost no prior study is conducted. It tries to see whether the willingness to pay of households varies under different enforcement mechanisms from which an important lesson can be drawn concerning formulation of appropriate enforcement mechanism. The study can also give insight to planners to introduce a cost sharing scheme in the provision of the service.

1.6 Methodology and Data Source

According to First Welfare theorem⁴, complete markets would imply that there is a market for each good so each individual can exchange them until there is an optimal distribution of resources (Viniegra et al., 2001). This is seldom the case when dealing with the environment as it is a particular type of public good. In case of public goods, the markets fail to send the correct signals. The lack of markets for environmental quality and solid waste makes it impossible to determine a price that reflects its value to society

(Ibid). Thus, an alternative method must be employed to determine the value of environmental quality. The method that is used in this study is Contingent Valuation.

Contingent Valuation Method (CVM) involves obtaining direct information from individuals about their willingness to pay (WTP) or willingness to Accept (WTA) money for changes in

⁴ The First Welfare Theorem requires the following conditions (1) the existence of a complete market where property rights are well defined and buyers and sellers are able to exchange goods; (2) buyers and sellers are price takers and are competitive; (3) all consumers and firms know the prices; (4) transaction costs are zero. If these four conditions hold, then the distribution will be optimal (Platteau, 1994 quoted in Viniegra et al., 2001)

environmental quality (Ibid). Residents of Adama are asked their WTP for an improvement in solid waste management through a survey based on well-designed questionnaire. The questionnaire is expected to elicit information about socio-economic, demographic and other factors that could help to explain households' WTP. A sample size of 250 households from urban dwellers associations (Kebeles) in Adama are interviewed (face to face interview based on stratified random sampling is employed for collection of data). The selection of the sample size is influenced by financial and time constraints. The main survey is preceded by a pilot survey to obtain starting values and other important information. Other information on solid waste management practices of Adama are obtained by interviewing officials of Adama City Administration and the private firms currently engaged in solid waste collection.

Both descriptive and econometric models (Tobit and Probit models) are employed to analyze the empirical work. Given the same scenario under which improved solid waste management is provided, households are asked to give their maximum willingness to pay under three different enforcement mechanisms. This is to conduct a methodological test on CVM. The Analysis of Variance (ANOVA) technique (The F-test) is employed to test whether the willingness to pay values under the three cases are significantly different from each other or not. Excel and Limdep programs are used for the analytical purpose.

1.7 Limitations of the Study

The scope of the study is limited to generating demand side information about solid waste management from households in Adama. The major limitation comes from the very hypothetical nature of CVM survey questions for which households may not give their true willingness to pay. Shortage of financial resource has also limited the sample size to only 250 households.

1.8 Organization of the Study

The remaining part of the paper is structured as follows: Chapter two deals with review of theoretical and empirical literatures. In the third chapter, the methodology employed is discussed. Included under this are: the definition of variables and hypotheses, specification of the models, description of the study area, and survey design and administration. Chapter four is concerned with empirical findings. The last chapter is devoted to summary, conclusions and policy implications of the study followed by references and appendices.

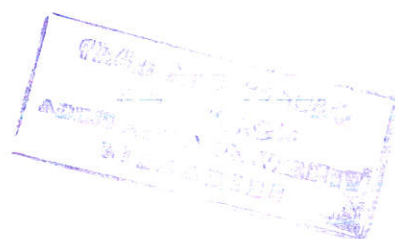
2. LITERATURE REVIEW

2.1. Review of Theoretical Literature

2.1.1. The concept of sustainable development and its implications

Sustainable development as a concept and development paradigm for lasting progress was originally defined by the world commission on environment and development (WCED, 1987) to mean” development that meets the needs of the present without compromising the ability of future generations to meet their own needs: (cited in FAO, 1999). The definition addresses both intragenerational & intergenerational equity issue. According to the commission, sustainable development involves policies, strategies, and programmes that do not make it more difficult for future generations to continue development process than it is for present generation (Ibid).

The United Nations Environment programme (UNEP, 1992) criticizes WCED (1987) definitions of sustainable development as ambiguous for interchangeably using “sustainable development”, “sustainable growth”, and “sustainable use” that do not having the same meaning. According to UNEP (1992), “sustainable growth” is regarded as contradictory in that nothing physical can grow indefinitely, where as “sustainable use” is applicable only to renewable resources in terms of using them at rates within the capacity for renewability. The definition forwarded by UNEP (1992) says sustainable development means improving the quality of human life while living within the carrying capacity of the ecosystem (FAO, 1999).The same source argues that most societies want to achieve economic development to secure higher standards of living, now and for future generations. They also seek to protect and enhance their environment, now and for their children and sustainable development tries to reconcile these two objectives



(FAO, 1999). The same source quotes Benneh (1993) as presenting an African concept of sustainability that extends WCED (1987) definition as “a strategy of resource management that regards the capital stock as a baton in a relay race handed down to us by our ancestors, and it is our duty to ensure that it is successfully transferred to future generations more or less intact and without much decline in value.”

The implications of sustainable development pose serious challenges for mankind now and in the future. With development activities, there should be maintenance of environmental quality by reducing to minimum the negative environmental effects and if possible by using waste products for productive purposes, enhancing productivity potentials through ensuring non-depletion of the natural capital stock, conserving biological diversity and the supporting ecosystem (FAO,1999).The same source Cites Daly (1991) mentioning a transition from a period where human-made capital was the limiting factor to the one in which the increasingly scarce natural capital has become a limiting factor to economic development. In line with this, Daly argues priority should be given to “qualitative development” based on more efficient use of energy and natural resources, an increase in use of a product thought recycling, and the reduction of waste and pollutants.

Economic development is sought by societies not only to satisfy basic material needs, but also to improve the quality of life through meeting the demand for health care, education and a good environment. Many forms of economic development make demands upon the environment; they use many natural resources which are in limited supply, and generate by-products of pollution and waste.

On the other hand, there are many ways in which the right kind of economic activity can protect or enhance the environment. These include waste minimization, environmentally friendly production practices, making better use of land and buildings, improved technology and techniques of management, and improved transport efficiency. The challenge of sustainable development is to promote ways of encouraging this kind of environmentally friendly economic activity, and of discouraging environmentally damaging activities.

2.1.2. Solid waste and solid waste management

2.1.2.1. Solid Waste: definition, types, and sources

There is no one best way of defining solid wastes. According to Beede and Bloom (1995), solid waste can be defined as all putrescible and non-putrescible wastes including garbage, rubbish, ash, sludge from sewage treatment plants, dead animals, appliances, construction and demolition debris, and wood waste. A non- liquid waste that fails to meet the definition of a regulated hazardous waste may be considered a solid waste. A material is considered as a waste when it can no longer be used or reused and requires treatment or disposal. Duston defines Solid waste as all solid materials that are thrown out after consumption or production (Viniegra et al, 2001). Solid wastes are all the wastes arising from human and animal activities that are normally solid and that are discarded as useless or unwanted (Adama Master Plan revision project, 2004).

Solid wastes arise from a multitude of industrial, commercial, institutional, agricultural and household sources. The literature identifies the types of wastes as Residential (domestic) wastes, Industrial wastes, Commercial and Institutional wastes, Municipality wastes, and Construction and Demolition wastes depending up on their respective sources. (Yoseph, 2004; Rand et al, 2000).

Industrial countries account for a disproportionately high share of the world's waste relative to their share of world population, while developing countries account for a disproportionately high share of the world's waste relative to their share of world income. The problem of solid waste goes hand in hand with economic growth, becoming a possible indicator of the level of life. According to Fields (1995), developed countries, like US and Japan, have rates of waste generation larger than other countries and European countries generate between 70% and 80% of those of the US (viniegra et al, 2001). Fosseberg (1999) showed that there is a positive correlation between the level of development of a country and its waste generation rate. Amiga quotes Cointreau (1999) as having calculated solid waste generation per capita per day for high, medium and low income countries in general to be in the range of 0.7-1.8, 0.5-0.9, and 0.4-0.6 Kg, respectively. That is, the low-income countries have a low rate of waste generation as they produce and consume less. There could be some deviation from this general trend as a result of difference in the definition of solid waste, availability of accurate data and the exclusion or inclusion of construction and demolition wastes. (Yoseph,2004). In the context of Ethiopia, simple analogy implies that the waste generation rate of Addis Ababa and other few big towns is much higher than that of the smaller towns. According to Yoseph (2004), the figure for Addis Ababa lies in the interval [0.1.-0.4 Kg.]. The information from Adama town municipality (2005) shows that solid waste generation per capita per day for Adama is 0.267 Kg in 2004/05 and 0.271 Kg. in 2005/06.

The differences in the degree of urbanization and income between the developed and developing countries make the magnitude of waste generation from the different sources to be different. In developed countries wastes generated from industrial, institutional and residential sources are

significant where as in developing countries, particularly sub-Saharan Africa, institutional & industrial wastes are very small compared to residential waste which accounts for the lion's share of total waste generated (Viniegra et al, 2001). The percentage share of each source in Adama is presented in section 1.2.

The composition of waste is influenced by topography, income, source of energy, consumption habits, climate and other factors. According to Fosseberg (1999), the general trend is that "low and middle income countries have a high percentage of compostable organic matter in the urban waste stream, ranging from 40 to 85 percent of the total "(Yoseph, 2004). According to the same source, organic content of waste is 41%, 58% and 28% for low, middle and high income countries, respectively. It is also projected that this share will increase significantly in both low – income and high-income countries but decline for middle-income countries. It is stated that for the low-income countries, current consumption and production pattern may continue on a greater scale. The high income countries may tend to become more environmentally conscious and implement waste reduction policies to reduce inorganic waste. The middle-income countries may tend to consume and purchase more packaged consumer goods, diversify and increase industrial production, raising the inorganic content in the urban waste stream (Ibid). The same source quotes Abdella (2001) as having reported that some 60% of the solid waste generated in Addis Ababa is composed of organic matter, which can be composted to produce fertilizers where as some 10% of the solid waste of the capital is cycleable. It is also expected that majority of solid waste in Adama and other big towns of the country is composed of organic matters due to less percentage of industrial, institutional and municipality wastes from the total waste generated. The waste composition could also be different for different income groups within the same country (Fosseberg, 1999, cited in Yoseph, 2004). The relatively rich households may generate higher

percentage of inorganic waste (paper, Plastic, metals and packaging materials) where as the relatively poor may generate relatively more compostable wastes such as food, vegetable, and ash wastes. That is, the small towns may generate relatively more organic waste than big towns and cities.

2.1.2.2. Solid waste management

Fosseberg (1999) defines solid waste management as “the selection and application of appropriate techniques, technologies, and management programs to achieve specific waste management objectives and goals” (Yoseph, 2004). United Nations Environment Program defines solid waste management as “rational control over all aspects of the life-cycle of a waste, in line with a well-defined set of objectives” (UNEP, 1994). It is an integrated system of activities involving waste reduction, collection and re-use/recycling, composting, incineration and land filling (SWM policy, 2002).

Waste must be managed in a way that minimizes risk to human health. However, today’s society demands more than this: apart from being safe, waste management must also be sustainable. It should be an integrated part of the overall environmental policy towards sustainable development. According to Rushbrook and Pugh (1999), sustainable waste management must be, at the simplest level, efficient in terms of environmental protection, socially acceptable and efficient in terms of economic viability. The same source maintains three objectives of sustainable waste management. The first one is clearly to reduce the amount of waste generated. However, waste will still be produced. The second objective is therefore to manage waste in a sustainable way. This involves minimizing the overall environmental burdens, minimizing the overall economic costs, and maximizing the social acceptability of the whole waste management

system. The third objective is to shift the 'waste' focus of the whole waste debate to a 'resource' focus. Only when waste management systems evolve into optimized resource management systems will they be truly sustainable (Rushbrook and Pugh, 1999). To put it in a nutshell, waste management has to become an integral part of sustainable integrated resource and waste management.

Environmentally sound waste management is recognized by most countries as an issue of major concern. For both developing and developed countries, waste management is an important factor in ensuring both human health and environmental protection. Article 21.4 of Agenda 21 of United Nations states that, "Environmentally sound waste management must go beyond the mere safe disposal or recovery of wastes that are generated and seek to address the root cause of the problem by attempting to change unsustainable patterns of production and consumption." (Cited in Rushbrook and Pugh, 1999).

A number of different factors such as environmental, cultural, social, economic and technical aspects must be taken into consideration in the setting up of a sustainable waste management system (Ibid). The above factors are mentioned by Rushbrook and Pugh as major reasons for the substantial variation of patterns of waste generation, its composition, its treatment and waste management schemes in different regions, countries and parts of the world.

Solid waste imposes an externality on others.⁵ These externalities do not appear in the price

⁵ Externality is a situation when consumption or production of an individual or enterprise affects the utility of another person or the production function of another firm. Externality can be positive or negative. Positive externality occurs when one economic agent benefits from the action of another economic agent where as negative externality decreases the utility or production of another economic agent-for example unsafe solid waste disposal.

system and thus affect the benefits or utility of third parties with no compensation what so ever. The markets are incapable of sending the correct signals in the case of environmental quality (which is a particular type of public good) as it is a type of market failure and therefore its unregulated use is not optimal. An optimal distribution of resources exists when the first welfare theorem holds (refer foot note 4). The presence of intergenerational externalities and the natural incentive to overuse environment (a common property resource) suggest that private economic behavior will not yield socially optimal outcomes in solid waste management and environmental quality in general. Thus, community intervention may be needed to promote the social good with arrangements to involve private firms (Beede and Bloom, 1995).

2.1.3. Instruments for Environmental Management

Instruments for environmental and natural resource management can be classified based on different characteristics. LUC (1998) classified them into two major categories: the first one known as effect-directed instruments are instruments aimed at improving the quality of the environment without changing the behavior of the polluter, and hence are corrective rather than preventive. Noise insulation wall, water treatment plants, filters to purify air are some examples. The second type known as source directed instruments are those aimed at protecting the environment by changing the behavior of the polluter. Hence these instruments are preventive measures. Some examples include subsidies, taxes, education, information and voluntary or imposed agreements. Source-directed instruments attempt to shift the costs and responsibilities associated with pollution back to the polluter, the polluter pays principles (PPP). As a result, source-directed instrument are generally preferred to effect-directed instruments.

There are two basic forms of source –directed instruments: command and control (CACs) and Economic instruments (EIs). CACs work by setting the kinds of abatement technologies that must be observed by all polluters or by setting the maximum allowable rates of emissions that each polluter can release into the environment. (Tietenberg, 1999). In the application of CACs, polluters have to observe the laws and regulations as stated and hence have no flexibility. Similarly, the control agency or environmental protection authority plays the role of the police in that it is supposed to apprehend and charge offenders in a court of law (Ibid). According to Bernstein (1993), these methods have been criticized on the grounds of being costly, difficult to enforce and does not encourage innovation.

EIs on the other hand provide the financial incentive to act in an environmentally responsible manner through the use of such mechanisms as marketable permits, changes to property rights, emissions or access charges and other financial approaches to modify behavior (Tietenberg, 1999; CEEPA, 2005). Thus, EIs internalize environmental costs and externalities through increasing the prices that individuals and firms must pay to use resources or to emit pollutants. As resources or waste disposal become more expensive, consumers have strong monetary incentives to reduce resource use, or reduce waste disposal either through conservation, substituting material with more favorable environmental impact or adjusting their consumption. Not only does this encourage reduced emissions and waste disposal, it can also be more conducive to sustainable development by reducing pressure on natural resources.

EIs have a number of inherent advantages over CACs: they are less expensive, more flexible, more dynamic, and encourage technological innovations to abate pollution (Ibid). But, application of EIs depends on effective regulation and monitoring (Bernstein, 1993). Moreover

EIs rely more on supportive infrastructures such as functioning markets, tax and fiscal payment systems that are not well functioning in many developing countries, especially in African economies. In practice, therefore, EIs work complementarily to CACs to increase policy efficiency, achieving environmental targets at a lower cost (Ibid). The application of these instruments to solid waste management is considered under the following sub topic.

2.1.4. Countries Experience

Practices for collecting, processing, and disposing of solid waste vary widely across countries, generally depending upon the nature of the waste stream and environmental and economic features (Beede and Bloom, 1995). Rushbrook & Pugh (1999) divided the world into four; namely, the European Union (EU), the United States, other high and medium income countries, and economically developing countries and tried to show the waste management experiences of these groups.

According to Rushbrook and Pugh, the member states of the EU have reached the most advanced state in waste management in the world. There is a continuous reduction in the land filled material due to extensive source separation and material and energy recovery. The policy-making in the area of solid waste management is primarily driven by environmental objectives. But nowadays there is a move to widen the perspective from a mainly environmental focus to the inclusion of economic and social aspects, within the general objective of attaining sustainable development. The EU is adopting a more integrated approach under the title 'the European waste management hierarchy (minimization-material recycling-energy recovery-disposal)' in a more comprehensive way to find the optimal combination of options (Ibid). The increasing consideration of economic aspects will probably lead to more cost-effective solutions for existing



and new regulations. For example, in Sweden Deposit Refund Schemes (DRSs), User charges, waste disposal charges and product charges are becoming successful. DRSs, in Sweden and Australia, are becoming successful with the return rate of 80-90% (Ibid). In Poland, a 20% income tax cut is given for a by-product production that uses wastes as input (Bernstein, 1993).

In the United States, the policy-making in the area of solid waste management is primarily based on economic consideration (cost-benefit analysis). As result, land filling has continued to be the most common solution (Rushbrook and Pugh, 1999). The economic instruments are providing incentives for households to reduce waste generation. For instance, a pay per-bag system in towns of new Jersey and Pennsylvania reduced waste collection by up to 50%; In Grenada, the implementation of domestic waste charges has contributed to a rise in waste collection services from 50% to 90% coverage in few years; in ten states of USA mandatory deposits on soft drinks and beer containers are implemented with promising return rates.(Ibid).

According to Rushbrook and Pugh, while some high-and medium-income countries facing limited available land follow the EU approach (countries like Hong Kong, Japan, Singapore), others with enough land fill tend to follow the pragmatic course of the USA (for instance Australia).

Solid waste management has become an issue of concern for public health and control agency in many developing countries. Most of these countries are characterized by either absence or poorly enforced modern regulations. The waste management systems in different developing countries vary significantly and in some cases almost non-existent (Ibid). Most of them lack financial and technical resource to safely dispose wastes. As a result, storage at a point of waste generation is



often inadequate and collection services are inefficient and insufficient. Final disposal in these countries is usually a matter of transporting the collected wastes to the nearest available open space and then discharging them. In some cases, the waste is set on fire in order to reduce its volume and to minimize the attraction of animals and vermin. The rapid population growth, the increase in economic activities and lack of training in modern solid waste management practices are complicating the existing efforts to improve solid waste service (Ibid). Some improvements are under planning, including extension of the waste collection system, storage of the wastes under improved conditions, introduction of cost-sharing by the polluters and enforcing existing regulations.

The case of Ethiopia is very similar to that of many developing countries. Solid waste management is becoming the concern of public health and environmental protection authority, especially in major towns of the country where waste disposal is ever increasing and its health and environmental risk is growing. The Ethiopian government has approved the environmental policy of Ethiopia in 1997, based on the Rio Earth summit-1992, which recognizes the need for sustainable development and environmental management. It states among other, political and popular support to be given for all environmental management activities (Environmental policy of Ethiopia, 1997). Ethiopia has also promulgated solid waste management policy (SWM, 2002) with the following objectives: to reduce waste generation at the source; to install a safe and cost-effective system of collection and disposal; to raise awareness and introduce behavioral changes amongst the urban population; to increase and coordinate the involvement of all stakeholder in solid waste management; to ensure that laws and regulations are effectively enforced. In practice, there is weak enforcement of the policy and solid waste services are poorly supplied in the country. Economic instruments are also lacking in the country. The municipality gives almost all

of the limited solid waste collection, transportation and disposal services (Dierig, 1999). Only few households getting services from private waste pickers pay a minimum amount. Amiga (2002) mentions that effort to introduce service charges to households in Addis Ababa city by different bodies, like Nor consult (1982), world Bank (1988, 1994, 1995), Regional Government Health Bureau 1995) and Abera (1997) has not been implemented. There are deposit refund schemes (DRS) used for soft drink, beer and some food items introduced by firms for commercial reasons. In Adama town only a small proportion of solid waste is properly collected and a small number of private waste pickers have started door-to-door collection at a minimum fee in recent years.

2.1.5. Environmental Valuation Techniques

According to Economics literature, the total economic value of an environmental good is composed of two types: Use value and non-use value. Use value refers to the benefits derived from actual use of the good now or in the future. Use value is further divided into three types. Direct use value, indirect use value and option value. From improved solid waste management, living in a habitable and clean environment, prevention of some disease, and expected benefits from living in a clean environment in the future represent direct, indirect and option values, respectively. On the other hand, non-use value or (passive use) is composed of existence and quasi-option (bequest) values. The former represents the value people attach to environmental service simply for its existence (not because they use it) where as the latter shows the value one expects his /her descendants to get from the service (Kartman, 1997).

Environmental goods are particular types of public goods for which the market fails to reflect the value people attach to them. Economists have developed a variety of techniques to value non-

market amenities consistent with the valuation of market goods (Carson, 2000). These techniques, known as Indirect methods, are based up on either observed behavior(revealed preferences) toward some marketed good with a connection to the non-marketed good of interest(Hedonic pricing methods, Travel cost methods, etc), or stated preferences in surveys with respect to the non-market good, known as Direct methods. The direct method includes contingent valuation method (CVM) and choice modeling method (CM). A CVM is used in this study to determine willingness of households' in Adama town to pay for improved solid waste management.

2.1.6. Contingent valuation Method (CVM)

CVM is a survey-based method frequently used for placing monetary values (both use and non-use values) on environmental goods and services not bought and sold in the market place (Carson, 2000). It involves directly asking people, in a survey, how much they would be willing to pay (WTP) for specific environmental services. In some cases, people are asked for the amount of compensation they would be willing to accept (WTA) to give up specific environmental services. It is called “contingent” valuation, because people are asked to state their WTP, contingent on a specific hypothetical scenario and description of the environmental service. The CVM first came into use in the early 1960s by Economist Robert K. Davis (1963) when he used questionnaire to estimate the benefits of outdoor recreation in a Maine backwoods area (USA). Since then, the CV technique has been utilized by various economists to measure the benefits of a variety of goods including recreation, hunting, water quality and toxic waste dumps (Mitchell and Carson, 1989).

The other methods which are based on revealed preferences; for example, Hedonic pricing method, do not capture non-use values that are very important when we deal with environment and hence underestimate the total economic value (Carson, 2000). Besides, the latter requires detailed micro data about the marketed goods related to environment which are very difficult to obtain in poorly developed markets like ours. As a result, CVM, the most preferred environmental valuation technique at present is chosen for this study.

2.1.6.1. Methodology of CVM

A CVM can be administered by mail, phone or in-person interviews. Given that enough resources are available to properly train and supervise enumerators, it is recommended if administered through in-person interview (Ibid).

The major steps involved in using CVM include:

First, designing and administering a CV survey that elicits individuals' values for a good or service.

Second, analyzing WTP responses.

Third, estimating and aggregating benefits and the total revenue.

Lastly, evaluating the CVM exercise (validation tests).

In the first step of CVM, a questionnaire consisting of three parts (Mitchell and Carson, 1989) is used to administer the survey. The first part of the questionnaire includes a hypothetical description of the terms under which the good or service is to be offered to the respondent. The second part tries to determine how much the respondent values a good or service (elicitation of WTP or WTA). The third part includes questions about the socio-economic and demographic characteristics of the respondent and his/her family such as income and education.

number of WTP amounts out of which they pick one. This format is simpler than open-ended format but requires respondents to be literate. In case of closed-ended with a follow-up format, a closed-ended question is followed by an open-ended question to elicit the actual maximum willingness to pay. This method may suffer from a starting point bias which can be minimized by conducting a pilot survey. Compared to bidding game, this method is easier for both the interviewer and respondent. Moreover, it is more familiar to urban dwellers of Ethiopia including Adama, where the seller encourages buyers to name a price if they are not willing to pay the initial amount. This study uses this format.

2.1.6.2. Limitations of CVM

Carson (2000), Onwnujekwe (2001) and many other studies have shown that CVM can give a reliable result if applied correctly and carefully. However, the method has a number of inherent shortcomings and we try to mention the major ones.

CVM assumes that people understand the good in question and will reveal their preferences in the contingent market just as they would in a real market. However, most people are unfamiliar with placing monetary values on environmental goods and services. Therefore, they may not have an adequate basis for stating their true value.

In CV survey, there is a potential for the respondent to give biased answers.

Five of the potential types of biases will be discussed.

Strategic Bias- arises when the respondents give responses which are not their true WTP/WTB, with the expectation of an outcome in their favor. Individuals may be tempted to understate their

true WTP for public goods in the hope of a “free ride” while others pay for the provision of the good or service. Alternatively, if the price to be charged for the public good is not tied to an individual’s WTP response, the respondent may over-report WTP in order to ensure the provision of the good. In both cases, the bid would be systematically different from the respondent’s “true” WTP. (Mitchell and Casron, 1989). To reduce this bias, a detailed description of the proposed improvement is given to respondents.

Information Bias- If a survey is not well designed, it is easy for the enumerator to ask question that he or she thinks is clear, but for the respondent to interpret it differently than was intended. An attempt was made to reduce this bias by carefully designing the survey, training the interviewers and supervising the survey well.

*Starting point Bias-*arises when the initial value suggested influences respondent’s WTP. Kartman (1997) quotes Boyle et al (1985) giving three possible sources for this bias: Lack of clear understanding of the good or poorly defined good, significant difference between respondent’s actual WTP and the starting value suggested (if used), and assumption of the respondent that the true value of the good to be around the starting point. The starting bids used in this study are obtained from the pilot survey so that this problem can be minimized.

*Hypothetical Bias-*Because of hypothetical nature of CVM, respondents may not be familiar with the scenario presented and their responses may not reflect their true WTP. A careful description of the proposed service was given to minimize this bias.

Instrument Bias- arises if the respondent is hostile to the means by which payment is likely to be collected, for example, a local tax or an entrance fee. Respondents were asked to choose the payment vehicle of their interest during the pilot survey to solve this problem.

2.1.6.3. Welfare measures for improved solid waste management.

Many environmental policy proposals involve changes in either the quantities or the qualities of non-market environmental goods and services. In this part, we try to derive welfare measures for improved solid waste management based on the work of Freeman (1993).

Consider an individuals whose utility function is given by:

$$U = U(X, Q) \text{-----} 2.1$$

Where X is the vector of private goods quantities ($X = X_1, X_2, \dots, X_n$) and Q is a vector of non-market environmental goods ($Q = q_1, q_2, \dots, q_m$) that is given to the individual. It is possible that for at least some of the elements in Q there is a positive price charged, where R is the vector of these prices and P be the vector of prices for X. The individual maximizes utility subject to a budget constraint $PX + RQ = M$, where M is money income. The solution to this constrained maximization yields demand functions for the marketed goods and indirect utility function, respectively,

$$X_i = X_i(P, M - RQ, Q) \text{-----} 2.2$$

$$V = V(P, M - RQ, Q) \text{-----} 2.3$$

From the dual of the maximization problem, the indirect expenditure function is obtained.

$$e = e(P, R, Q, U^o) \text{-----} 2.4$$

Welfare measures can be defined for either changes in Q or changes in R, or both. To consider welfare measures for changes in Q, let's assume that Q consists of only one element, q, with a price of r. The marginal value of a small increase in q is the reduction in income that is just sufficient to maintain utility at its original level. If W_q is the marginal value of a change in q, it is given by the derivative of the indirect expenditure function with respect to q:

$$W_q = \frac{-\partial e}{\partial q} \text{-----} 2.5$$

The right-hand side of this expression is also equal (in absolute value) to the slope of the indifference Curve through the point at which the welfare changes is being evaluated.

Compensating Surplus (CS) and equivalent surplus (ES) are the relevant measures of welfare changes in case of improvement in solid waste management.

In the first way, from the indirect utility function the CS and ES measures are defined implicitly as the solutions to the following expressions:

$$\text{CS is the solution to } V(P, M - r.q^0, q^0) = V(P, M - r.q^1 - \text{CS}, q^1) \text{-----} 2.6$$

$$\text{ES is the solution to } V(P, M - r.q^0 + \text{ES}, q^0) = V(P, M - r.q^1, q^1) \text{-----} 2.7$$

These two measures can also be defined in terms of the expenditure function.

$$\begin{aligned} \text{CS} &= e(P, r, q^0, U^0) - e(P, r, q^1, U^0) \\ &= M - e(P, r, q^1, U^0) \text{-----} 2.8 \end{aligned}$$

$$\begin{aligned} \text{ES} &= e(P, r, q^0, U^1) - e(P, r, q^0, U^0) \\ &= e(P, r, U^1) - M \text{-----} 2.9 \end{aligned}$$

The third way to derive the ES and CS measures is to make use of W_q . The value of a non marginal change in q is the integral of $W_q = -\partial e / \partial q$ taken over the relevant range, or

$$W_q = - \int_{q^0}^{q^1} \frac{\partial e(p, r, q, u')}{\partial q} dq \text{-----2.10}$$

This is either a CS or ES measure, depending on whether $t=0$ or 1 , respectively.

As the WTP refers to the amount of money an individual is willing to give up in order to secure a welfare improvement, it is given by CS. The WTA measures the minimum amount of money an individual is willing to accept for forgoing welfare improvement and hence is given by ES. The Adama town resident's WTP for an improvement in solid waste management gives as CS.

2.2. Review of Empirical Literature

The contingent valuation method (CVM) has been widely used in recent years in the area of environmental and public goods and reliable results have been found. Some researches conducted in Ethiopia using CVM have also shown the importance of the method.

Viniegra, et al (2001) conducted a CV survey to determine the economic value of an improvement in environmental quality due to implementation of improved household garbage collection and selections system for the inhabitants of San Pedro Cholula, a semi-urban community in central Mexico. They estimated the project's total cost based on information obtained from the municipality where as a CVM, based on the bidding game format, was used to determine the value to the community of having such a waste management system. From the total 150,000 inhabitants of San Pedro Cholula, 260 households were selected using sampling by groups, a selection process where the elements of the sample are pricked from a pre-grouped

population. From these 260 interviewees, 220 (85%) were analyzed where as the remaining 40 (15%) were eliminated as 31 were protest answers with WTP zero (12%) and 9 answers (3%) with a very high WTP (more than the 5% of the current monthly income of the individual).

The results of the multivariate regression analysis, which was done using OLS, showed that the average WTP for the project was \$ 1.85 dollar/month per household. Multiplying the number of dwellings by the average WTP, they obtained the aggregate WTP for the project amounting to \$ 420 thousand dollars per year. While log of income (with positive sign), age (with negative sign) and government trust (with negative sign) were significant at 95% level of confidence and hence important determinants of WTP, children, education, environmental ethics, gender and wealth were non-significant variables.

The result of the survey showed that although the cost of running the project exceeded the benefits, the positive WTP by individuals indicated a prospect for partial cost recovery.

Viniegra et al (2001) used the bidding game format which is boring for both the respondents and interviewers and could result in biased responses. They did not mention why they preferred this method.

Altaf and Deshazo (1996) undertook a case study in Gujranwala, Pakistan, on household demand for improved solid waste management. They used CVM based on iterative bidding procedure to elicit willingness to pay. The results of the survey showed that of the 968 households in the sample, 695 (71%) were willing to pay a positive amount for it. The mean willingness to pay was Rupees 11.20 (\$ 0.58) per month. Of the 99 households who were interested in the service but not willing to pay anything for it, a majority (84%) considered the provision of such a service to be a responsibility of the government. Out of the 174 households (18% of the total) who indicated no

interest in the improved service offered, 62% said that collection and disposal of solid waste was the government's responsibility while 29% were satisfied with the existing service. The average WTP of all those who were interest in the service was rupees 9.80 (\$ 0.50) per month indicating some prospects for limited cost recovery.

The multivariate analysis of the willingness to pay, which was done using ordinary least squares (OLS) method, showed that the bids increased systematically with increase in average education, discretionary income, and wealth. The key independent variables such as wealth, household expenditure and discretionary income, were significant and had the predicted sign suggesting that solid waste service is a normal economic good. Altaf and Deshazo finally concluded that solid waste service is not the lowest priority among municipal services for urban residents in Gujranwala.

The CVM was also applied by salequzzaman, et al (1998) to assess the factors that influence the willingness to pay for community-based solid waste management and its sustainability in Bangladesh. The research findings showed that the WTP for solid waste management in Bangladesh was influenced by different factors such as the perceived benefits of a new facility, prevailing local customs in relation to paying for services, level of income and perception of ownership and understanding. The study also revealed that the NGOs in Bangladesh have been using the theory of bidding game to establish the WTP for community-based solid waste management in different communities. The researchers concluded their work emphasizing that involvement of private sector, NGOs, government and more importantly, communities in solid waste management is the best option for the sustainability of solid waste management.

In Ethiopia, only a few studies have been conducted on households' demand for improved solid waste management by applying CVM. Here we see some of the empirical studies conducted in Ethiopia using CVM.

Amiga, Aklilu (2002/03) used CVM based on closed-ended with a follow up format to elicit willingness to pay for an improved solid waste management of households of Addis Ababa, the capital of Ethiopia. A random sample of 430 households were drawn out of which 141 (32.9%), 215 (49.9%) and 74 (17.2%) were from low-income, middle-income and high-income areas, respectively. From these, 18 (4.2%) were eliminated as 12 were protest answers with WTP zero and 6 with incomplete information. Therefore, 412 (95.8%) of the questionnaires were analyzed. From the 412 households in the sample 385 (93.45%) gave positive amounts as their WTP where as the remaining 27 (6.55%) were true zeros, most of them (20) from low income areas while 6 and 1 were from middle and high income areas, respectively. The mean monthly WTP amount was 7.09 birr with 2.96 birr, 7.76 birr and 13.07 birr for low-income, middle income and high income areas, respectively. The total WTP amount from the total households in Addis Ababa was 3,663,209 birr per month where as the maximum total revenue that could be collected per month was 1,729,626 birr charging 10.25 birr per month per household.

The Tobit model, one of the two models used in the study, showed that income of household, time spent in the area, quantity of waste generated, responsibility of solid waste management, education dummies, ownership of the house and the number of children had positive and significant effect on WTP. Amiga mentioned that a 1Birr increase in income would cause a 3.74 Birr rise in WTP but did not mention whether the dependent variable (WTP) was also in log form as did the income, without which it is difficult to accept the conclusion. Results of the Probit model showed that age (with negative sign), number of children, income of the household, time

spent in the area, quantity of waste generated and educational dummies had positive and significant effects on WTP.

Amiga put questions on socio-economic characteristics of the households on the first part of the questionnaire; that is, before questions on WTP and existing solid waste handling, which could result in biased responses. Rather, questions on socio-economic characteristics should appear in the last part of the questionnaire.

Other CV studies conducted in Ethiopia and Africa are summarized in table 2.1

Table 2.1 Summary of CVM studies in Ethiopia and Africa

Name	Year	Commodity valued	Location of the study	Number of observations	Elicitation Method	Econometric modeling
Assefa Chaka	1998	Improved water service	Addis Ababa	220	Iterative Bidding-game	Binomial and Ordered Probit models
Dunfa Lemessa	1998	Improved rural water provision	Ada'a Liben, Central Ethiopia	228	Iterative Bidding-game	Ordered Probit model
Alemu Mekonnen	2000	Community forestry in rural Ethiopia	Four peasant Associations	480	Discrete question with Open-ended follow-up	Tobit model
Heleen Bartelings	1996	Improved solid waste collection	Rabat and Sale, Morocco	400	Open-ended	Probit; Multivariate linear models analysis

Source: own compilation

Both Chaka and Lemessa used iterative bidding game but did not reason out why they selected this method which is boring for both the enumerators and the interviewees and could result in strategic bias. Similarly, Heleen did not mention why open-ended questions were used in the study, which could result in a large number of non-responses and protest zeros.

The reviewed literature shows that CVM is a valuable tool in valuing goods for which there is no market in both developed and developing countries. The potential socio economic, demographic and other factors that can influence Adama town households' WTP for improved solid waste management are identified from the reviewed literature.

3. METHODOLOGY

3.1. Definition of variables and Hypotheses

According to economic theory, willingness to pay should reflect the value to the community of having a better environmental quality. Researches conducted in the area of solid waste in developing countries have identified some socio- economic variables which determine the willingness to pay amount and whether households are willing to allocate monetary value for improvements in solid waste services. Some of these factors and the relationship they may have with households' willingness to pay are given below.

Monthly Income of the Household (INCOME)

The monthly income of the household includes the income of the head and of all other members of the household from different sources (in Birr). There is a general consensus about a direct relationship between income level of households and their willingness to pay for improved solid waste management. Hence, income is expected to be a strong determinant when explaining WTP.

Sex of Respondent (SEX)

This is a dummy variable taking 1 if the respondent is male; 0 otherwise. Female respondents are expected to be more willing to pay than their male counterparts as cleaning the house and disposing of the waste is their traditional role.

Age of Respondent (AGE)

Age of the respondent is expected to be inversely related to WTP because older people are not as informed about environmental topics as younger generations. Hence, younger respondents are expected to be more willing to pay than older respondents.

Education of respondent

WTP for improved solid waste management is expected to have a positive relation with the year of education, since the latter should increase the awareness about the benefits from a cleaner environment and the consequences of poor solid waste handling. That is, the more the years of schooling, the more the respondent is willing to pay and vice versa. EDUP is a dummy variable taking 1 if the respondent's educational level is primary education; 0 otherwise. EDUS is a dummy variable taking 1 if the respondent's educational level is up to secondary education; 0 otherwise. EDUS is a dummy variable taking 1 if the respondent's educational level is tertiary education; 0 otherwise.

Marital status of respondent (MARITAL)

This is a dummy variable taking 1 if the respondent is married; 0 otherwise and is expected to be positively related to WTP. Married people are likely to have a larger family size and face a higher risk from unclear environment than unmarried ones and hence expected to be more willing to keep the environment clean and more willing to pay for improved solid waste management.

Time spent in the area (TIME)

This refers to the number of years the household has been staying in the area. The longer the year the household has been living in the area, the more they would understand the problem of solid waste management of the area and the more they are concerned to contribute to improvement in solid waste management. Hence, time spent in the area is expected to be positively related to WTP.

Number of children in the household (CHIL)

This refers to the number of children below 15 years of age. Having children in the household should increase WTP because of an altruistic attitude towards future generations. That is, the more children in the household the more willing are the households to pay for an improved solid waste management to have a cleaner environment in which children grow.

Family size (FAMSIZE)

This refers to the number of individuals living at home. The larger the family size the more the consumption per unit time and the larger the solid waste generation. Hence, family size is expected to be positively related to WTP for improvement in SWM.

Quantity of waste Generated (QUANTITY)

This refers to the quantity of solid waste generated each week by a household and is measured by a container commonly used by most of the households known as “madaberiya”, a container for carrying fertilizer (50 kg each). The more the quantity of solid waste households generate, the more problems of storage and disposal they face and the more they would be willing to pay. Thus, quantity of waste generated and WTP are expected to be positively related.



Responsibility for solid waste management (RESP)

This is a dummy variable taking 1 if the respondent believes households have responsibility with the government to improve solid waste management; 0 if the respondent believes it is altogether government's responsibility. This variable is taken as a proxy to examine the attitude of the respondent towards cost sharing in solid waste management. This study expects positive attitude towards cost sharing and hence positive relation to WTP.

Case of Diseases in the household (DISE)

This refers to occurrence of solid waste related disease (like dysentery, influenza, typhoid, trachoma, etc) in the post one year. It is a dummy variable taking 1 if any member of the household was attacked by the disease in the past one year; 0 otherwise. It is expected that being a victim of waste related diseases would increase the WTP for improved solid waste management.

Housing Ownership (HOUSE)

This is a dummy variable taking 1 if the household owns the house in which it is living; 0 otherwise (that is, if rented from individuals, kebeles or public Agency) Those living in their own houses are expected to be more willing to pay for improved solid waste management than those living in rented houses. The fact that some house owners get additional incomes from renting rooms and the attitude some renters have that it is responsibility of the owners to pay for waste services can explain the expectation.

Starting bid (BID)

This variable is included in the regression analysis to examine the existence and significance of starting bid bias.

Status of the respondent (STATUS)

This variable is included in the regression analysis to examine whether interviewing the representative of the household than the head has an impact on willingness to pay or not. It is a dummy variable taking 1 if the respondent is the head of the household; 0 otherwise. Head of the household is expected to be more willing to pay than their representatives as they can give what they feel is the correct value than their representatives who may name lower values with the hope of pleasing the heads.

Waste Receptacle (RECE)

This is a dummy variable taking 1 if the household has a waste receptacle in an accessible area; 0 otherwise. Those lacking any waste receptacle are expected to be more willing to pay than those who do have as they want solid waste collection services to frequently collect and dispose the waste so that its negative impacts due to mishandling can be minimized. Those having waste receptacle may properly collect the wastes and dispose in transfer containers located at their neighborhood and hence may be less willing to pay.

Head Occupation (OCC)

This is a dummy variable taking 1 if the head is employed in either public or private organizations or own business; 0 otherwise (that is, if not employed). The employed heads are

expected to be more willing to pay than their unemployed counterparts as they are expected to earn more income.

Municipality service (MUNC)

This is a dummy variable taking 1 if the household is getting solid waste services from the municipality; 0 otherwise. The study expects those who are not currently getting the service to be more willing to pay for improved solid waste management than those who are enjoying the service. This is due to the fact that problems of collection and disposal of the waste is more felt by the former than the latter, positively affecting WTP responses of the former.

The study also tried to test the impact of different enforcement mechanisms on the maximum willingness to pay of households for improved solid waste management. Given the same scenario under which the improved solid waste management is rendered, the respondent is asked to give the maximum WTP amount

- Where no legal punishment/absence of enforcement mechanism/ is imposed on those who may be caught illegally dumping the waste.

- Where a strong legal punishment/in the existence of strong enforcement mechanism/ is imposed on those who may be caught illegally dumping the waste (50 Birr as a fine) and

- Where weak legal punishment/in the existence of weak enforcement mechanism/ is imposed on those who may be caught illegally dumping the waste (20 Birr as a fine which the City Administration proposed few years ago but now thinking of revising it upwards so that its implementation may reduce the current wide practice of illegal dumping) (refer to the questionnaire in the appendix V).

For this purpose the Analysis of Variance (ANOVA) technique (The F-test) is used where we assume that the enforcement mechanisms are not different in their effect on household's willingness to pay. Therefore, the null hypothesis is that the mean willingness to pay values are equal under the three cases and the alternative hypothesis states that they are different. That is,

$$H_0 = \bar{X}_1 = \bar{X}_2 = \bar{X}_3 \text{-----} 3.1$$

$$H_1 = otherwise \text{-----} 3.2$$

Where $\bar{X}_1, \bar{X}_2$ and $\bar{X}_3$ represent the mean willingness to pay values under no, strong and weak enforcement mechanisms, respectively.

F value is computed using (Luck and Rubin, 2002),

$$F = \frac{BMS(\text{between-column means square})}{WMS(\text{within-column means square})} = \frac{\frac{SS_B}{k-1}}{\frac{SS_W}{n-k}} \text{-----} 3.3$$

Where, k=No. of cases (Here 3),

n = the no. of observations (239, in our case),

K-1= 3-1=2, degree of freedom in the numerator

n-k=239-3=236, degree of freedom in the denominator.

The critical F-value is obtained at $F_{0.05}(2,236)$ where 0.05 is the probability that a true hypothesis is rejected. We accept the null hypothesis if the computed F-value is less than $F_{0.05}(2,236)$ and fail to accept it (accept the alternative hypothesis) if computed F-value exceeds the critical F-value.

3.2 Model Specification

In the study we observe the independent variables for the whole sample, but have only limited information about the dependent variable (willingness to pay) for some observations. Thus, we have a problem of censoring in the open-ended questions and the appropriate model is censored Model- Tobit, where there is censoring from below at zero willingness to pay. The Tobit model is used to identify factors that affect the level of the willingness to pay (WTP) of households for the proposed improvement in solid waste management. The other model used in the study is a Probit model which is employed to identify factors that affect the probability of having a positive WTP.

The Tobit Model

From the 250 sample size, 239 (95.6%) were analyzed. The rest were eliminated from the data set as 9(3.6%) were protest zeros (invalid responses) and 2(0.8%) were incomplete responses.

The information obtained from the survey was used to test the Tobit model that explains the WTP of the people for the previously mentioned environmental improvement as a function of several variables (defined above). The questionnaire also assessed WTP under three different enforcement conditions: in the absence of any of enforcement mechanism, existence of strong enforcement mechanism and existence of weak enforcement mechanism.

The formulation of the Tobit model (censoring) is the following

$$MWTP^* = \beta_0 + \beta' X_i + \varepsilon_i, \text{ with } \varepsilon_i \sim N(0, \sigma^2) \text{-----3.4}$$

$$MWTP_k = 0 \text{ if } MWTP^* \leq 0 \text{-----3.5}$$

$$MWTP_k = MWTP^* \text{ if } MWTP^* > 0 \text{-----3.6}$$

Where $MWTP_i$ = Maximum willingness to pay under each enforcement conditions

$k=1,2,3$

X_i = a vector of explanatory variables

B' = a vector of coefficients

ε_i = the disturbance term

That is, $MWTP^*$ is a latent variable which is not observed when it is less than or equal to zero but is observed if it is greater than zero.

Written in its expanded form, the Tobit model becomes

$$\begin{aligned} MWTP^*_k = & B_0 + B_1 INCOME + B_2 SEX + B_3 AGE + B_4 EDUP + B_5 EDUS + \\ & B_6 EDUT + B_7 MARITAL + B_8 TIME + B_9 CHIL + B_{10} FAMSIZE + \\ & B_{11} QUANTITY + B_{12} RESP + B_{13} DISE + B_{14} HOUSE + B_{15} BID + B_{16} STAT \\ & + B_{17} RECE + B_{18} OCC + B_{19} MUNC + \varepsilon_i \text{-----} (3.7) \end{aligned}$$

With $\varepsilon_i \sim N(0, \sigma^2)$ where all the variables are as defined in section 3.1

$B_0 - B_{19}$, are coefficients

$k= 1, 2, 3$

The Probit Model

The Probit Model is used to identify factors that affect the probability of having a positive WTP. In this study, households are given initial bid which they may accept or reject. Hence, it is a single bounded dichotomous choice model to be framed under the random utility method.

Haab and McConnell (2002) quoted Hanemann (1984) having developed the basic model to analyse dichotomous responses based on the random utility theory. The central theme of this

theory is that although an individual knows his/her utility certainly, it has some components which are unobservable from the view point of the researcher. As a result, the researcher can only make probability statement about respondent's 'yes' or 'no' responses to the proposed scenario.

The indirect utility function for the j^{th} respondent can be specified as follows:

$$U_{ij} = U_i(Y_j, X_j, \varepsilon_{ij}) \text{-----} 3.8$$

Where $Y_j = j^{\text{th}}$ respondent's income

$i=1$ denotes the final state and $i=0$ the status quo (or the initial state)

X_j = vector of household characteristics and attributes of a given choice

ε_{ij} = random component of the given indirect utility

If a payment (also called the initial bid, β_i^*) is introduced due to improvement in solid waste management, the household accepts the proposed bid only if

$$U_{1j}(Y_j - \beta_i^*, X_j, \varepsilon_{1j}) > U_{0j}(Y_j, X_j, \varepsilon_{0j}) \text{-----} 3.9$$

For the researcher, however, the random components of preferences cannot be known and he/she can only make probability statement of 'yes' or 'no' responses. Thus, the probability that the respondent says 'yes' is the probability that he/she thinks that he/she is better off in the proposed program. For individual j , the probability is:

$$P(Yes) = \left[U_{1j}(Y_j - \beta_i^*, X_j, \varepsilon_{1j}) > U_{0j}(Y_j, X_j, \varepsilon_{0j}) \right] \text{-----} 3.10$$

This probability statement provides an intuitive basis to analyse binary responses. Assuming the utility function is additively separable in deterministic and stochastic preferences:

$$U_i(Y_j, X_j, \varepsilon_{ij}) + \varepsilon_{ij} \text{-----} 3.11$$

given the additive specification of the utility function the probability statement for respondent j becomes:

$$P(Yes) = \left[U_{1j}(Y_j - \beta_i^*, X_j) + \varepsilon_{1j} > U_{0j}(Y_j, X_j) + \varepsilon_{0j} \right] \text{-----} 3.12$$

This probability statement is the point of departure for the linear utility function in income and covariates, which is assumed by our empirical models.

The Probit model can be defined as

$$T_i = \beta_0 + \beta' X_i + \varepsilon_i \text{-----} 3.13$$

Where

- β' is vector of parameters of the model
- X_i is vector of explanatory variables

- ε_i (the error term) is assumed to have random normal distribution with mean zero and common variance δ^2 (Greene, 1993).
- T_i =unobservable households' actual WTP for improved solid waste management service. T_i is simply a latent variable. What we observe is a dummy variable WTP_i , which is defined as:

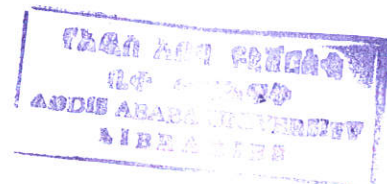
$$WTP_i = 1 \text{ if } T_i \geq \beta_i^* \text{-----3.14}$$

$$WTP_i = 0 \text{ if } T_i < \beta_i^* \text{-----3.15}$$

In the single bounded elicitation format, the j^{th} respondent is asked if he/she would be willing to pay the initial "bid", (β_i^*) , to get a given improvement in environmental quality via improved solid waste management. The probability of a "yes" response, or a "no" response, $p^Y \text{ or } p^N (\beta_i^*)$ can be set in terms of random utility maximization chosen by the respondent. It is clear from the random utility framework that the individual's WTP is a random variable from the point of view of the researcher. Thus, while the individual knows his/her own maximum WTP, T_i , to the observer it is a random variable with a given cumulative distribution function (cdf) denoted by $G(T_i; \theta)$ where θ represents the parameters of this distribution, which are to be estimated on the basis of the responses to the CV survey. Then, following the work of Hanemann (1984), the response probabilities related to the underlying WTP distribution are:

$$p^Y \equiv p \{ \text{yes to } \beta_i^* \} \equiv p \{ \beta_i^* \leq T_i \} = G(\beta_i^*; \theta) \text{-----3.16}$$

$$p^N \equiv p \{ \text{no to } \beta_i^* \} \equiv p \{ \beta_i^* > T_i \} = 1 - G(\beta_i^*; \theta) \text{-----3.17}$$



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

$$\ln L(\theta) = \sum \{ d_i^Y \ln G(\beta_i^*; \theta) + d_i^N \ln [1 - G(\beta_i^*; \theta)] \} \text{-----} 3.18$$

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

Equation (3.13) can be expanded as follows

$$\begin{aligned} T_i = & B_0 + B_1 INCOME + B_2 SEX + B_3 AGE + B_4 EDUP + B_5 EDUS + \\ & B_6 EDUT + B_7 MARITAL + B_8 TIME + B_9 CHIL + B_{10} FAMSIZE + \\ & B_{11} QUANTITY + B_{12} RESP + B_{13} DISE + B_{14} HOUSE + B_{15} BID + B_{16} STAT \\ & + B_{17} RECE + B_{18} OCC + B_{19} MUNC + \varepsilon_i \text{-----} (3.19) \end{aligned}$$

All the variables are as defined under 3.1

The Probit model is also used to calculate mean willingness to pay which equals

$$MeanWTP = - \frac{Intercept}{Bidcoeff} \text{-----} 3.20$$

3.3 Description of Study Area

At present, Adama is the largest city in Oromiya region and one of the largest towns in the country. Adama has been serving as an administrative center for different levels of administrations at different time (In 1946, seat of the then Yerer and Kereyu Awraja; in 1988 seat of the East Shewa Administrative Region; since 1992, seat of East Shewa Zone administration,

from July 2002-2005, capital of Oromiya National Regional state; and now an autonomous City Administration. (Anteneh and Associates, 2003).

The total area of the town is about 4320 hectares. It was divided into two weredas and 20 kebeles upto 2003/04 (1996 E.C). and now into 14 kebeles. Adama is located on land with generally flat topography surrounded by hills and mountain ridges on three sides and this has exposed the city to floods and gully erosion as the natural drainage out falls have to cross a virtually flat area to the south (Ibid) .

Anteneh and Associates quote CSA 1999 to have reported unemployment in Adama to be close to 21% in 1999. Economic and social life of residents of Adama has been worsening since then due to absence of any tangible plans and programs to reduce poverty and unemployment (Ibid).

The total road coverage of the town as of December 2003 was 35.3 Km of asphalt, 16.6 km of gravel and 38 km of dry weather road; private operators are the only urban transport service providers, with taxis and horse-drawn carts widely used; starting in 2002, the water supply has significantly improved although not all the poor benefit from it; the same source also quotes Meheret(2002) as having mentioned that only about 37.5% of all dwelling units have private electric connections, about 56% use joint or commonly owned connections and about 6.2% have no facility at all. Adama has all levels of educational institutions ranging from kindergarten to tertiary levels, with enrollment rates increasing in most of them. Both the public and private sectors provide health service in Adama with private involvement increasing. Housing is a critical problem in Adama and is found to be among the top three priority needs identified (food and jobs the other two) (Ibid). The overall sanitary situation and drainage system of Adama can

be described as totally inadequate (Ministry of Water Resources, 2002 cited in Anteneh and Associates, 2003.) The town is facing ever increasing environmental problems, which includes poor waste management and the resulting environmental pollution.

Article 12 (1-3) of Federal Government of Ethiopia's proclamation number 200/1992 on public health protection states the following: Every body should store wastes in a place that is safe to health; Nobody should dispose wastes of all kinds in a manner that can affect health of citizens or the environment; solid, liquid and other wastes from hospitals and health centers should be handled in very safe manner and their disposal must satisfy standards set by Ministry of Health(Adama City Administration Health Bureau,2005-Translated from Amharic Article).

3.4 Survey Design and Administration

Adama is selected for this study as it is one of the major urban centers of the country with severe solid waste related problems. The data type used in the study mainly includes primary and cross-sectional for the time period of 2006. Data sources were mainly the CV survey conducted for this purpose and relevant documents from Adama Municipality. The primary data were collected by making a household survey with questionnaire having three parts: Existing solid waste handling condition and problems, questions on willingness to pay for the proposed improvement in solid waste management under three different conditions, and household characteristics, adopting the Mitchell and Carson techniques (Mitchell and Carson, 1989).

After designing the draft questionnaire, pre-testing of the questionnaire was conducted through a focused group discussion with municipality officials, the three existing private solid waste collectors and fifteen randomly selected households (five of the households were not getting

service from the private firms). In the pre-test, an open-ended question was used for elicitation of the WTP amount, which asked the respondents the maximum amount they would be WTP for the service per month. The purposes of the pre-test were to make some possible modifications in the design of the questionnaire for the main survey, to choose the appropriate payment vehicle and to obtain starting values (as closed- ended with an open- ended follow up format is used) so that objectives of the survey can be met.

Based on the pre-test the order of the questionnaire was restructured, making questions on household characteristics (particularly questions with economic characteristics, income, for which households were reluctant to give true responses) to appear in the last part and to include questions on monthly expenditure. The willingness to pay section was also polished so that it becomes easier to understand by both the respondents and the interviewers. The payment vehicle is chosen to be user charge to be collected in its own based on the pre-test result. The starting values were also obtained from the pre-test conducted with open-ended questions. The existing private solid waste collectors charge a uniform fee of 10 birr per month for services given once every week. They mentioned that they are planning to raise the fee on those households producing larger amounts of wastes to 12-16 birr and the pre-test also showed that the relatively rich households from five households (from kebeles 10 and 11) are willing to pay the proposed amount (12, 12, 14, 16 & 16 birr per month) as they generate larger amounts of solid wastes than others. Hence, 14 birr is used as one starting value. Five households from kebeles 09 and 16 said they are contented with the current fee they pay to private firms and hence 10 birr is used as the second starting value. Five households from kebeles 01 and 15, who are not getting services from private firms, mentioned they could not afford the prevailing service charge and are willing to use the service if asked to pay from 4 birr – 8 birr per month (4, 4, 6, 8 & 8 birr). The private solid waste

collectors also showed their interest to serve the currently not served households if their capacity is developed. Hence, the average, 6 birr is used as the third starting value.

The three starting prices (6, 10 and 14 birr per month) were equally and randomly distributed in all the 20 kebeles interviewed. Households interviewed during the pilot survey were not included in the main survey.

A considerable effort was made to make the survey as representative as possible. As the survey methods do not stipulate a priori percentage or figure that is adequate in any study (Fowler, F.J., 1993 cited in Chaka, 1998), time and financial limitations were taken into account and a random sample of 250 households are used in the survey. In a town with approximately 37,383 households⁶ in 2006, it means the sample has covered 0.6688% of the total households.

A Stratified random sampling technique was used for the study. Due to lack of well documented information on number of households and their location for the newly established 14 kebeles, data on the previously existing 20 kebeles is used in the study. A proportional size of households⁷ from each kebele is interviewed to have a representative sample of households in the town. Households from each kebele were selected by randomly picking the starting house (with the help of random table) from the household number lists obtained from the respective kebele offices and then systematically sampling the kebele, with the assistance of Ato Sheko, CSA Adama Branch head.

⁶ The number of house holds in 2006 is calculated using population projection for 2006 and the mean family size of 5.35 obtained from own survey (CSA, Adama Branch, 2006 and own survey).

⁷ $\frac{\text{kebele's household number}}{37383} \times 250$

A total of six enumerators, four of them diploma holders and attending degree program in colleges and two college students and two supervisors including the researcher, participated in the main survey. For this purpose, a two-day long training was given to the enumerators on nature of the survey and how to administer it. The survey was conducted from February 15 up to March 5, 2006. Finally, the data collected was coded and prepared for analysis using Excel and Limdep was used for econometric analysis.

4. EMPIRICAL FINDINGS: RESULTS AND DISCUSSION

Both descriptive and econometric analyses (with Limdep) are used in analyzing the information obtained from the survey. The willingness to pay amount is also aggregated for the total population and results are also interpreted.

4.1. Descriptive Analysis of the Survey Data

Out of the total 250 households interviewed, a total of 239(95.6%) are analyzed. The remaining 11(4.4%) are rejected as 2(0.8%) are incomplete responses and 9(3.6%) are invalid responses (protest zeros), as they gave zero value to WTP questions protesting the proposed improvement in environmental quality. Out of these 9 invalid responses, 6(2.4%) believe that it is entirely responsibility of the government to properly manage solid waste where as the rest 3(1.2 %) households are satisfied with the existing system as the family labor is enough to dump the waste in transfer stations (containers) and hence they believe the current service do not need improvement.

4.1.1. Household characteristics

According to the survey result, 72.9% of the interviewed households were male headed while the remaining 27.1% were female headed. Of the total respondents 73.2% were representatives of the household and 26.8% were heads. While 29.3% of the respondents were male, the rest 70.7% were female. 50.6% of the respondents reported that they were married while 49.4% were widowed, divorced or not married at all. The average family size was 5.35 with 1 and 11 the minimum and the maximum sizes, respectively. 54.8% of the respondents had family size of 1-5,

while 43.1% and 2.1% had 6-10, more than 10 family sizes, respectively). On average, each household has 1.6 children, the minimum number being 0 and the maximum 7. The mean age of the respondent was 28.5 with the youngest with 18 years and the oldest 76 years.

The educational level of the respondents was categorized into four levels for analytical purpose. Those who can not read and write are categorized under Illiterate group and constitute 5.5% of the total respondents. Those with a formal education of 1-6 grades and hence can read and write are grouped under elementary level education and form 17.1% of the total respondents. Those with a formal education of between 7 and 12 grades constitute 59.4% of the total respondents and grouped under secondary level. 18% of the respondents have attended formal education above grade 12 (Tertiary level education).

The survey result shows that 31.4% of the heads were not currently working for money while 68.6% were employed. Of this 37.1% were employed in government sector, 11.5% were employed in private organizations and non-governmental organizations and 51.4% in own business of different size. The mean income for the sample was 751.9 birr per month, with the minimum of 75 birr per month and maximum of 4530 birr per month. Where the respondents were not interested in disclosing their monthly income, their monthly expenditures on major items were asked and used as a proxy to monthly income. The survey finding revealed that 50.2% of the interviewed households live in their own houses while 49.8% live in rented houses from individuals, kebeles and local institutions (Idir and mehaber). The interviewed households reported to have lived in the houses for an average of 17.4 years, with a minimum of 0.083 years and a maximum of 60 years.

4.1.2. Current situation of solid waste management

The study revealed that there was no actual measurement of solid waste generated by each household using a standard unit of measurement. Hence, the local container commonly used by most of the households, known as “madaberiya”, is used to measure the amount of waste the interviewed households generate per week. Accordingly, on average each household interviewed generated 1.2 ‘Madaberiya’, with the lowest amount 0.25 and the largest amount 5 ‘Madaberiya’ Per week.

55.2% of the interviewed households mentioned that they have some primary waste storage receptacle in their compound while 44.8% did not have any. These storage receptacles were not originally produced for this purpose and are of different types. Out of the total households who were using waste storage receptacle, 72.2% were storing in receptacle made of plastic bag (mostly “madaberiya”) while 11.1%, 11.1% and 5.6% were using materials made of metal, sisal and wood(bamboo), respectively. The main problems the households encounter in solid waste storage are, according to the survey result, lack of enough space to store the waste and locate the receptacle, absence of timely solid waste collection and disposal service as existing solid waste collection and disposal service coverage is low, poor storage receptacle and the concomitant breeding of flies and bad smell.

The survey finding indicates that the solid waste is mainly composed of organic matter (ash, food remains, etc), plastics, glasses and metals.

The study result also shows that 25.6% of the interviewed households dispose of the solid waste by taking it to the nearby secondary storage receptacle (“genda”) while 18.6% use municipality



trucks that transport the waste to its final disposal site. 11.6% of the interviewed households use private collectors who give door-to door service every week for 10 birr per month. The remaining 25.6%, 7.0%, and 11.6% of the households dig a hole around the house and bury and/ or burn it, throw it on an open space, and throw it into the nearby river, respectively. Those households who throw the waste on an open space or on the street responded that they use this method due to lack of municipality service and inability to use the service of private collectors. Those households who bury and/ or burn the waste and throw it in to the nearby river believe that these methods are the appropriate ways of handling solid waste under existing conditions. The illegal dumping of waste on open space, street and rivers and the lack of standard primary storage receptacle have their own negative implications on the environment and health of the community. Of the total 18.6% of the interviewed households who were getting direct services from the municipality, most of them (96.8%) responded that they were not satisfied. The major reasons they mentioned include the community containers are not sufficient, they are not lifted timely, they produce unpleasant odor and the municipality trucks do not come frequently. These show that the existing service is inadequate and weakness in existing solid waste collection and disposal practice. From the total 11.6% of households who were getting services of private collectors, 57% said that they are satisfied and happy to continue using the service while the remaining 43% are not satisfied. The fact that majority of the interviewed households are not satisfied by services of the municipality but users of private collectors are satisfied shows that a lot has to be done by the municipality to improve the service and encourage participation of the private sector in the provision of the service.

The majority of the interviewed households (92%) believe that solid waste management is responsibility of both government and individual households who generate the waste while 8%

believe it is entirely government's responsibility. This fact suggests that efforts attempting at improving solid waste management via the general public participation can become successful.

Most of the interviewed households (96%) mentioned at least two types of problems households face as a result of mishandling of solid waste: health risks and aesthetic risks (bad odor, unpleasant vision) are commonly mentioned with few respondents mentioning environmental risks (pollution of air and water). Similarly almost all of the respondents, 98.8%, mentioned types of diseases related to poor solid waste management where as 1.2% failed to name one. 39.3% of the households reported to have family members suffered from diseases related to indiscriminate solid waste management in the past one year where as 60.7% said no member of their family was affected by solid waste related disease in the past one year. The study findings suggest that most of the households in Adama town are aware of consequences of poor solid waste management. Asked to rate the seriousness of the solid waste problem in Adama, 33.3% of the respondents said it is very serious where as 41.7% and 25% said it is less serious and not serious at all, respectively. This shows that 75% of the respondents claim that the problem is either very serious or serious.

4.1.3. Households' willingness to pay for improved solid waste management

The open-ended willingness to pay question was raised to the respondents under three different conditions: under conditions where there are no legal punishments, strong legal punishments (enforcement mechanism), and weak legal punishments on those who may be caught illegally disposing of the waste. This is to evaluate the impact of different enforcement mechanisms on households WTP amounts.

As discussed above 11 observations were eliminated, 2 being incomplete and 9 invalid responses. From the remaining 239 observations, 29(12.1%) are true zeros under existence of strong and weak enforcement mechanisms and 38(15.9%) in the absence of any enforcement mechanism. While these households are interested in the proposed improvement in solid waste management, they mentioned that they could not afford to pay any amount. But they are willing to cooperate by supplying their labor service. From the 38 respondents with zero WTP values in the absence of any enforcement mechanism, 9 of them gave positive values in the presence of enforcement mechanisms but stressed importance of effective enforcement mechanism on those who may be caught illegally disposing of the waste. Otherwise, if only some households contribute to environmental protection while others are practicing illegal dumping, they are unwilling to contribute any amount because they can not fully avoid risks associated with inappropriate solid waste management.

The mean WTP under the first condition/where there is no enforcement mechanism) is 8.26 Birr/month with 0 & 21 Birr/month the minimum and maximum WTP amounts, respectively. The mean WTP amount under the existence of strong enforcement mechanism equals 8.66 Birr/month (the minimum and the maximum values being 0 and 25 birr/month, respectively). Similarly the mean WTP amount in the existence of weak enforcement mechanism equals 8.41 Birr/month where as the minimum and the maximum values are 0 and 20 Birr/month, respectively. The maximum WTP values under the three cases are summarized below. The majority of the respondents, 168 (70.3%), 175 (73.22%), and 177 (74.06%), gave a WTP amount of 10 Birr and less per month under the presence of no enforcement mechanism, strong enforcement mechanism, and weak enforcement mechanism, respectively. 69 (28.87%) , 63 (26.36%) and 62 (25.94%) of the respondents gave values between 11 and 20, inclusive, under

the three cases, respectively where as 2 (0.84%), 1 (0.42%) and 0 gave values greater than 20 Birr per month under the three cases, respectively.

Table 4.1 : Maximum WTP values stated by Respondents under the three cases

Maximum WTP (Birr)	WTP under condition 1 (No enforcement mechanism)		WTP under condition 2 (Strong enforcement mechanism)		WTP under condition 3 (Weak enforcement mechanism)	
	No. of respondents	% of respondents	No. of Respondents	% of respondents	No. of respondent	% of respondents
0	38	15.6	29	12.13	29	12.13
1	0	0	0	0	0	0
2	5	2.1	3	1.25	3	1.25
3	4	1.7	6	2.51	7	2.93
4	6	2.51	5	2.1	6	2.51
5	10	4.2	10	4.2	11	4.6
6	33	13.81	38	15.9	40	16.74
6.5	1	0.42	1	0.42	1	0.42
7	3	1.25	4	1.67	3	1.25
8	11	4.6	5	2.1	5	2.1
9	5	2.1	6	2.51	6	2.51
10	52	21.76	68	28.45	66	27.61
11	1	0.42	2	0.84	2	0.84
12	16	6.7	9	3.76	10	4.2
13	6	2.51	3	1.25	3	1.25
14	27	11.3	29	12.13	31	12.97
15	13	5.44	10	4.2	9	3.76
16	4	1.7	2	0.84	2	0.84
17	0	0	1	0.42	0	0
20	2	0.83	7	2.93	5	2.1
21	2	0.83	0	0	0	0
25	0	0	1	0.42	0	0
Total	239	100	239	100	239	100

Source: own survey, 2006

Since the actual number of households for the year 2006 is not available, the projected population size of Adama town and the average family size⁸ of the town are used to estimate the number of

⁸ The average family size of 5.35 obtained from the survey is used in this paper.

households is 2006. Dividing the projected population size of 200,000 by the mean family size of 5.35 (CSA, Adama Branch, 2006 and own survey, 2006), we may have an estimate of 37,383 households in Adama in 2006. Aggregating the average WTP value over these households gives a total of 308,783.58, 323,736.78, and 314,391.03 Birr per month and 3,705,402.96, 3,884,841.36 and 3,772,692.36 Birr per annum under the presence of no enforcement mechanism, strong enforcement mechanism, and weak enforcement mechanism, respectively. These amounts indicate the existence of strong potential to succeed if improved solid waste management is introduced based on fair user charges. The City Administration has spent 288,000 (0.8% of the annual budget of the city for the year 2005) to provide the service which has covered only 41% of the total solid waste generated in 2005. Although cost of providing improved solid waste management service is not known, but one can expect it to increase from its current level, the above calculated revenue suggests that there is a strong prospect for cost recovery by improving the existing service.

The relationship between WTP amounts and several socio-economic variables is examined using rigorous econometric techniques in the next section.

4.2. Econometric Analysis

As discussed under the 'Model specification' sub-topic, two maximum likelihood estimates are made. One is the Tobit model used to identify the socio- economic and solid waste related factors that affect the amount of money households are willingness to pay for the proposed improvement in environment quality via improved solid waste management. The other one is the Probit model employed to identify those factors affecting the probability of having a positive willingness to pay for the proposed service.

The presence of multicollinearity between (among) variables reduces the precision of estimating the coefficients of the strongly correlated variables. Hence test was made to check whether or not this problem existed. The result indicated multicollinearity is not a serious problem as the correlation matrix results are less than 0.8.⁹ A result of greater than or equal to 0.8 is an indication of the presence of serious multicollinearity problem, according to rule of thumb (Gujarati, 1995).

A test for the presence of heteroscedasticity problem in the model was also done. The test result shows that the null hypothesis of homoscedasticity is rejected implying that there is heteroscedasticity problem in the model, which is expected from the survey data (it is a common problem in cross-sectional data). (Look at Appendix- I for the test) .To minimize the problem, heteroscedasticity-consistent Tobit and Probit models from Limdep program are used. To check for the existence of starting price bias, the starting bid is used in the model as an explanatory variable. To check whether or not asking representatives of the households rather than the heads affects the willingness to pay responses, a dummy variable (status of the respondent) taking 1 if the head is the respondent; 0 otherwise is included in the model. To evaluate whether the willingness to pay values are significantly different under different enforcement mechanisms or not, three different enforcement mechanisms are presented to the respondent: the first one asking for the maximum WTP amounts in the absence of any legal punishments on those who may be detected illegally dumping the waste, the second and the third cases asking for the maximum WTP amounts in the presence of strong (50 Birr fine) and weak legal punishment (20 Birr fine) on those who may be caught illegally disposing of the waste, respectively.

⁹ The correlation matrix between number of children and family size is 0.62 and is the largest value.

4.2.1. Tobit Model: Results and Discussion

The Tobit results obtained from Limdep are given in table 4.2.

Income of the household

This variable has a positive impact on the willingness to pay amount as expected and is significant at 1% under the three cases. That is, demand for improved solid waste management moves in the direction of changes in income and hence is a normal economic good. Thus, income is a strong determinant in explaining willingness to pay and thus, any attempt to introduce user charges for provision of the service should take into account ability of the users in addition to their willingness to pay.

Sex of Respondent

This variable has a negative sign as expected but is insignificant under the three cases. This shows that although female respondents are more willing to pay than their male counter parts, the willingness to pay amount does not significantly differ sex wise (there is no difference between men and women about their WTP).

Age of Respondent

As expected, age of the respondent has a negative impact on the willingness to pay amount and is highly significant (at 1%) under the three cases. That is, as people age increases, the willingness to pay amount significantly decreases. This may be due to the fact that the older people are less informed about environmental topics than the younger generations. This may also show that younger people are more concerned with the beauty of their town.

Education Dummies

From the four categories of educational level, the illiterate group is taken as a control group (to avoid a dummy variable trap). The three educational dummies show positive effect on willingness to pay amount. The primary education dummy is not significant at 10% level of significance under the first case where as it is significant at 10% under the existence of strong and weak enforcement mechanisms. This shows that the primary educational level is not a significant determinant of the amount households are willing to pay for the proposed service in the absence of any enforcement mechanisms on those who may be caught illegally dumping of the waste but is a significant determinant if there is some enforcement mechanism. The secondary and tertiary education dummies are significant at 1% under the three cases showing that higher levels of schooling lead to higher willingness to pay amounts. This may be due to the awareness that education is expected to create about the benefits from cleaner environment and the consequences of poor handling of the mother environment. Thus, encouraging and promoting expansion of educational service helps in creating and maintaining a habitable and clean environment

Table 4.2 Maximum Likelihood Estimates for the Determinants of WTP (Tobit Model-The three cases)

Expl. Var.	In the Absence of enforcement mechanism(case 1)				In the presence of strong enforcement mechanism(Case 2)				In the presence of weak enforcement mechanism(Case 3)			
	coefficient	Marg. effect	Stand. Error		coefficient	Marg. effect	Stand. Error		coefficient	Marg. effect	Stand. Error	
CONST.	0.09378299	0.08864623	2.81428600		1.79771461	1.74524798	2.60633690		2.26140273	0.03608468	2.56599560	
INCOM E	0.00172663	0.00163206***	0.00055671		0.00232537	0.00225750***	0.00051496		0.00172118	0.00166699***	0.00050803	
SEX	-0.14790210	-0.13980109	0.73833691		-0.90536990	-0.87894652	0.68138520		-0.84296961	-0.81642886	0.67141694	
AGE	-0.14923260	-0.14105871***	0.04107910		-0.16799827	-0.16309521***	0.03811954		-0.15811405	-0.15313586***	0.03746519	
EDUP	2.42020879	2.28764713	1.68744210		2.91025210	2.82531585*	1.56276940		2.81334919	2.72477136*	1.53434890	
EDUS	5.13563966	4.85434620***	1.63587740		4.91885872	4.77530092***	1.51772620		4.58979629	4.44528732***	1.49120500	
EDUT	5.61191919	5.30453855***	1.72685020		5.47517089	5.31537701***	1.60333640		5.34198359	5.17379213***	1.57584160	
RESP	1.11827237	1.05702144	1.22558480		0.08226865	0.07986762	1.11708800		0.23260024	0.22527686	1.10109530	
MARIT												
AL	2.16582142	2.04719328***	0.77826903		3.38387464	3.28511563***	0.71933095		3.18002186	3.07989941***	0.70883267	
TIME	0.06129343	0.05793621**	0.02667005		0.05250226	0.05096998**	0.02467624		0.05162114	0.04999586**	0.02432290	
CHIL	0.29359348	0.27751254	0.31494474		0.16910498	0.16416962	0.29109363		0.09062010	0.08776694	0.28713302	
FAMSI												
ZE	-0.19020882	-0.17979055	0.19670784		-0.10210399	-0.09912407	0.18193663		-0.08051076	-0.07797590	0.17939266	
QUANT	0.75759629	0.71610060*	0.41819526		0.82721898	0.80307644**	0.38664231		0.78430416	0.75961048**	0.38132007	
DISE	1.42159439	1.34372966**	0.67100118		1.35842194	1.31877615**	0.62127023		1.34329653	1.30100307**	0.61234850	
HOUSE	2.49198260	2.35548969***	0.67190285		1.68745015	1.63820161***	0.62238895		1.66130323	1.60899737***	0.61359708	
STAT	1.00227201	0.94737475	0.85746402		0.39347917	0.38199541	0.79167021		0.43083455	0.41726979	0.78036193	
RECE	-1.41030486	-1.33305849**	0.62316782		-0.50548610	-0.49073339	0.57558325		-0.82269690	-0.79679443	0.56749913	
OCC	0.86544452	0.81804169	0.74452837		0.55597888	0.53975254	0.68703459		0.73260057	0.70953476	0.67725154	
MUNC	-0.41964211	-0.39665713	0.75626877		-0.81769139	-0.79382691	0.70033224		-0.63951371	-0.61937873	0.69044464	
BID	0.08806734	0.08324364	0.09840259		0.06063164	0.05886210	0.09118857		0.03608468	0.03494856	0.08989015	

Source: Own Survey, 2006

***significant at 1%, **significant at 5%, *significant at 10% The stand. Errors are for marg. Effects.

Marital Status of Respondent

This variable has a positive sign as expected and is significant at 1% under the three enforcement conditions. That is, married people are more willing to pay than unmarried ones for the proposed service. This may be due to the fact that married people are likely to have larger family size and may generate large quantities of solid waste and hence more willing to pay for improved environmental quality and thus minimize the risks from unclear environment.

Time spent in the area

This variable has a positive sign as expected and is significant at 5% under the three cases. It shows that the willingness to pay amount increases with the years the households stay in the area.

It could be because staying for longer years in the area would help the households to be more acquainted with the local area and understand the existing environmental problems better than those who lived in the area for short time period.

Number of Children in the Household

There is a positive relationship between number of children in the household and the amount of willingness to pay for the proposed service. That is, the willingness to pay amount increases with the number of children in each household. But, it is insignificant at 10% under the three cases showing that number of children is not a significant determinant of the willingness to pay amount. This fact coupled with the negative relationship between age of respondent and willingness to pay amount implies lack of altruistic attitude towards future generation (the preference for consuming in the present rather than to inherit a better environment).

Family Size of the Household

It was expected that households with large family size are more willing to pay than those with small family size as the former may generate more solid waste than the latter. But, the maximum likelihood estimation shows that family size is inversely related to the willingness to pay values that the respondents attached to improved solid waste management. This may be because with large family size the household can use family labor to dispose of the waste than paying money for external collectors; expenditure on major commodities increases and may force the household to consider improved solid waste management of less priority. The fact that, it is insignificant (at 10%) shows that family size is not a major determinant of the willingness to pay amount for the proposal service in Adama town.

Quantity of Solid Waste Generated

This variable is positively related to willingness to pay amount, as expected, and is significant at 10% and 5% level of significance under the absence of enforcement mechanism, existence of strong and weak enforcement mechanisms, respectively. The possible explanation for this is that the more the quantities of solid waste households generate, the more problems of storage and disposal they face and consequently the more they would be willing to pay for the improvement in solid waste management. Thus, quantity of solid waste generated per time is a strong determinant of the willingness to pay amount, particularly in the presence of enforcement mechanisms.

Case of Disease in the Household

This variable is significant at 5% and is positively related to willingness to pay amount under the three cases, as expected. That is, households that were victims of solid waste related diseases are

more willing to pay for improved solid waste management. This variable significantly determines the willingness to pay values households attach to improved solid waste management to minimize the prevalence of diseases due to indiscriminate solid waste handling.

House Ownership

As expected, this variable directly affects the WTP of households for improved solid waste management and is significant at 1% under the three cases. That is, those households living in their own houses are more willing to pay than those living in rented houses. It is significant under the three cases indicating that it is one of the major factors determining the amount households are willing to pay for the proposed change. This may be as a result of the concern house owners have to keep their residential area cleaner and the attitude renters may have that it is responsibility of the owners to keep the area cleaner.

Status of Respondent in the Household

As per the expectation, this variable has a positive sign but is insignificant at 10%. That is, although household heads are more willing to pay than their representatives, it does not significantly affect the willingness to pay amount. Therefore, whether or not the heads were responded, there would be no significant differences in the willingness to pay amounts obtained from the study.

Waste Receptacle

This variable is negatively related to the WTP amount as expected and while it is significant at 5% under the absence of enforcement mechanism, it is insignificant even at 10% under the presence of any enforcement mechanism. That is, those who do not have any primary waste

receptacle in their compound are more willing to pay than those who do have the receptacle. This variable significantly affects the WTP amount in the absence of legal punishment on those who may be caught illegally dumping the waste but is not a major determinant of the WTP amount if there is some legal punishment on those illegally disposing of the waste. In the absence of enforcement mechanisms, illegal dumping may be widely practiced causing more risks associated with poor solid waste handling. As a result, households with no primary waste receptacle would be willing to pay more and it significantly affects the WTP amount. With existence of enforcement mechanisms, illegal dumping is expected to reduce minimizing the associated risks and hence making the variable not a major determinant of the WTP amount.

Household Head Occupation

This variable is directly related to the WTP amounts as expected but insignificant (at 10%) under the three cases. This shows that heads who are employed for some amount of money are more willing to pay than their unemployed counter parts, as they are expected to earn more. But, it is not a major determinant of the WTP amount.

Municipality Service

There is an inverse relationship between this variable and the WTP amount, as expected, although it is insignificant at 10% under the three cases. Those who do not currently get solid waste services from the municipality are more willing to pay than those who enjoy the service as the former face greater difficulty of dealing with collection and disposal of solid waste. But, this variable does not significantly affect the WTP amount. In fact, as discussed under the descriptive analysis part, most of those households currently getting the municipality service are not satisfied

with the existing service and this fact can partly explain why the variable is not a major determinant of the WTP amount.

Bid

This variable has a positive sign as expected showing that there is a starting bid bias but is insignificant (at 10%). That is, the initial bid given to the respondents is not a major determinant of the amount the households are willing to pay for the proposed improvement in solid waste management. This could be due to the care taken in conducting the pre – test and the main survey to let respondents answer all questions as truthfully as possible.

Responsibility for Solid Waste Management

There is a positive relationship between this variable and the WTP amount, as expected, but is insignificant (at 10%) under the three cases. Households who believe it is responsibility of both households and the government are more willing to pay than those who believe it is basically government's responsibility. But, it is not a major determinant of the WTP amount. In fact those households who said it is entirely responsibility of the government are excluded from the analysis as they gave zero values/ refused to pay any amount.

4.2.2. Probit Model: Results and Discussion

The goodness of fit for Probit model is measured by the Likelihood Ratio Index (LRI)¹⁰ and the computed value equals 0.416. The computed ratio shows that 41.6% of the variation in the dependent variable (the probability of having a positive WTP) is explained by changes in the explanatory variables included in the model. The Probit result is given in Tables 4.3.

¹⁰ Refer Appedix II for the computation.

Income of the Household

Income of the household is positively related to the probability of having a positive WTP. It is highly significant (at 1%). This shows that for a 1 Birr increment in income, the probability of being willing to pay increases by 0.014, keeping all other factors constant. Thus, income of the household is a major determinant in explaining the probability of having a positive WTP.

Sex of Respondent

This variable has a negative sign as expected (female are more willing to pay than male) and is significant at 10%. That is being a male affects the probability of saying yes to the initial bid negatively by 9.37.

Age of Respondent

Age of the respondent has a negative sign, as expected, and is highly significant at 1% indicating that with age the probability of getting a positive WTP falls. One additional year reduces the probability of saying yes by 0.577, other things remaining constant.

Status of Respondent in the household

This variable is positive and significant (at 5%) indicating that being a household head is one of the major determinants of the probability of getting a positive willingness to pay. Being household head affects the probability of saying yes to the initial bid by 6.67.

Table 4.3 Maximum Likelihood Estimates of the Determinants of Probability of Having a Positive WTP (Probit Model)

Variable	Coefficient	Marg. Effect	Stan. Error	P-Value
CONSTANT	0.50865976	0.06269615	0.13965650	0.6535
BID	-0.03898221	-0.00480485	0.00541844	0.3752
INCOME	0.00111976	0.00013802***	0.00004609	0.0027
SEX	-0.62026226	-0.09372753*	0.05571076	0.0925
AGE	-0.04678536	-0.00576665***	0.00224148	0.0101
EDUP	0.09763197	0.01145742	0.06309235	0.8559
EDUS	0.68377020	0.09486147	0.09505133	0.3183
EDUT	0.64230444	0.05849808	0.04809610	0.2239
RESP	0.35173444	0.05404569	0.08096273	0.5044
MARITAL	0.41506652	0.05185466	0.04411956	0.2399
TIME	0.00816874	0.00100686	0.00149569	0.5008
CHIL	0.18305439	0.02256283	0.01875416	0.2289
FAMSIZE	-0.07888709	-0.00972343	0.01115974	0.3836
QUANTITY	0.29635131	0.03652753	0.02993918	0.2224
DISE	0.17180311	0.02062145	0.03619939	0.5689
HOUSE	0.63612926	0.08031251**	0.04079167	0.049
STAT	0.67311660	0.06671407**	0.03177156	0.0357
RECE	-0.48778308	-0.06012294*	0.03390001	0.0761
OCC	0.44281937	0.06227263	0.04523737	0.1686
MUNC	0.18691192	0.02134378	0.03548798	0.5475

Source: Own Survey, 2006 ***Significant at 1%;**Significant at 5%;*Significant at 10%

Stand. Error is for Marg. Effect

House ownership

This variable is significant at 5%. Being the owner of the house in which the household lives affects the probability of getting a positive WTP by 8.03 units.

Waste Receptacle

This variable has a negative sign and is significant at 10%. Having any primary waste receptacle affects the probability of saying yes to the initial bid negatively by 6.01.

Education dummies, responsibility for solid waste management, Marital status of respondent, Time spent in the area, number of children in the household, quantity of solid waste generated, case of Disease in the household, Household occupation, and Municipality service have positive signs as expected but are insignificant showing that they are not major determinants of the probability of getting a positive WTP.

Family size of the household and bid have negative signs, both insignificant, indicating that with family size and bid, the probability of having a positive WTP declines.

The mean willingness to pay is also calculated using the probit model with no specifications under which the improved service is provided and equals

$$MeanWTP = -\frac{Intercept}{Bidcoeff} = -\frac{0.50865976}{-0.03898221} = 13.04851$$



That is, mean willingness to pay is 13 Birr (with 3.222332 standard error) as calculated using responses to the closed-ended format.

4.3. Comparison of Mean willingness to pay values under the three cases

The mean willingness to pay values under the three cases are presented in Table 4.4.

Table 4.4: Mean WTP values under the three conditions(From Tobit models)

Variable	Obs	Mean	Std. Dev.	Min	Max
WTP1(With no enforce.Mech)	239	8.261506	5.078338	0	21
WTP2(with strong enforce.Mech.)	239	8.658996	4.976186	0	25
WTP3(With weak enforce.mech	239	8.40795	4.757778	0	20

Source: Own survey, 2006

As presented in table 4.4 the mean willingness to pay values are 8.26, 8.66 and 8.41 Birr per month in the absence of enforcement mechanism, in the existence of strong and weak enforcement mechanisms on those who may be caught illegally dumping the waste, respectively. To check whether these mean WTP values are significantly different from each other, the Analysis of Variance (ANOVA) technique (The F- test) is conducted. The test result shows that there is no significant difference among the mean willingness to pay values as F-calculated ($=0.131$) is less than $F_{0.05}(2,236)=3$. Look at Table 4.5. Hence we accept the null hypothesis implying that there are no significant differences among the willingness to pay values under the three cases. That is, the amount of money households are willing to pay for improved solid waste management is not very much sensitive to whether or not there are enforcement mechanisms. This may be explained based on the responses given to the debriefing questions. There is lack of commitment from the side of the city administration in implementing existing rules and regulations pertinent to illegal waste disposal practice. A significant number of households

mentioned that they have not seen the city administration or social gatherings penalizing those practicing illegal dumping of waste. Moreover, many households dump the waste illegally during the nights. There are also many households who detect their neighborhoods illegally disposing of waste but have no incentive of discouraging this act by informing the concerned body. This may be due to lack of awareness about existence of legal punishments in case of illegal dumping and/or not to lose their social ties. Some households also mentioned that irrespective of whether or not there are legal punishments on others, they are concerned about the environment and hence gave equivalent amounts of money as their willingness to pay for improved solid waste management under the three cases.

Table 4.5 ANOVA table for comparison of the WTP Values

Square of Variation	Sum of Square(SS)	Degree of Freedom	Mean sum of square
Between Group	19.32	2	$SS_B/2=BMS=9.66$
Within Group	17418.84	236	$SS_W/236=WMS=73.81$
Total	17438.16	238	$F_{cal}=BMS/WMS=0.131$

Source: Own Calculation, 2006

The mean willingness to pay values range from 8.22, under no enforcement mechanism in case of open ended questions, to 13, calculated from the responses to closed-ended questions.

4.4 Estimating Total Willingness to Pay and Total Revenue

In this section total willingness to pay and the total revenue at different prices that households in Adama are willing to pay is computed. The demand curve for improved solid waste management is also derived.

There are around 37383 households in Adama in 2006 based on the projected population size of 200,000 and average family size of 5.35 (CSA, Adama Branch and own survey, 2006). To make the aggregation, class boundaries for the maximum willingness to pay values are utilized.

Table 4.6: Total WTP and Total Revenue from Improved Solid Waste Management Service (case1)

Class bound. For WTP amount	Class mark for WTP amount	Sample Dist ⁿ		Total No. of HHs	Total WTP	Sample HHs WTP atleast that amount (cumm.)		Total HHs WTP at least that amount (Cumm)	Total Revenue
(1)	(2)	(3) No.	(4) %	(5)	(6)	(7) No.	(8) %	(9)	(10)
0-2	1	43	17.99	6726	6726	239	100	37,383	37,383
3-5	4	20	8.37	3128	12512	196	82	30657	122628
6-8	7	48	20.08	7508	52,556	176	73.64	27,529	192703
9-11	10	58	24.27	9072	90720	128	53.56	20021	200210
12-14	13	49	20.50	7664	99632	70	29.29	10949	142337
15-17	16	17	7.11	2659	42544	21	8.79	3285	52560
18-20	19	2	0.84	313	5947	4	1.67	626	11894
21-23	22	2	0.84	313	6886	2	0.84	313	6886
Total		239	100	37383	317523				

Source: Own survey, 2006

Table 4.7: Total WTP and Total Revenue from Improved Solid Waste Management
Service (case 2)

Class bound. for WTP amount	Class mark for WTP amount	Sample Dist ⁿ		Total No. of HHS	Total WTP	Sample HHS WTP at least that amount(Cumm.)		Total HHS WTP at least that amount (cumm.)	Total Revenue
(1)	(2)	(3) No.	(4) %	(5)	(6)	(7) No.	(8) %	(9)	(10)
0-2	1	32	13.39	5005	5005	239	100	37383	37383
3-5	4	21	8.79	3285	13140	207	86.61	32378	129512
6-8	7	48	20.08	7508	52556	186	77.82	29093	203651
9-11	10	76	31.80	11888	118880	138	57.74	21585	215850
12-14	13	41	17.15	6413	83369	62	25.94	9697	126061
15-17	16	13	5.44	2033	32528	21	8.79	3284	52544
18-20	19	7	2.93	1095	20805	8	3.35	1251	23769
21-23	22	0	0.00	0.00	0	1	0.42	156	3432
24-26	25	1	0.42	156	3900	1	0.42	156	3900
Total		239	100	37383	330183				

Source: Own survey, 2006

Table 4.8: Total WTP and Total Revenue from Improved Solid Waste Management
Service (case 3)

Class bound. for WTP amount	Class mark for WTP amount	Sample Dist ⁿ		Total No. of HHS	Total WTP	Sample HHS WTP at least that amount (cumm)		Total HHS WTP at least that amount (cumm.)	Total Revenue
(1)	(2)	(3) No.	(4) %	(5)	(6)	(7) No.	(8) %	(9)	(10)
0-2	1	32	13.39	5005	5005	239	100	37383	37383
3-5	4	24	10.04	3754	15016	207	86.61	32378	129512
6-8	7	49	20.50	7664	53648	183	76.57	28624	200368
9-11	10	74	30.96	11575	115750	134	56.07	20960	209600
12-14	13	44	18.41	6882	89466	60	25.10	9385	122005
15-17	16	11	4.60	1721	27536	16	6.70	2503	40048
18-20	19	5	2.09	782	14858	5	2.10	782	14858
Total		239	100	37383	321279				

Source: Own survey, 2006

From the class boundaries (intervals) for the willingness to pay amounts, the class marks (the mid willingness to pay amounts) are calculated and the results are shown in the second columns of Tables 4.6, 4.7 and 4.8. The third and the fourth columns show the number and the percentage of the sample households whose maximum willingness to pay amounts fall within the given intervals, respectively. The total number of households in Adama is multiplied by the proportion of sample households falling in each boundary to obtain the total number of households whose WTP amount lies in each boundary (column 5 of the tables). Total willingness to pay (column 6 of the tables) is obtained multiplying the mid willingness to pay amount by the total number of households willing to pay that amount.

Summation of the total WTP values in column 6 gives the grand total willingness to pay amount. Thus, the total amount all households in Adama are expected to pay if the proposed improvement in solid waste management is implemented equals 317,523, 330,183 and 321,279 Birr per month under the existence of no enforcement mechanism, strong and weak enforcement mechanisms, respectively.

Columns 7 and 8 of the three tables indicate the number and the proportion of sample households willing to pay at least the amount in each boundary and the figures continuously diminish as class mark for WTP amount increases. Similarly, the total number of households who are willing to pay at least the amount in each interval (computed taking into account column 5) falls as the mid willingness to pay amount rises. This relationship can be easily depicted by deriving a demand curve for the improved solid waste management. For this we measure the mid willingness to pay amount along the vertical axis and the number of households willingness to pay at least that mid value per month along the horizontal axis.

As shown in figures 4.1, 4.2 and 4.3 in Appendix IV the demand curve is negatively sloped indicating that, the demand for improved solid waste management service falls as user charges increase like most economic goods, other things remaining the same.

Total revenue (10th column of the tables) is obtained by multiplying the mid WTP amount (column 2) by the corresponding total number of households willing to pay at least that amount (column 9). As can be seen from the total revenue columns, total revenue initially increases as monthly payment increases and reaches a maximum of 200,210, 215, 850 and 209,600 birr per month under no, strong, and weak enforcement mechanisms , respectively, at the monthly payment of 10 Birr per household. After that it decreases and reaches a minimum of 6886, 3900¹¹ and 14, 858 birr per month under the three cases respectively at the highest monthly payments of 22, 25, and 19 Birr per household, respectively, due to relatively small number of households willing to pay these amounts.

These amounts of total revenue indicate the existence of strong potential to succeed if improved solid waste management service is realized based on fair users charges. The fact that solid waste management is a public good implies consideration of efficiency and equity issues in setting service charges. Hence, the municipality has to find ways of improving the service by taking advantage of the households willingness to pay.

¹¹ There is no household willing to pay 22 Birr per month under strong enforcement mechanism.

5. SUMMARY, CONCLUSION AND POLICY IMPLICATIONS OF THE STUDY

5.1 Summary and Conclusion

Like many urban centers of developing countries, the major urban centers of Ethiopia, including Adama, are characterized by continuous urbanization and rapid population growth. With this production and consumption activities are expanding causing ever increasing environmental damages. Of the outstanding environmental problems, poor solid waste management is recognized as one of the most important concerns by both professionals and municipalities.

In Adama, only 41% of the total solid waste generated per year was collected in 2005 where as the remaining 59% remained unattended. This was mainly due to limited capacity of the City Administration. A significant proportion of inhabitants of Adama practice illegal dumping and it is a common practice to see wastes accumulated on open lands, in drains, and in the living area of many people in the town resulting in significant environmental and health hazards. These environmental and health impacts of improper handling of waste call for an integrated effort among the different stakeholders: the government institution(the City Administration), the community, private sectors and the likes so as to have effective and sustainable improved solid waste management system in Adama town. One way in which the community can participate is by requiring them to pay for the solid waste service. In connection with this, this study tried to see the possibility of cost sharing by analyzing the demand for improved solid waste management of inhabitants of Adama town. For this a contingent valuation method (CVM) is employed to estimate the value households in Adama attach to the proposed improvement in solid waste management. For this purpose, a total of two hundred fifty (250) households were interviewed from all kebeles of Adama. A closed-ended with an open-ended follow-up elicitation technique

was used. Households were asked to give their maximum willingness to pay values for the proposed service under three different enforcement mechanisms. This is used to test whether or not willingness to pay values are affected by enforcement mechanisms.

Information obtained from the survey was analyzed using descriptive statistics and econometric models. The descriptive analysis shows that 44.8% of the interviewed households have no primary storage receptacle while 55.2% have some storage receptacle originally produced for other purposes. These receptacles are made up of plastic (72.2%), metals (11.11%), sisal (11.11%) and wood (bamboo) (5.5 %). The solid waste is mainly composed of organic matters (ash, food remains, dead animal bodies, etc), plastics, glasses and metals.

25.6% of the interviewed households dispose of the waste in to secondary storage, 18.6% use municipality trucks and 11.6% use services of private collectors for a monthly payment of 10 Birr per household. About 25.6% of the households dig a hole around their houses and bury and / or burn the waste. The remaining 18.6% of the interviewed households practice illegal dumping by throwing the waste into an open space, street or rivers. That is, while 55.8% of the households are getting solid waste collection service, including those getting private collection services, 44.2% are not covered. The poor storage receptacles, practice of illegal dumping and low service coverage have a negative implication on the environment and health status of the community. Hence, considerable efforts should be exerted to improve solid waste services in Adama.

96.8% of the households are not satisfied with the current services provided by the government where as 57% of the households getting private services are happy with the service. The majority



of the interviewed households (92%) believe proper solid waste management is responsibility of government and households and are willing to cooperate in all aspects, including cost sharing.

The mean monthly WTP amount, calculated from the Tobit models, is 8.26 Birr, 8.66 Birr, and 8.41 Birr under the existence of no, strong, and weak enforcement mechanisms, respectively. The F-test shows that these mean WTP values are not significantly different from each other implying that the current households' WTP values are not very much sensitive to whether or not there are enforcement mechanisms. This may be due to lack of commitment from the side of the City Administration in implementing existing rules pertinent to illegal waste disposal and hence lack of experience about enforcement mechanisms related to inappropriate solid waste management. The environmentally concerned households (households aware of the consequences of inappropriate solid waste handling) are also willing to pay what they think is fair value irrespective of whether or not there are enforcement mechanisms against illegal dumping practices. Hence, the City Administration and other stakeholders (like social gatherings) should work jointly to implement existing rules against illegal dumping. In doing so, the adverse consequences of poor solid waste handling can be minimized and it becomes possible to tap maximum possible WTP value of households, as the current relatively larger mean WTP value under existence of strong enforcement mechanism shows. The total WTP amount for all households in Adama equals 317,523, 330,183 and 321,279 Birr per month, under the three cases, respectively. The maximum total revenue that can be generated per month under the three cases equals 200,210, 215,850, and 209,600 Birr, respectively, when a service charge of 10 Birr per month is charged.

Based on the nature of the data, two econometric models are used. A Tobit model, because there is censoring of WTP amount at zero, is used to identify factors that affect the amount of money households are willing to pay for the proposed improvement in solid waste management. The Probit model is used to identify those factors that affect the probability of having a positive WTP for the proposed service.

The Tobit model shows that there are several factors that affect the WTP value. Income of the household, education dummies(except that primary education dummy is insignificant in the absence of enforcement mechanism), Marital status, Time spent in the area, Quantity of solid waste generated, Case of disease and House ownership have positive and significant effects on WTP, under the three cases. Age of respondent has a negative and significant effect on WTP amount under all cases. Sex of respondent, family size, waste receptacle (is significant under no enforcement mechanism) and Municipality service have negative but insignificant effects on WTP amount under all cases. The remaining variables; namely, number of children, status of respondent in the household, head occupation, responsibility for solid waste management and bid have a positive effect but were found to be insignificant to explain WTP under the three cases.

Results of the Probit model indicate that Income of the household, house ownership, status of respondent in the household (three of them with positive signs), Sex, Age, and waste receptacle (the three of them with negative signs) have significant effects on the probability of getting a positive WTP. The rest of the explanatory variables (education dummies, responsibility for solid waste management, marital status, time spent in the area, number of children, quantity of solid waste generated, case of disease, head occupation, and municipality service all with positive signs as expected, while family size and bid are with negative signs) were found to be

insignificant to explain the probability of having a positive WTP. The mean willingness to pay value is 13 Birr as calculated from the Probit model. Hence the mean willingness to pay value ranges between 8.26 and 13 Birr. The identification of factors that can affect the WTP of households for improved solid waste management is crucial in formulating a participatory approach under which the major stakeholders, households, can contribute their best to implement the proposed improvement in environmental quality through improved solid waste management service.

There should be an integrated effort among the major stakeholders in order to have an improvement in environmental quality through improved solid waste management: the government authority (municipality) has the ultimate responsibility for refuse collection; the community is the major generator and victim of solid waste related problems and consumer of solid waste service and hence should participate in the provision of the service; the private sector should be involved as they have a great capacity to mobilize resources and run their operations on commercial principles. According to Contreau (1994), provision of the service involves low economies of scale, moderate investment costs and technological simplicity making it feasible for private firms to participate in the provision of the service.

5.2 Policy Implications of the Study

The existing low and poor solid waste service coverage in Adama due to limited capacity of the city administration and poor private sector participation needs expansion and improvement. One way of achieving this is by encouraging households, the major generators of solid waste and victims of solid waste related risks, to share the costs of expanding and improving the service. The majority of the households (92%) acknowledge the need to pay for the service.

Determination of service charges should take into account the ability of households and the quantity of waste they generate in addition to their willingness to pay. Private firms should also be encouraged so that they can provide the service to households that are not served by the city administration. The city administration is also expected to improve its financial and technical capacity(efficiency of trucks, to mention).

The fact that education is a significant determinant of willingness to pay value implies the need to work towards increasing awareness of the society about risks of inappropriate solid waste handling.

Most of the wastes include organic matter (ash, vegetables, food remains and others), plastics and glasses. Hence, the city administration should encourage reuse of the materials (compost making, for instance) and recycling of wastes.

A significant proportion of the households either has no primary waste storage receptacle (44.8%) or has poor quality containers and hence faces serious risks in storing the waste. Hence, the city administration or concerned body should try to introduce standardized primary storage receptacles at fair prices.

There should be a genuine commitment by the city administration in enforcing laws and regulations pertinent to illegal solid waste disposal practices. In Adama, there is a written law to impose penalty on those who may be caught illegally dumping of the waste but almost not practiced. As a result, a significant proportion of households (18.6%) practice illegal dumping. Hence, people should be well-informed that there are laws and the laws should be implemented

timely. This helps in minimizing the free-riding behavior of some households and in tapping the maximum willingness to pay of households for the provision of the improved service.

REFERENCES

- Adama City Administration, Environmental and Sanitation Section (2006). Articles.
Adama
- Adama City Administration, Health Bureau (2006). "Annual Health Reports of 1996-1997 E.C". Adama
- Adama Master Plan Revision Project (2004). "Solid Waste Disposal Site Selection".
Solid Waste Disposal Site Selection Study Team, Adama
- Addis Ababa City Administration (2002/03). "Solid Waste Management Policy".
Addis Ababa-Prepared in Amharic
- Anteneh, A. And Associates (2003). "Urban Poverty Action Research Study in
Selected Ethiopian Secondary Cities: Adama City Profile". (Vol. 1),
Adama
- Altaf, M.A. and Deshazo, J.R. (1996). "Household Demand for Improved Solid
Waste Management: A Case Study of Gujranwala, Pakistan". **World
Development**, Vol.24, No. 5, PP 857-868
- Amiga, Aklilu (2002). "Households' Willingness to Pay for Improved Solid Waste
Management: The Case of Addis Ababa". MSc Thesis, Department of
Economics, School of Graduate Studies, Addis Ababa University
- Bartelings, Heleen (1996). "Contingent Valuation Survey in Morocco and Sweden".
The Netherlands: WAU
- Baraki, Atakilt H. (2002). "Contingent Valuation Survey on Households' Willingness
to Pay for Improved Solid Waste Collection and Disposal Service: The Case
of Mekelle Town". BA Senior Essay, Department of Economics, Ethiopian
Civil Service College, Addis Ababa

- Bayrau, Alebel and Walelegne, Dawit (2004). "Integrated Solid Waste Management in Addis Ababa". Regional and Local Development Studies, Addis Ababa University
- Beede, D.N. and Bloom, D.E. (1995). "The Economics of Municipal Solid Waste". **The World Bank Observer**, Vol. 10, No. 2
- Bernsteins, J.D. (1993). "Alternative Approaches to Pollution Control and Waste Management: Regulation and Economic Instrument". **Discussion Paper**. **World Bank**, Washington, D.C.
- Carson, R. (2000). "Contingent Valuation: A User's Guide". Department of Economics, University of California, San Diego, California
- Center for Environmental Economics and Policy in Africa (CEEPA) (2005). "Environmental Valuation and Policy". University of Pretoria, Republic of South Africa
- Chaka, Assefa (1998). "Determinants of Household Demand for Improved Water Services in Addis Ababa". MSc Thesis, Department of Economics, School of Graduate Studies, Addis Ababa University
- Contreau-Levine, Sandra (1994). "Private Sector Participation in Municipal Solid Waste Services in Developing Countries". World Bank, Washington, D.C.
- Dierig, S. (1999). "Urban Environmental Management in Addis Ababa: Problems, Policies, Perspectives and the Role of NGO's". Hamburg: African Studies
- Federal Democratic Republic of Ethiopia, Central Statistical Authority (CSA) (1999, 2004). "Statistical Abstracts". Addis Ababa
- Federal Democratic Republic of Ethiopia, Central Statistical Authority (CSA) (2005/06), Adama Branch, Articles, Adama

- Federal Democratic Republic of Ethiopia (1997). "Environmental Policy of Ethiopia". Ministry of Economic Development and Environmental Protection Authority, Addis Ababa, Ethiopia
- Federal Democratic Republic of Ethiopia, National Bank of Ethiopia (2004/05). "Annual Report". Addis Ababa
- Fossberg, Melissa et al (1999) (eds.). "Waste: Solid Waste Management in Asia". Urban Development Sector Unit. East Asia and Pacific Region
- Food and Agricultural Organization (FAO) (1999). "Sustainable Development". USA
- Freeman III, A.M. (1993). "The Measurement of Environmental and Resource Value: Theory and Methods". Resources for the Future, Washington, D.C.
- Green, W. H.(2003). "Econometric Analysis." 5th ed. Pearson Education, Inc. Singapore
- Gujarati, D.N. (1995). "Basic Econometrics". (3rd edition). McGraw-Hill International Editions. Economic Series, USA.
- Haab, T.C. and McConnell, K.E.(2002). "Valuing Environmental and Natural Resources: The Economics of Non-market Valuation". Edward Elgar, Cheltenham.
- Holmes, J.R. (1984) (ed.). "Managing Solid Wastes in Developing Countries". USA.
- Kartman, B. (1997). "The Contingent Valuation Method: A Contribution to the Discussion". kompendiet. Gutenberg. Memorandum 230.
- Kenya Country Report (2000). "Solid Waste Management". Nairobi
- Lemessa, Dunfa (1998). "The Willingness to Pay of Rural Households for Improved Rural Water Provision in ada'a-Liben District, Central Ethiopia". MSc Thesis, Department of Economics, School of Graduate Studies, Addis Ababa

University.

- Luc,L. (1998). "Environmental Management in Practice: Instrument for Environmental Management". Nathan, B. et al (eds.). (vol.1). T.J. International Ltd. Padstow, Cornwall, Great Britain.
- Luck J.D. and Rubin S.R.(2002). "Marketing Research". (7th edition). New Delhi, India
- Maddala,G.S. (1992). "Introduction to Econometrics". (2nd edition). Prentice-Hall, USA.
- Mekonnen, Alemu(2000). "Valuation of Community Forestry in Ethiopia: A Contingent Valuation Study of Rural Households". **Environment and Development**, Vol.5 (2000), pp. 289-308.
- Ministry of Federal Affairs National Urban Planning Institute and Ethiopian Civil Service College (2000). "Urban Grading Project, Summary Report on Trends and Process of Urbanization in Ethiopia". Addis Ababa.
- Mitchell, R.C. and Carson, R.T. (1989). "Using Surveys to Value Public Goods: The Contingent Valuation Method". Washington, D.C. Resources for the Future.
- Onwunjekwe,O. (2001). "Searching for a Better Willingness to Pay Elicitation Method in Rural Nigeria: The Binary Question with Follow-Up Method versus the Bidding Game Technique". **Health Economics**. No. 10, pp. 147-153.
- Rand, T.,Haukohl,J., and Marxen,U. (2000). "Solid Waste Incineration, Requirements for Successful Project". World Bank, Washington, D.C.
- Rushbrook, P. and Pugh, M. (1999). "Solid Waste Land fills in Middle and Lower Income Countries: A technical guide to planning and design and operation".

- World Bank Technical Paper, No. 426.
- Salequzzaman, M.D. et al (1998). "Willingness to Pay for Community Based Solid Waste Management and its Sustainability in Bangladesh". Australia.
- Tietenberg, T. (1999). "Environmental and Natural Resource Economics". 6th International edition, Pearson Education, Inc.
- United Nations Commission on Sustainable Development (1999). "Solid Waste Management". USA.
- United Nations Environment Programme(UNEP) (1992). "Sustainable Development". USA.
- United Nations Environment Programme (UNEP) IE (1994). "Wastes and Their Treatment". Nairobi.
- Viniegra et al (2001). "Economic Valuation of the Environmental Impact of Solid Waste Management: A Case Study". Mexico.
- World Commission on Economic Development (WECD) (1987). "Sustainable Development and its Implications". USA.
- Yoseph, Getachew (2004). "Urban Solid Waste Management". Environmental Economics Forum, Economic Development Research Institute, Addis Ababa.

Appendix I

Test of Heteroscedasticity

One of the important methods used to test the existence of heteroscedasticity in Tobit model is the log – likelihood ratio test (LR) test. The LR statistics of testing the null hypothesis of homoscedasticity assumption is obtained by

$$\lambda_{LR}=2[\text{Log Lu}-\text{LogLr}]; \text{ Where}$$

log Lu is the value of unrestricted log-likelihood function and

log Lr is the value of restricted log –likelihood function

λ_{LR} has a $X^2(n)$ distribution with n degrees of freedom where n is the number of independent restriction. If the data do not support the null hypothesis (homoscedasticity assumption), then the value of the test-statistic becomes large and null hypothesis is rejected; i.e, if $\lambda_{LR} \geq X^2(n)$. The result of the test for the model is shown below

Case 1 In the absence of enforcement mechanism

$$\begin{aligned}\lambda_{LR} &= 2[\text{Log Lu}-\text{LogLr}] \\ &= 2[-683.1404 - (-726.9965)] \\ &= 2[43.8561] \\ &= 87.7122\end{aligned}$$

Case 2 In the presence of strong enforcement mechanism

$$\begin{aligned}\lambda_{LR} &= 2[\text{Log Lu}-\text{LogLr}] \\ &= 2[-668.3919 - (-722.1399)] \\ &= 2[53.748] \\ &= 107.496\end{aligned}$$

Case 3 In the presence of weak enforcement mechanism

$$\begin{aligned}\lambda_{LR} &= 2[\text{Log Lu}-\text{LogLr}] \\ &= 2[-665.8529 - (-711.4129)] \\ &= 2[45.56] \\ &= 91.12\end{aligned}$$

The critical value of the chi-square at 19 degree of freedom is 30.14 at 95% level. Comparison of the results (test statistics) with critical table value shows that all of the test statistics (computed values) are found to be larger than the critical table value. This implies that the null hypothesis of homoscedasticity is rejected, i.e. heteroscedasticity is the problem for the model. The condition is the same for Probit model as the below calculated result shows.

$$\begin{aligned}\lambda_{LR} &= 2[\text{Log Lu}-\text{LogLr}] \\ &= 2[-61.14241 - (-104.6822)] \\ &= 2[43.53979] \\ &= 87.07958\end{aligned}$$

Appendix II

Likelihood Ratio Index (LRI)

The likelihood ratio index, equivalent to R^2 in a conventional OLS regression model, is used to measure the goodness of fit of the Probit model. It is computed using the formula,

$LRI = 1 - \ln L_r / \ln L_o$; where

$\ln L_r$ is the value of unrestricted log-likelihood function and

$\ln L_o$ is the value of log-likelihood function. Its value lies between 0 and 1.

If it is one it implies “perfect” fit. According to Green (1993) values between zero and one have no natural interpretation but as LRI approaches one it shows improvement in goodness of fit.

Then the computed value of LRI for our probit model is:

$$LRI = 1 - (-61.14241 / -104.6822)$$

$$.415924$$

Appendix III

ANOVA (The F-Test)

We assume that the enforcement mechanisms are not different in their effect on household's willingness to pay. Therefore, the null hypothesis is that the mean willingness to pay values are equal under the three cases and the alternative hypothesis states that they are different. That is,

$$H_0 = \bar{X}_1 = \bar{X}_2 = \bar{X}_3$$

$H_1 =$ Otherwise

Where $\bar{X}_1, \bar{X}_2$ and $\bar{X}_3$ represent the mean willingness to pay values under no, strong and weak enforcement mechanisms, respectively.

F value is computed using (Luck and Rubin, 2002),

$$F = \frac{BMS(\text{between-column means square})}{WMS(\text{within-column means square})} = \frac{\frac{SS_B}{k-1}}{\frac{SS_W}{n-k}}$$

Where, k=No. of cases (Here 3),

n = the no. of observations (239, in our case),

K-1= 3-1=2, degree of freedom in the numerator

n-k=239-3=236, degree of freedom in the denominator.

The critical F-value is obtained at $F_{0.05}(2, 236)$ where 0.05 is the probability that a true hypothesis is rejected. We accept the null hypothesis if the computed F-value is less than $F_{0.05}(2, 236)$ and fail to accept it (accept the alternative hypothesis) if computed F-value exceeds the critical F-value.

Test Statistics

$$SS_T \text{ (Total Sum of Squares)} = \sum_{i=1}^3 \sum_{j=1}^{239} \left(X_{ij} - \bar{X} \right)^2$$

$$SS_W \text{ (Within-group Sum of Squares)} = \sum_{i=1}^3 \sum_{j=1}^{239} \left(X_{ij} - \bar{X}_i \right)^2$$

$$SS_B \text{ (Between-group Sum of Squares)} = n \sum_{i=1}^3 \left(\bar{X}_i - \bar{X} \right)^2$$

$$SS_T - SS_W = SS_B$$

Where $\bar{X}$ = WTP value,

i = 1, 2, 3 representing the three cases with 1-no enforcement, 2-strong and 3-weak enforcement mechanism,

j = 1, ..., 239 representing the number of observation with n=239 the total observation,

$\bar{X}_i$ = Mean WTP values under the three cases with $\bar{X}_1 = 8.26, \bar{X}_2 = 8.66, \bar{X}_3 = 8.41$,

$$\bar{X} = \frac{\sum_{i=1}^3 \sum_{j=1}^{239} X_{ij}}{n} = \frac{\sum_{i=1}^3 \bar{X}_i}{3} = 8.44 = \text{Grand mean WTP}$$

The computed F-value is less than the critical F-value, as shown in part 4.3, and hence the null hypothesis is accepted.

Appendix IV

Figure 4.1 Estimated Demand Curve for Improved SWM in Adama
(With no enforcement mechanism)

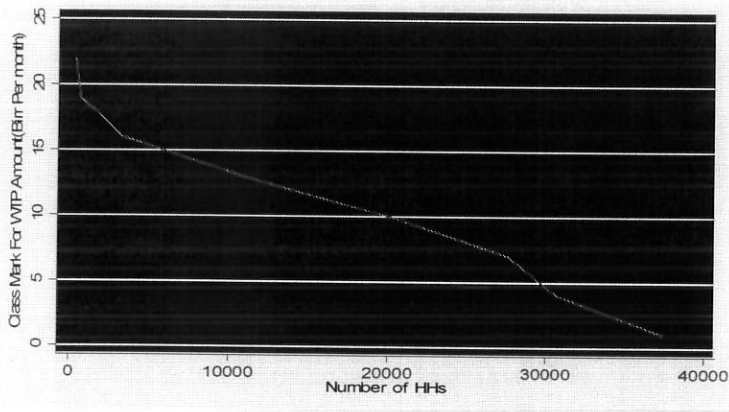


Figure 4.2 Estimated Demand Curve for Improved SWM in Adama
(With strong enforcement mechanism)

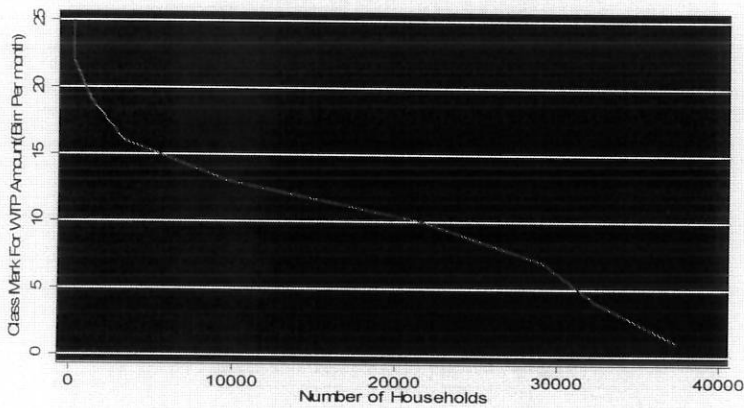
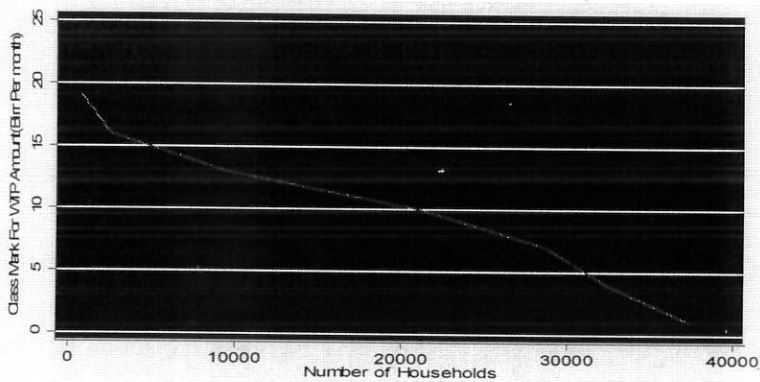


Figure 4.3 Estimated Demand Curve for Improved SWM in Adama
(With weak enforcement mechanism)



Appendix V

CONTINGENT VALUATION SURVEY -HOUSEHOLD QUESTIONNAIRE

This survey is being undertaken by a student of Addis Ababa University Faculty of Business and Economics in the Department of Economics as a partial fulfillment for the award of MSc in Economics. This questionnaire is designed to obtain information on the current situation of solid waste and Adama town residents' willingness to pay for an improved solid waste management in Adama town.

The findings of this study may help concerned bodies in the town understand the severity of the problems related to poor solid waste handling, consider the need for improving solid waste management and take advantage of the monetary values households are willing to allocate to improve the service.

The information collected from the survey will be kept confidential and name and personal information of the respondent will never be disclosed. Hence, you are requested to participate in this discussion as truthfully as you can.

TO BE FILLED BY THE INTERVIEWER

Name of the Interviewer: _____

Date of Interview: _____

Time of Interview: From _____ to _____

THE FOLLOWING THREE SECTIONS ARE QUESTIONS AND STATEMENTS TO BE READ ALOUD TO THE RESPONDENTS AND FILLED BY THE INTERVIEWER.

SECTION 1. CURRENT SITUATION OF SOLID WASTE MANAGEMENT

1. How many 'Madaberiya' of solid waste are generated in your household per week? ____
2. Do you have a storage receptacle for solid waste in your house or in your compound?
A. Yes B. No

If 'Yes', go to Question 3

If 'No', go to Question 4

3. What is it made of?
A. Plastic C. Wood (Bamboo)
B. Metal D. Sisal
E. Other (Specify): _____

4. Would you please list the composition of solid waste generated from your household in terms of their quantity in descending order? (Ash, food remains, dead animal bodies, plastics, glasses, metal, paper, etc)

5. What are the main problems you encounter in solid waste storage?

6. How do you dispose off your solid waste?

- A. Take it to the nearby secondary storage receptacle ('genda')
- B. Digging a hole around the house/ in the village and bury or burn it
- C. Throw it on an open space or on the street
- D. Throw it into the nearby river
- E. Private collectors take it
- F. Any other (Specify): _____

If the answer is 'E' go to Question 7;

Otherwise, go to Question 8

7. A) How many times they collect your waste per week? _____

B) How much do you pay for this service per month? _____

C) Are you satisfied with their service? _____

8. Is your household getting the services of solid waste collection or disposal from the municipality?

A. Yes

B. No

9. Are you satisfied with the existing waste collection and disposal service provided by the municipality?

A. Yes

B. No

10. What do you suggest to improve this condition?

11. Who do you think is responsible to properly manage solid waste (for instance, financing it) in Adama?

A. The Municipality

C. Households

B. Private Companies

D. Others (specify) _____

12. Which of the following do you think is the best institute to handle solid waste in Adama?

A. The Municipality

C. Households

B. Private Companies

D. Others (specify) _____

13. What are your reasons for your choice in Question 12?

14. What problems do you think households face as a result of mishandling solid waste?

15. Can you mention some diseases related to poor solid waste management?

16. Did any of your family members suffered from any of the mentioned disease in the past one year?

A. Yes

B. No

17. How do you rate the seriousness of the solid waste problem in Adama?

A. Very serious

C. Less serious

B. Serious

D. Not serious at all

18. Do you think it is possible to reduce the quantity of solid waste generated from each household?

A. Yes

B. No

19. If your answer to Q.18 is "Yes", can you mention how?

SECTION 2. HOUSEHOLD'S WILLINGNESS TO PAY FOR IMPROVED SOLID WASTE MANAGEMENT

The current inappropriate handling of solid waste in Adama town is causing serious human health and environmental problems. This calls for an efficient collection system and environmentally sound disposal mechanism. Assume that the Municipality is planning to provide an improved solid waste management in your area. Suppose this service involves door-to-door collection of your solid waste twice 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 twice 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.

20. Are you willing to participate in this project?

A. Yes

B. No

21. Would your Household be willing to pay 6/ 10/ 14 per total 'Madaberiya' of solid waste generated in a month for this improved solid waste management service?

A. Yes

B. No

If 'yes', go to the three scenarios;

If 'No', go to Question 25.

Case 1

22. Given that the municipality provides the above service. Who pay for the service get the service and others are not fined anything for illegal dumping, what is the maximum amount your

household is willing to pay for all 'Madaberiya' of solid waste you generate per month(in Birr)?

Case 2

23. Given scenario 1, and all households pay the same amount for equal amount of solid waste they generate and there is _____Birr fine on households who are detected dumping the waste illegally, what is the maximum amount your household is willing to pay for all 'Madaberiya' of solid waste you generate per month (in Birr)? _____

Case 3

24. Given scenario 1 but with only ----Birr fine for illegal dumping, what is the maximum amount your household is willing to pay for all 'Madaberiya' of solid waste you generate per month(in Birr)? _____

25. Could you tell me the reason why you do not want to pay anything for this improved solid waste management?

- A. We are poor and we could not afford
- B. We are satisfied with the current situation (it does not need improvement)
- C. Proper management of solid waste is the responsibility of the government
- D. Other reasons (specify) _____

26. What comments and suggestions you give for the improvement of solid waste management concerning:

26.1The handling of solid waste

26.2 Responsibility of
Households _____

Government _____

Private sectors _____

Others (specify) _____

26.3 Payment and payment vehicle _____

SECTION 3 HOUSEHOLD CHARACTERISTICS

- F.B.I.

43. How long have you been staying in this house (in months)? _____

44. Housing arrangement?

- A. Privately Owned
- B. Rented from kebele
- C. Rented from Rental Houses Agency
- D. Rented from individuals

THANK YOU

Declaration

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university, and that all source of materials used for the thesis have been duly acknowledged.

Declared by:

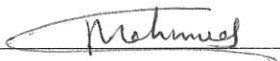
Name: Tolina Tirach

Signature: 

Date: _____

Confirmed by Advisor:

Name: Mahmud M. Yezuf

Signature: 

Date: _____

Place and date of submission: _____.