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

HOUSEHOLDS' HEADS WILLINGNESS TO PAY  
FOR IMPROVED SOLID WASTE MANAGEMENT  
THE CASE OF COMMON BUILDING RESIDENCES  
IN ADDIS ABABA

BY: SELESHI FANTU HAILE



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



(ENVIRONMENTAL AND RESOURCE ECONOMICS)

2007

ADDIS ABABA UNIVERSITY  
SCHOOL OF GRADUATE STUDIES

“Households’ Heads Willingness to Pay for Improved Solid  
Waste Management: The Case of Common  
Building Residences in Addis Ababa.”

By

Seleshi Fantu Haile



Approved by the Board of Examiners:

Prof/Dr. Mahmud Y.  
Advisor

[Signature]  
Signature

Wassé Berhanu  
Examiner

[Signature]  
Signature

Muleta Demke  
Examiner

Muleta D  
Signature

## ACKNOWLEDGEMENTS

The completion of this thesis wouldn't have been realized had it not been for my advisor Mohammud Yusuf (PhD) Addis Ababa University who has given me his intellectual experiences and comments. Besides I want to thank Yordanos G/Meskel, Solomon Lemma and Yonathan Shiferaw who add their pieces of advice for improvements.

I wish to express my gratitude to ENDA Ethiopia and residences of the Common Buildings who have given me their deep committeemens for references and questioning respectively.

It is my pleasure to acknowledge my sister in love W/t Atkelet Abebe who has done more than typing the manuscript.

Any errors of analysis or interpretation which no doubt, different readers will find in this thesis remain my responsibility.

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## ACRONYMS

<b>BCA</b>	<b>Benefit Cost Analysis</b>
<b>CV</b>	<b>Compensating Variation</b>
<b>CVM</b>	<b>Contingent Valuation Method</b>
<b>ETB</b>	<b>Ethiopian Birr</b>
<b>EV</b>	<b>Equivalent Variation</b>
<b>IV</b>	<b>Intrinsic Value</b>
<b>LRI</b>	<b>Log-likelihood Ratio Index</b>
<b>LRT</b>	<b>Log-likelihood Ratio Test</b>
<b>MSE</b>	<b>Micro and Small Enterprise</b>
<b>NUV</b>	<b>Non-use Value</b>
<b>SBDC</b>	<b>Single Bound Dichotomous Choice</b>
<b>SWM</b>	<b>Solid Waste Management</b>
<b>UV</b>	<b>Use Value</b>
<b>WTA</b>	<b>Willingness to Accept</b>
<b>WTP</b>	<b>Willingness to Pay</b>



## **Abstract**

What motivates people to demand higher environmental quality? Do desires for an improved environment come merely from person motives or otherwise?

The premises that triggered the study is the campaign type of Solid Waste Management in Addis Ababa. Most of these activities are not undertaken on daily bases. As a result the study aims to look into the factors that motivate households to care for their solid wastes.

In this paper, I tried to see whether motives do influence heads of households WTP for improved SWM in Common building residences of Addis Ababa or not. The study is undertaken in 3 sites in Bole, Gulele and Addis Ketema Sub-cities.

The output of the tobit estimation confirm that the motives like Cond, Variable representing ownership of Condominium, CSWS, current solid waste service and Locashn, location of the site are found to significantly influence heads WTP for improved SWM.

Moreover, the probit estimation for the mean WTP for the improved SWM is found to be 13.15 Birr per month for the survey area.

Based on the significant variables used it recommends the expansion of public utilities like Condominiums. Besides the location of the site being close or further from highways and the current condition of solid waste service also affect people's demand for improved SWM.

The significance of life expectancy implies the need to educate older generation about the benefits sustainable development and environment.

## **1. Introduction**

What motivates people to demand higher environmental quality? Do desires for an improved environmental quality merely come from self-interest, or do motives play a role as well? Using aggregate voting data, Holmes (1990) concludes that altruistic motives do influence the voting decision. This conclusion contrasts with a similar study by Deacon and Shapiro (1975) which concluded that altruism does not play an important role in such decisions. The paper uses information on life expectancy to develop a test of altruistic demand for preservation of the environment based on concern for the welfare of future generations.

The question of whether motives play a role in decisions about environmental quality demanded is important for several reasons. First, it helps to determine how an individual's utility function should be defined. Pursuing environmental objectives for altruistic reasons is not inconsistent with the concept of maximization of utility if the utility function is defined so that utility is a function of the welfare of others. If motives do exist for protecting the environment, methods that attempt to place a value on natural resources must take these motives into account. Furthermore, even if current generations do express concern for future generations, we must ask whether such altruistic concerns are expressed in the marketplace. Concern for future generations has led some economists to argue that the social discount rate used in such situations should be lower than the private discount rate observed in market transactions. Finally, if altruistic motives do not play a role in individual decision making government intervention may be necessary to assure that future generations will be able to enjoy the amount of environmental quality that they desire.

## 1.1 Back ground

The current urban proportion of the population of Ethiopia is relatively low accounting only 15% of the total population. But the rate of growth of the cities is 5.4% and this rate is expected to grow to 30% in the year 2020 (1997 environmental policy). Addis Ababa, a capital city of the federal government of Ethiopia accommodates more than 4 million people with 3.8 percent rate of growth. The city has sever problem of urban sanitation in adequate water supply, inadequate excreta disposal facilities and poor drainage and solid waste management systems. According to the environmental policy of Ethiopia, in efficient and very poor housing quality is another challenge for the city administration. About 31% of the households in Addis Ababa have no sanitation facilities at all. Girma 2004 cited by CGDP\* (2004)

Solid waste in urban areas includes household produced garbage, street thrown garbage industrial and commercial by products and others. The amount of solid waste in Addis Ababa as well as in other cities is increasing from time to time. For instance, the amount of waste generated in Addis Ababa is 0.252 kg per person per day and the daily solid waste generated in the city is 2,297 m<sup>3</sup> or 851 ton. Out of this 65% is collected, 5% recycled and 5% composed. While the remaining 25% is imply damped on open sites, drainage channels, rivers as well as on the streets Abdulwahid 2003. cited by CGDP(2004).

Though 65% of the SW generated is collected by the city administration, the collection activity carried out by residences of the city are usually time oriented. This is to imply that the sanitation activities are undertaken during historical moments, events or special occasions. Hidar 12 is one of those occasions when a pile of solid wastes are collected and burned from different households. Moreover, these days campaigns by kebele residences to clean pile of solid wastes is not unusual.

These SWM activities triggered this study to investigate the motives (altruistic or otherwise) behind these activities.

## **1.2 Existing Solid Waste Management in Common Building Residences**

The recently built Common Building residences by the Addis Ababa City Administration are supposed to solve the chronic housing problem of the city. Population increment entails negative externalities as generation of wastes rises. These residences are not unique to such problems. Unlike non-common building residences these sites have a solid waste service (SWS) providers organized by their respective kebeles.

The SWS providers collect wastes in a door-to-door system. The solid wastes collected are only generated inside the household. The service never includes wastes around the compounds or vicinities of the sites located. The service is given twice per week which requires a monthly payment of Birr 5 on average. Most of the residences are satisfied with current SWS though a very few of them are dissatisfied with sanitation of their compounds.

## **1.3 Statement of the problem**

Solid wastes arise from human activities, domestic, commercial, industrial wastes from public and others, all of which increase with urbanization. Domestic sources constitute the major sources of solid waste in urban Ethiopia. According to Fossberg (1999) cited by CGDOP 2004, there's a positive correlation between the level of development at a country and its waste generation rate. This implicitly implies that solid waste management activities should parallel to the ever rising level of wastes produced daily. However, solid waste management actors usually taken by residence of Addis Ababa largely targets special occasions like the "Hidar Werershghe" a campaign for collecting and burning of a pile of solid wastes on November 20. Though this act of solid waste management is an age old tradition, one can also witness similar management options.

Currently undertaken by metropolitans of Addis Ababa which target special occasions or public events. (Researcher's observation)

Moreover, most residences in Addis Ababa are congested and lack proper waste disposal method. This may demand the construction of modern residences which acquire these facilities. The study wants to investigate the role common building residences play in this respect. It tries to undertake a survey on the demand for environmental quality (SWM) by incorporating motives in the demand analysis.

#### **1.4 Research Objectives**

The study generally tries to determine factors that affect the Willingness to pay (WTP) head of households for an improvement in environmental quality. Specifically, it attempts to:-

- i. Examine whether heads of households attach personal motives like altruistic or others in their WTP.
- ii. Examine whether being a resident of Condominium motivates heads' for WTP for improved solid waste improvement.

#### **1.5 Significance & Limitations of the study**

##### **1.5.1 Significance**

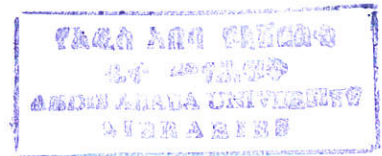
With ever increasing urbanization the generation of wastes is eminent. Unlike most studies done so far, which incorporate socio-economic variables as explanatory variables for demand assessment for environmental improvement this particular study includes motives in general and life expectancy as a test for altruism.

This helps to determine how an individual's utility function should be defined. If motives do exist for protecting the environment, methods that attempt to place a value on the environment that could take motives into account. For instance, if current generations do express concern for future

generations, we must ask whether such altruism concerns are expressed in the market place. If altruistic motives do not play a role in individual decision making, government intervention may be necessary to assure that future generations will be able to enjoy the amount of environmental quality that they desire.

### 1.5.2 Limitations

The study is undertaken using a contingent valuation method (CVM) which is criticized for its hypothetical nature. Moreover, the research limits itself to a smaller segment of the urban population in the city i.e.- common buildings residences in Addis Ababa only which entails aggregation of benefits so difficult.



### 1.6 Methodology

The most widely used method of valuation of non-market benefits is Contingent Valuation (CV) and especially its dichotomous choice form. CV is a method of recovering information about preferences or willingness to pay from direct questions. The purpose of CV is to estimate individual WTP for changes in the quantity or quality of goods or services, as well as the effect of Covariates on WTP. (Timothy et al 2002).

#### Sampling method

The survey has focused on owners of common building residences in Addis Ababa who spent a minimum of a year in the site. A sample of 160 head of households have been interviewed using a random sampling method on 3 sites in the city namely Gulele, Addis Ketema and Bole Gergi sites. These sites are selected on the basis of their stay (minimum of one year) and must be provided with a Solid Waste service.

Prior to the main survey, a pilot survey was made to elicit starting bid values and residences experience with the SWM practices were undertaken with respective committees of the sites.

Initial bids for the main survey was elicited through an open ended format by asking respondents their maximum willingness to pay for the improved Solid Waste Service.

### **Elicitation method**

The elicitation format was changed from double bound to a single bound model due to the significant correction between the first and the second responses ( 0.19 ). As a result the study employed the first response for the probability model (probit) and their second response for their maximum WTP (tobit model).

The WTP for the improved SWM is elicited through a single-bound dichotomous format. It asks simple yes or no questions of the stylized form: Would you be willing to pay and followed by the most they would be WTP for the improvement i.e. open – end questions.

### **Analysis of WTP response**

- i. Frequency distribution of WTP response for improved SWM is analyzed.
- ii. WTP responses are cross tabulated with Socio - economic characters of the respondent
- iii. A multivariate analyses of the determinants of WTP responses estimates the valuation function through (tobit and probit) models that relates the hypothesized determinates with WTP responses.

Lastly, methodological tests for hetroscadacity, overall significance and goodness of fit are checked.

## **2. Literature Review**

### **2.1 The concept of Economic Value and Sustainability**

#### **2.1.1 The concept of Economic Value**

The economic concept of value has been generally defined as any net change in the welfare of society. From an economic perspective, values can be associated equally with the consumption of goods and services purchased in markets and with the services from goods and services for which no payments are made. In this sense, anything from which an individual gains satisfaction is deemed to be of value, so long as the individual is willing to give up scarce resources for it. The total economic value comprises explicit use benefits as well as implicit non-use benefits. There are therefore different types of economic value, in which the sum of all the values defines the total economic value of any change in wellbeing due to an intervention; In this sense total economic value does not include the opportunity costs associated with an intervention. Besides the standard value associated with consumption of a good – known as 'use value' – it has been argued that individuals place monetary value on goods that is independent of their present consumption. This implies that the total economic value goes beyond what is possible to estimate using market analysis. The first systematic attempts to account for values other than 'use-value' were by Weisbrod (1964) and Krutilla (1967). Weisbrod focused on uncertainty and what become known as 'option value', whereas Krutilla focused on 'non-use value' (also named 'passive use value'). 'Option value' refers to the value that people place on having the opportunity to consume the good in the future. Due to the uncertainty of consumption linked to option value, there is disagreement among economists as to whether it should be classified as a use or a non-use value, or placed horizontal to these two values. The uncertainty paradigm related to option value has created problems due to the fact that future decisions are random as viewed from today.

Non-use value refers to the value beyond current or future consumption. For instance, an individual who never sees a polar bear in real life might feel a need to secure its survival; i.e. the individual values the existence of the polar bear. Furthermore, the individual might assign value to the opportunity of the next generation to experience the polar bear - this is termed bequest value. These descriptions of non-use value have been developed by environmental economists and hence tailored for this field. In health care non-use value might rather be characterized as a 'caring externality for other peoples' health that implies an altruistic way of thinking. Altruistic value can be divided into a concern about the general utility levels of others. (i.e. 'individual altruism') and a concern about the consumption of specific goods by others (i.e. 'paternalistic altruism'). For example, giving money to the poor is individual altruism, i.e. "it brings me utility to help others consume a good that gives them utility". On the other hand, a non-smoker being willing to attend a stop-smoking course is paternalistic altruism, i.e. "I know that is best for you and therefore I decide for you". And there is the problem; what if smokers do not want to attend the stop-smoking course? Then we put value onto a good where the potential consumers do not want to consume the good, i.e. the good has a negative utility for the consumers. In the worst case we might end up offering a good that no one wants to consume or ,alternatively, end up valuing the good twice-referred to as double counting.

Another one-use value is the value of positive externality. That one individual quits smoking has a positive externality on other individuals, as the cigarette smoke will not longer bother them. In this case the smoker (user) will indirectly affect the non-smokers (non-users) and hence will experience a gain in utility. The exclusion of such non-use value might result in an underestimation of the associated value of a good.

In general the clarification of non-use (NUV) value can seem problematic and even though economists working in the field of cost benefit analysis accept the hypothesis of non-use value, there is little consensus as to terminology, definitions, what motivates people to hold non-use values, and how to measure non-use value empirically.

Motives and their relation to sources of utility have been central to discussions following Weisbrod (1964) and Krutilla (1967). In a welfare theoretic context, Smith (1987) defined as an economic value anything (i.e. motives) from which utility is derived and which is scarce. By extension, therefore, anything which gives rise to such values would also matter. Madriaga and McConnell (1987) argued this point explicitly. First, they put forward that there is an intrinsic motive, closely related to the environmental ethic. They further argued that altruistic motives can determine whether NUV should influence BCA.

Freeman et al (1990), arguing against the importance of motives such as altruism, have tended to focus on the fact that in the conventional economic paradigm, motives do not matter. In an extensive review of NUV, Cummings and Harrison (1992) noted pervasive problems of operationalizing motives. Also criticized the tendency among some analysts to define a different value for each of any number of identifiable motives. This practice runs the risk of double counting if a given willingness to pay (WTP) is assigned to several motives.

### **2.1.2 Definition of sustainable development**

The introduction of environmental economics raises the question of what is meant by a sustainable development. There are many possible definitions, as shown by Pearce et al. (1990), but two vague ones are the following:-

- i. No degradation of resources is permitted. This means that the use of exhaustible resources is prohibited and that the harvest from renewable one must not exceed their growth.
- ii. The economy should be run in such a way that the welfare of future generations can be sustained indefinitely at or above some minimum level.

The first definition of sustainability is different from the latter one in that it never considers welfare of individuals into account. The second definition is relevant to our analysis because incorporates the concept of altruism in sustainable development.

### **2.1.3 Sustainability Why?**

It is hard to find someone who openly thinks it acceptable for future generations to be worse off than today. But the rationale for being concerned about sustainability is still hotly debated.

Some argue that whatever one might think about intergenerational responsibility in concept, the issue is moot in practice because, there is good reason to expect technical and economic progress to continue, leaving future generations better off than today. Others take the view that economic progress and ecological protection over several centuries are not so automatically assured.

Classical utilitarianism is concerned with ends – individual welfare but rejects the notion that individuals should be regarded differently just because of the time when they are alive, as occurs when future welfare is discounted in a typical intergenerational optimization problem. This approach can throw up some challenging incentive compatibility issues. If individuals in fact do experience some intergenerational concern (altruism), but do not weigh the welfare of future generation equally with their own, then they will not accept the inter temporal resource allocation implied by the classical utilitarianism.

A second view is based on rights-based or entitlements based view of intergenerational obligation. Rawls' (1971) new classical construction of a rational for maximizing the well-being of least well-off is a relatively familiar example of this approach in the sustainability literature. Another variant is the notion of kantron imperative, a kind of Golden Rule in which we seek to treat others as we would wish to be treated. This approach also could lead to inconsistency with an individual utilization preference ordering in which people value the well-being of future generations, but less than their own well-being.

## **2.2 Previous work on Motives and Environmental Protection**

The paper by Deacon et.al (1975) was among the first to look at the result of voting on referenda as a way of revealing preferences for public goods. They conclude that individuals are motivated by self-interest in demanding public goods. Holmes (1990) extends the basic voting model variable for altruism, which he finds to be significant. Thus, Holmes (1990) concludes that altruism affect the demand for public goods.

In contrast, Holmes (1990) includes both socioeconomic variables and proxies for altruistic motives in his regression. Following Kau et al (1979), Holmes (1990) uses the residuals from a regression of self-interest on voting behavior as a proxy for ideology. He considers country-wide votes cast for Senator in the same election as the Safe Drinking Water referendum. He includes several variables representing the self-interest of country residents, such as income and the percentage of agricultural workers in a country, in a regression explaining votes for Sentaor Alan Cranston, a Democrat with a strong environmental record. The residual from this regression is interpreted as a measure of ideology. That is a positive error term (countries that voted for Cranston although self-interest would predict that they would not) is interpreted as an ideological learning towards Cranston's more liberal political views. Holmes (1990) then uses this proxy variable in a separate

regression of votes for the Safe Drinking Water referendum. Since the coefficients of these dummy variables are significant, Holmes (1990) concludes that altruism is a factor in voting on environmental referenda.

Hochman and Rodgers (1969) described conditions under which income redistribution might be Pareto-optimal provided one agent was sufficiently altruistic. Bernheim et.al (1988) show that differential altruism within families may lead to redistribution away from the more altruistic members. Kranich (1988) showed that classical welfare theorems do not generally hold if altruistic transfers are permitted. Sen (1967) proposed the "isolation paradox". The basic idea was that, although people would not be willing to make individual altruistic donations, they might give unanimous support to a tax that would fund such transfers.

The early debate focused on altruism towards future generations and its implications of altruism has come to the fore in discussions of individual willingness to pay (WTP) to present inaccessible wilderness areas or wild species which the person concerned is unlikely ever to see. Studies using the contingent valuation method have often found this type of WTP to be substantially larger than the benefits associated with direct consumption of market and non-market goods Michelle et.al (1989).

P. David (2001) extends the results of these studies by using survey data, rather than voting data, so that individual preferences can be observed. By doing so, more direct measures of altruism can be used. In particular, he examines a specific type of altruism; protecting the environment for future generations. Information on the life expectancy of individual respondents is used to determine the present value of benefits from an environmental project that they can expect to receive in their lifetime. The benefits of environmental protection accrue for many years after the initial expenditure. Thus, if people are motivated only by self-interest, we would expect the amount

individuals are willing to pay for environmental protection to fall as life expectancy decreases, since older people will not be alive to enjoy the benefits of preserving resources for later years. In contrast, if caring for the environment was also motivated by concern for future generations, this would not be the case.

### **3. Issues on solid waste management**

#### **3.1 The concept of solid waste**

##### **Solid waste**

Solid waste is defined as non-liquid, non-gaseous disposed-off matter created by human activities in Miller (1998) cited by CGADP (2004). This type of waste includes residential solid waste, commercial solid waste, institutional solid waste, street solid waste, industrial solid waste, construction solid waste and agricultural solid wastes. Similarly, Tchonobanglous (1993) cited by CGADP (1993) defines solid waste as all waste arising from human and animal activities that are normally solid and are discarded as useless or unwanted. It includes municipal garbage, industrial and commercial wastes, sewerage slug, waste of agricultural and animal husbandry, demolition waste and mining residues.

##### **Waste collection**

Waste collection involves the primary collection of the solid waste from those generating it. The source can be household, commercial organizations, factories and others.

##### **Waste disposal**

Waste disposal means depositing, dumping, injecting or placing of waste or hazardous material into or onto the land.

##### **Solid waste management**

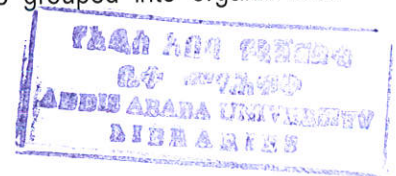
Solid waste management is planning, designing, implementing, controlling and monitoring of the appropriate solid waste collection, disposal and recycling mechanisms so as to minimize its environmental and social costs.

### Recycling of solid waste

Recycling means to re-use the material thrown away for some thing important which is totally different form its original purpose it is made to serve Tchonobanglous (1993) cited by CGADP (2004). Reuse is different from recycling it is bringing back the material thrown as useless in to use in the same purpose.

### 3.2 Volume and types of solid waste

The composition of a solid waste depends on the economic activities and life style of the society producing it. For instance, the types of solid waste in urban areas are different in amount and composition as compared to the waste generated in rural areas. As economic prosperity of a society increases, the density of the solid waste decreases and the composition tends to be more of paper, glass, metal and plastic. Generally speaking the waste density in less developed countries kg/m<sup>3</sup>. Solid waste is composed of matters that can be grouped into organic and inorganic materials. (ibid)

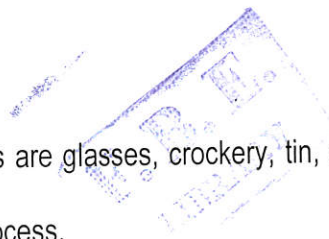


#### Organic solid waste

Organic residential and commercial wastes contain food leftovers, paper of all types, textile, plastic of all types, textiles, and rubber, leather, wood and yard wastes. According to the records of Addis Ababa sanitation, beautification and parks development agency most of the solid waste in the city are composed of organic materials. (ibid)

#### Inorganic Solid waste

The inorganic part of solid waste constituents are glasses, crockery, tin, cans, aluminum, ferrous metals which can't undergo decomposition process.



### **Residential solid waste**

Residential solid waste contains rapidly decomposing animal and vegetable matters which are the by products of the handling, preparing, cooking and consumption of foods, paper, cardboard, textile, ash, wood, cans, old furniture, old household utensils and etc. Residential wastes may include hazardous materials, such as used batteries, expired medicines, expired cosmetics, detergents and others.

The contents of household or residential wastes changes along with the change in the socio-economic situation of the society. In line with this the composition of the residential wastes has been changing into higher proportion of plastics, papers, packaging materials and alkaline batteries. This type of solid waste accounts the highest amount of the entire solid in Addis Ababa, 65 percent. (ibid)

### **Commercial solid waste**

Commercial solid wastes are produced in the activities restaurants, store, markets, printers, and repair and maintenance shops. The proportion of the commercial waste in Addis Ababa is estimated to be 10 percent.

### **Industrial and Institutional solid waste**

Institutional wastes are garbage from schools, hospitals, factories government offices, wastes from hospitals mostly contain hazardous materials like syringes, pharmaceuticals, chemicals, etc. the number of industries in Addis Ababa is increasing over time and most factories in Addis Ababa lack proper waste disposal system and their wastes are led into the nearby rivers and streams end up in polluting the water bodies Dierig (1999) cited by CGADP (2004).

### **Street solid waste**

Garbage thrown away on the streets by pedestrians, and squatter settlers are include road side litter and municipal litter.

### **Construction solid waste**

Materials from demolished structures, roads and buildings including concrete, soil bricks, stones, wood, metals, broken glasses, electric appliances produced in the process of new construction activities or maintaining and repairing the old ones.

### **Agricultural solid wastes**

Agricultural solid wastes are the results of urban agricultural activities like vegetables production, diary production and animal husbandry.

### **3.3 Mechanisms Collection of Solid waste**

Municipal waste collection is handled in three ways: door-to door collection for households along accessible streets, block collection for clients (large hotels, enterprises and institutions) requesting the municipality to provide them with refuse containers and containers system which expects residents to carry and dump their waste in 8m<sup>3</sup> refuse containers placed supposedly accessible sites.

As effort to improve dry waste management, the city administration has transferred the service provision of dry waste management to the newly established Addis Ababa City Sanitation Beatification and Park Development Agency since January 2003, with objective to make the city naturally balanced, green and favorable environment through integrated management and urban recreational area development. The agency as part of future approach, trying to establish decentralize dry waste collection in 10 sub-city's dry waste managements teams.

Moreover, the city council is mainly sole responsible for its management. Recently, 74 Micro and Small Enterprises (MSE) are engaged primarily collection from households to municipal container – improved collection of waste and created job for jobless youths. They charge 10 – 12 Birr/hhs/month. There are also 6 SMEs collecting and transporting. However, majority operates in the middle and high income areas.

A recent study made by the Addis Ababa City Administration shows that the coverage has been constantly increasing from 38 percent in 1993 to 40 percent in 1994 and 53.9 percent in 1996. The amount of waste generated in the city increased by 4 percent (Hassen, 1998) cited by Girma. Generally in Addis Ababa, each kebele (equivalent to neighborhood) has no more than two or three solid waste collection containers. The settlement pattern of Addis Ababa is a spreading out; people need to travel long distance to use containers while the recommended distance by the same study is not to exceed 200 mts.

There are four ways of solid waste collection mechanisms in Addis Ababa: communal container collection, institutional collection, door-to-door collection and daily collection by street sweeping. Other waste disposal method such as composing of agricultural wastes, incineration and recycling of wastes are not used.

### **3.3.1 Collection of solid wastes**

#### **A. Communal container collection**

The communal container system covers 67% of the total garbage collection service in the city. The collection is made through metal containers of volume 8m<sup>3</sup> placed in some designated places in the city which are to be collected when full. But this collection mechanism is not efficient; containers are not emptied as they get full. Besides, the places they are placed are not suitable for the purpose. (Abdulwahid 2003) cited by CGADP describes that most of them are placed on by the

roadsides of main streets and the garbage is spread out of the container by pickers who look for some useful items in the garbage. Moreover, the garbage in the containers and the surrounding cause bad smell causing flue for the by passer and the surrounding resident.

Although the objective is to service every 2-3 days, containers are actually emptied in more than a week period on average. Besides, some households are located 1 km away from their closest container that people tend to throw their waste in sewerage and ditches. All solid waste collected by the municipality to single landfall, rapid dumping site, 40 years old (located south of the city) that is proved to be difficult to prevent scavengers from scratching through hazardous waste. The efficiency of this method is limited because of the capacity of the city council to deploy adequate number of vehicles and waste containers, which in tern has direct relationship with revenue generation of the city.

### **B. Institutional collection**

Organizations, factories and institutes use 8m<sup>3</sup> steel containers which are emptied when they are full up on their request to be collected. The institutes are charged Birr 11 per m<sup>3</sup> of garbage collected. But this service is not satisfactory as the municipality is not efficient enough in collecting the containers. Most of the time they fail to pick the containers as they are informed to collect it.

### **C. Door-to-door collection**

These days the door-to door collection is made mostly by micro and small enterprises by charging households for the collection service they provide. They collect the garbage from every household once in a week and charge in the range from Birr 10 – 15 monthly for the service.

On the other hand, similar service is provided by municipality of the city. Even though there is no regular collection schedule, Claxton is used to inform the people that the truck is there to collect the

garbage. However, the service lacks properly planned and designed collection route and fixed time for collection with regular frequency.

#### **D. Daily collection by street sweeping**

All streets of Addis Ababa don't get this service. Street sweeping is limited to some streets even though the coverage is not exactly known. Sub-cities are responsible for the proper provision of this service. The sweepers use manual, inefficient equipments to sweep and collect the garbage on the streets. The laborers are not given with clear rule which are to cover and to what extent to clear the roads.

### **3.3.2 Disposal of solid waste**

After collection of garbage from various places it needs to be dumped in properly designed waste disposal places. From environmental safety and health perspective, it is extremely important to select in away it will not pollute the air, the water and the beauty of the city. According to CGADP (2004) there are different methods of disposing solid waste:-

- A **Landfills** are disposal structures of land where in the waste is dumped in or on the land. They have some mechanism to prevent leakage or surface runoffs.
- B **Surface impoundments** are artificial or natural basins to be used as dumping places of hazardous solid wastes.
- C **Underground injection well** are concrete or steel made containers placed built or placed deep in the earth where in waste are injected under pressure.
- D **Incineration** is the burning of organic waste by setting fire on the waste material.

At present the waste collected from various places is dumped in an open area established from this purpose forty years ago. This open land dumping mechanism is very hazardous as dangerous chemicals as it only involves spraying and leveling the waste on the land.

Landfill sites itself needs an attention. Landfill has impact on the surface and ground water. Decomposition of organic materials produces different gases, which has effect on the air above. Hence proper use of landfill requires certain standard including spreading refuse in the thin layers and compacting by bulldozer before next year spread. All measures meant to control contamination of surface and ground water as well as the air.

### **3.3.3 Recycling of solid wastes**

Most of what people perceive as waste are in fact valuable resources and can be reused or recycled. Waste reduction through reuse and recycling is very important component of any attempt to address the waste management effort of the cities of less developed countries. Reuse or recycling reduces the pollution effort of the garbage and reduces the demand for virgin material which so as to minimize the pressure on natural resources. The recycling of waste is almost inexistent in Addis Ababa. Although there is no well organized recycling mechanism in the city, the amount being recycled is estimated to be 5% of the solid waste. This represents materials which can benefit households and separated and sold in the informal market. However, it is believed that about 15% of the total waste generated can be recycled.

### **3.4 Environmental Impact of Solid Waste**

Inadequate municipal and industrial dry waste collection and disposal creates a range of environmental problems in Addis Ababa. A considerable amount of solid waste ends up in open dumps or drainage system, threatening both surface water and ground water quality and causing flooding, which provides a breeding ground for diseases – carrying pests. Open air burning of

waste, spontaneous combustion in landfills, and incinerating plants that lack effective treatment for gas emissions are causing air pollution. The situation is exacerbated in slums where households cannot make use of garbage collection containers. Lack of the most basic solid waste services in crowded, low-income neighbors is a major contributor to the high morbidity and mortality among the urban poor. The adverse effect of inadequate solid waste service on productivity and economic development of the city is expected to be significant.

Using Landfill has also an impact on the surface and ground water. Decomposition of organic materials produces different gases, which has effect on the air above. Hence proper use of landfill requires certain standard including spreading refuse in the thin layers and compacting by bulldozer before next year spread. All measures meant to control contamination of surface and ground water as well as the air. None of these practices are apparent in the landfill site of the city. Moreover, it is unprotected where children, destitute women and youngsters scavenging for survival. This also needs proper attention.

The Containers which are used as the main means of collecting garbage are not protected from rain and sun that makes the garbage to cause smell pollution, unsightly urban scene and deterioration of the neighborhood and disturbance of human activities. The site is also exposed from animals like dog, cat and others during scavenging scatter the waste in the surrounding area. The situation in the newly developed parts of the city is not different. Solid waste disposal system not integrated with settlement development.

Theses days, the plastic bags are mainly used as a means of carrying every day consumables which finally thrown making a significant fraction of the solid waste in the city, stores hand out the plastic bags for free for carrying the purchased items. The quantity of plastic bags in the solid waste has significantly increased dramatically in the past 10 years (Girma 2004). Since these

plastic bags are made of decomposing they stay for long time and are carried away by wind into ditches, rivers, gardens, poles, fences etc.

The disposal mechanisms of these plastics, therefore, should be a matter of concern for everyone as it has hazardous impact on the health of human and animal. The pigments of the colored plastic bags contain toxic metals like copper, lead, chromium, cobalt, selenium and cadmium. Due to this fact some environmentalists protest the use, sale and production of plastic bags and advocate substituting them with natural fiber or textile made bags (CGADP 2004).

## **4. Contingent Valuation Method and Welfare Measures**

### **4.1 Methodological issues in Contingent Valuation Method (CVM)**

Contingent valuation (CV) is a method of recovering information about preferences or willingness to pay from direct questions. The purpose of contingent valuation is to estimate individual willingness to pay for changes in the quantity or quality of goods or services, as well as the effect of covariates on willingness to pay. The major methodological issues to CV relate to its elicitation, bias and acceptability.

#### **4.1.1 CVM Elicitation methods**

- a. **Open ended:** a CV question in which the respondent is asked to provide the interviewer with a point estimate of his or her willingness to pay.
- b. **Bidding game:** a CV question format in which individuals are iteratively asked whether they would be willing to pay a certain amount. The amounts are raised (lowered) depending on whether the respondent was (was not) willing to pay the previously offered amount. The bidding stops when the iterations have converged to a point estimate of willingness to pay.
- c. **Payment cards:** a question format in which individuals are asked to choose a willingness to pay point estimate (or a range of estimates) from a list of values predetermined by the surveyors, and shown to the respondent on a card.

#### **4.1.2 Possibilities and Problems with CVM**

Contingent valuation method entails a number of characteristics which allows for enhancing the extent to which changes to environmental goods can be assessed on a monetary basis. However, the method also involves a number of problems and short-comings. Below are outlined possibilities and problems of CVM.

The possibilities created by CVM include the following:-

- valuation can reflect use as well as non-use values;
- CVM focuses on ex-ante valuation;
- direct estimation of willingness to pay;
- experimental approach allows for valuation of a variety of different environmental goods.

CVM values will reflect total value rather than use value only. In this way it is possible to obtain a comprehensive measure for the value associated with a specific environmental good. The focus on ex-ante valuation provides a useful input to decision making processes where concern is about a potential policy change; this should be contrasted to travel cost and hedonic pricing methods where the values in general are derived on an ex-post basis. Direct estimation of willingness to pay can provide useful information about the values for a specific environmental good within a sample of a given population being derived from the active involvement of the respondents. The experimental approach in CVM extends the valuation of environmental goods which cannot be assessed through indirect valuation methods. However, this is subject to the valuation task relating to a well-perceived situation or experience.

O'Doherty (1996) have identified the following problems:-

- large difference between willingness to pay and willingness to accept measures;
- controlling the validity and reliability of estimates;
- strategic behavior in responses;
- hypothetical nature of survey;
- survey design related issues;

An often cited problem in relation to CVM is large differences between willingness to pay (WTP) and willingness to accept (WTA). In standard situations WTP is lower than WTA, although the

difference should be small provided the income effects are small. Diamond and Hausman (1993) argue that the income effects in relation to CVM studies can be expected to be small due to the money values involved and the fact that CVM surveys have indicated that obtained WTP's do not increase in proportion to income. The response from CVM proponents have mainly approached this problem by arguing that environmental goods contain use as well as non use values (including existence values). This could imply inflated WTA values while WTP values could in theory be elicited correctly. Furthermore, it can be argued that the value function for losses is steeper than for gains, thereby providing for a difference between WTA and WTP. Finally, it should be noted that market prices are the result of repeated valuations while CVM often represents one-off valuations; this could provide the basis for caution in the evaluation phase.

The validity of CVM values is difficult to determine given that the true WTP is often unknown. If the true WTP was known there would no reason to undertake a CVM study. The best approach is to examine carefully the questionnaire design in order to ensure that the questions are clear and reflect the situation to be examined. Furthermore, indications about the validity of CVM values can be provided through comparisons to the values obtained from other methods. e.g. revealed preference and hedonic pricing methods. The lack of information about the true WTP is also a problem in relation to controlling the reliability of the obtained CVM values. Indications about reliability can be obtained through undertaking a given CVM study at different points in time, the so-called test-retest situation. This can provide information about the extent to which similar CVM values are obtained given no change in other conditions.

The structure of CVM surveys can lead to strategic behavior among the respondents. For example, if the respondents perceive that the environmental good is likely to be provided irrespective of the stated preferences then there could be incentives to free-riding implying lower WTP's. On the other

hand if respondents perceive that the provision of the good is contingent on the stated preferences combined with the impression that eventual payment is a fixed amount then that could lead to overstating the true preferences. O'Doherty (1996) argues that carefully survey design can minimize the extent to which strategic behavior occurs. For example, free-riding can be eliminated by ensuring that the participants do not have the impression that the good in focus will be provided irrespective of the stated preferences.

The hypothetical character of CVM could lead to problems if the respondents have difficulties in coping with such a survey. It could lead to irresponsible behavior giving too high or too low values because of uncertainty concerning the good in question and because the hypothetical character could be perceived as implying that responses given have no consequences. To a large extent this problem can be limited through appropriate survey design and using CVM in relation to situations/experiences which are familiar and well-perceived.

It should be noticed that improving a CVM study is not done through provision of more information only, of importance is how the information is perceived by the participants.

The format used to elicit preferences can induce biases in the stated values. For example, the iterative bidding games can involve a so-called starting point bias due to the choice of a specific starting value for the WTP's. On the other hand the open-ended format can result in a large number of zero values along with very large values. Therefore, the selection of the format for eliciting preferences is important in order to minimize the presence of biases.

#### **4.2 Welfare measures to value public Goods**

The indirect utility function and the expenditure function provide the theoretical structure for welfare estimation. For stated preference approaches, one needs the changes in these functions. Timothy et.al (2002).

If we let  $\mu(x, q)$  be the individual preference function, where  $x = x_1 \dots x_m$  is the vector of private goods, and  $q = q_1 \dots q_n$  is the vector of public goods, which may also be characteristics of private goods.

The  $x$  are assumed available at parametric prices,  $p_1 \dots p_m = p$ , which may or may not be market determined. The individual maximizes utility subject to income  $y$ . The indirect utility function is given by:-

$$V(p, q, y) = \max_x \{u(x, q) / p \cdot x = y\} \dots \dots \dots (1)$$

The minimum expenditure function  $m(p, q, u)$  becomes

$$m(p, q, u) = \min_x \{p \cdot x / u(x, q) \geq u\} \dots \dots \dots (2)$$

There are two equally valid ways of describing money welfare measures:- one is with the ideas of compensating and equivalent variation and the other is with the ideas of willingness to pay and willingness to accept. They measure the increment in income that makes a person indifferent to an exogenous change, where the change might be price, quality or a change in some public good.

Willingness to Pay (WTP) is the maximum amount of income a person will pay in exchange for an improvement in circumstances or the maximum amount a person will pay to avoid a decline in circumstances. Willingness to accept (WTA) is the minimum amount of income a person will accept for a decline in circumstances, or the minimum a person will accept to forego an improvement in circumstances. Compensating variation (CV) is the amount of income paid or received that leaves the person at the initial level of well-being, and equivalent variation is (EV) the amount of income paid or received that leaves the person at the final level of well-being. WTP and WTA relate to the right to a utility level when one is required to pay to maintain current well-being or achieve a higher well-being, the right to that level of well-being lies elsewhere.

When one must be paid to accept a worse situation, the right to the current level of well-being adheres to the individual who accepts payment. EV and CV rely on the initial versus final well-being for their distinction. When the final well-being is worse than the initial well-being, it's WTA but when the final well-being is better than the initial well-being, it is WTP. EV is the opposite it is WTA for situations where well-being is improved and WTP when well-being declines. (ibid)

For an individual, WTP is the amount of income that compensates for (or is equivalent to) an increase in the public good:

$$V(p, q^1, y - WTP) = V(p, q^0, y) \dots \dots \dots (3)$$

When  $q^1 > q^0$  and increases in  $q$  are desirable i.e. the change in indirect utility  $V$  for unit changes in  $q$  is an improvement. It's the marginal value of change in  $q$ .

$$\frac{\partial V}{\partial q} > 0 \dots \dots \dots (4)$$

The changes in price  $P$  can be valued by evaluating the indirect utility function at a new price vector  $P^*$  and also with the expenditure function as follows.

$$WTP = m(p, q^0, u) - m(p, q^1, u) \dots \dots \dots (5)$$

When  $u = V(p, q, y)$  and assuming no change,  $y = m(p, q, \mu)$  WTP is the amount of income an individual would give up to make him indifferent between the original state: income at  $y$  and public good at  $q^0$  and the improved state  $q^1$ : income is reduced to  $y - WTP$  and public good is increased to  $q^1$ . The WTP for a decline in price can be defined as:-

$$WTP = m(p^0, q, u) - m(p^1, q, u) \dots \dots \dots (6)$$

when  $u = V(p, q, y)$  the WTA is the change in income that makes an individual indifferent between two situations the original public good  $q^0$ , but income at  $y + WTA$  and the new level of public good or environmental improvement,  $q^1$ , but income at  $y$ . It is given as follows:-

$$V(p, q^0, y + WTA) = V(p, q^1, y) \dots \dots \dots (7)$$

Using the expenditure function:-

$$WTA = m(p, q^0, u^*) - m(p, q^1, u^*) \dots \dots \dots (8)$$

When  $u^* = V(p, q^1, y)$ . By this definition,  $WTA \geq 0$  when  $q^1 \geq q^0$ .

## **5. Methodology of the study and model specification**

### **5.1 Survey Methodology**

#### **5.1.1 Survey Delineation**

Addis Ababa is a large town within the administrative boundary of region 14. The region has an estimated total population of about 4 – 5 million. The city has 10 sub-cities with ever increasing population and housing problems. The region administration has set a plan to solve housing problems of the city by constructing common building residences.

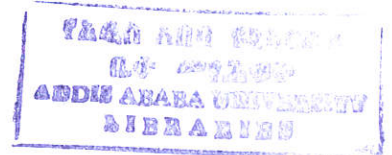
Most of the buildings are either under construction or partly resided while a very few of them are completely resided (Addis Ababa Housing Agency). The survey has considered three sites, namely the Gergi (Bole sub-city), Gulele and Addis Ketema sites. Each with a total population of 250, 45, 150 respectively. These sites are selected based on their being resided for at least a year and their being provided with solid wastes service by private service providers.

#### **5.1.2 Survey questions & techniques**

A pilot survey is undertaken to elicit information on the current solid waste service, type of the service, current payment amount and frequency of the service. Besides, starting bid value is elicited through open-ended questioner format.

Based on the gathered information from the pilot survey the main survey is modified with regards to the elements of the status quo, the improvement and socio-economic questions. The followings are major parts of the questioner in the main survey.

- Part
- I. Current SWM of the residences
  - II. Environmental concern & attitudes of respondent
  - III. WTP questions for improved SWM
  - IV. Socio-economic back ground of the respondent



The explanatory variables used in the survey include the starting bid, the socio-economic variables and personal motives.

The main survey employed contingent valuation method (CVM) with a single bound dichotomous choice elicitation format followed by an open-ended question for the valuation part.

A proportional random sampling method is used to sample from the selected sites. Heads of households who have lived for a minimum of 1 year and are currently receiving solid waste service by private service providers are interviewed.

### **5.1.3 Selecting & training enumerators**

The enumerators were chosen on the basis of their academics, their experience on survey related issues, loyalty and diligence. This made the training so smooth and easily communicable and took 1 ½ hrs for elaboration. Most of the discussions focus on the WTP questions in the questionnaire valuation part.

### **5.2 Definition of variables and hypotheses**

This study considered some used socio-economic variables as a major determinants of individual demand (WTP). Moreover, motivations including altruistic ones are added for assessing the WTP for improved SWM.

#### **Socio-Economic explanatories**

##### **Monthly income of the head of the household (Income)**

The monthly income of the head of the household is considered as income. It's believed that the level of individual's income is positively related to his/her WTP for environmental improvement.

### Life expectancy of head of household (Life expec\*)

The most significant variable of the study which is employed to test the existence of strong altruism. It takes the number of years of the head is expected to live. A positive slope explains absence of strong forms of altruism (i.e.:- the head cares not only for current generation). The relationship between life expectancy and age is linear Popp. D (2001). Thus an alternative interpretation of life expectancy coefficient is that differences in environmental preferences among age cohorts. Rather than altruism, insignificance of the life expectancy variable (negative correlation) could simply mean that older generations have greater desire for environmental quality. Age of the respondent was converted in to life expectancy using data from Addis Ababa charts.

### Starting Bid (Bi)

In the absence of starting bid bias Bi is expected to have a negative relationship with the WTP for improved SWM.

### Motivational Factor (Variables)

#### Location of the Condominium Site (Locashn)

Locshn is a dummy variable taking 1 if the condominium site is close to a highway, 0 otherwise. The study believes that proxy to a highway positively motivates people concern for their surrounding giving rise to positive relationship toward SWM improvement.

#### Resident of Condominium (Cond)

Condominium

Cond takes 1 if the respondent believes that living in common buildings motivates for WTP for SWM and 0 otherwise. The variable helps to check whether better housing conditions motivate people to ease SWM and is one of the most relevant variables in the study.

\*Life expec: - implies the number of years an head of household individual is expected to live. It is given by taking by  $LE_i = 48.4 - 0.87Ag_i$  where LE= life expectancy Ag= age of head of household

### **Frequency of Solid Waste Service per week (Freque)**

Freque is a dummy used to examine whether the frequency of solid waste service per week affects their WTP. It takes 1 if the service per week is 1 and 0, otherwise.

### **Type Solid Waste Service (Tsws)**

SWS takes 1 if the respondent opts for recycling & separation of wastes and 0 otherwise. The type of SWS may motivate people to demand more of the service if the service qualifies their preference. Hence may have positive impact on WTP.

### **Status of Current Solid Waste Service (Csws)**

CSWS takes 1 if the respondent is happy with the current SW service, 0 otherwise. The variable is expected to have a positive relationship with the WTP for the improved SWM.

### **Current pay for Solid Waste Service (Cpay)**

Cpay is a dummy which takes 1 if the current pay for the service is expensive and 0, otherwise.

### **Intergenerational Motives (Interg)**

Interg is used as an explanatory variable to examine whether people attach altruistic value to environmental improvement or otherwise. The variable takes 1 for future generation, 0 otherwise.

## **5.3 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 heads of household

for the proposed improvement in solid waste management. The other model used in the study is a probit model which is employed to compute the mean and median WTP for improved for SWM.

**5.4 The Tobit Model**

From a sample 160 heads of households were analyzed. There were 2 protests zeros 2 incomplete responses and 13 zero responses. The protests and incomplete responses are canceled from the sample. Moreover, 26 respondents who are not heads are excluded. The formulation of the Tobit model (censoring) looks as follows:-

$$MWTP^* = \beta_0 + \beta_1 \chi_i + \varepsilon_i, \text{ with } \varepsilon_i \sim N(0, \sigma^2) \dots\dots\dots 9$$

$$MWTP = 0 \text{ if } MWTP^* \leq 0 \dots\dots\dots$$

$$MWTP = MWTP^* \text{ if } MWTP^* > 0 \dots\dots\dots$$

Where  $MWTP_i$  = Maximum Willingness to pay for improved SWM

$\chi_i$  = Vector of explanatory variables

$\beta^1$  = Vector of Coefficients

$\varepsilon_i$  = The disturbance term

The Tobit model for this particular study is as follows

$$MWTP^* = \beta_0 + \beta_1 S + \beta_{12} M + \varepsilon_i \dots\dots\dots 10$$

With  $\varepsilon \sim N(0, \sigma^2)$  where all the socio – economic variables are represented by S and the motivational factors by M.

**5.5 The Probit model**

The study assumes that individual gains utility from SWM improvement and program observable characteristics that may affect individual's preferences for the SWM improvement programs are

included the socioeconomic variables and the personal motivations are represented by S and M respectively

If we consider two possible levels of SWM the status quo of no improvement, represented by SWM<sub>0</sub>, and a specific level of improvement SWM<sub>1</sub>, then if the individual remains at the status quo of no improvement, his utility function can be written as:-

$$U_0 = U(SWM_0, Y; S, M) \dots\dots\dots (1.2)$$

and if the individual undertakes SWM improvement, his utility function is

$$U_1 = U(SWM_1, Y; S, M) \dots\dots\dots (2.2)$$

Since U<sub>0</sub> and U<sub>1</sub> are essentially random variables as (Hanemann 1999) argues their mean utilities are respectively V(SWM<sub>0</sub>, Y; S, M) and V(SWM<sub>1</sub>, Y; S, M). Equations a and b can then be written as

$$U(SWM_0, Y; S, M) = V(SWM_0, Y; S, M) + E_0 \dots\dots\dots (3.2)$$

and  $U(SWM_1, Y; S, M) = V(SWM_1, Y; S, M) + E_1 \dots\dots\dots (4.2)$

where the random error terms E<sub>0</sub> and E<sub>1</sub> are assumed to be independently and identically distributed with zero means.

The individual is faced with a choice whether to maintain the status quo of no improvement, SWM<sub>0</sub>, at zero cost or to undertake the improvement, SWM<sub>1</sub> at a bid of B. The individual will choose to undertake SWM<sub>1</sub> at bid of B if,

$$V(SWM_1, Y-B, S, M) + E_1 > V(SWM_0, Y; S, M) + E_0 \dots\dots\dots (5.2)$$

Otherwise, the individual chooses to remain at the status quo SWM<sub>0</sub>. We can only view the individual's response as a random variable with a probability distribution given by;

$$P_1 = P_r(\text{accepts SWM}_1) = P_r\{V(SWM_1, Y-B; S, M) + E_1 > V(SWM_0, Y; S, M) + E_0\}$$

$$= P_r\{V(SWM_1, Y-B; S, M) - V(SWM_0, Y; S, M) > E_0 - E_1\}$$

$$P_0 = P_r(\text{Rejects SWM}_1) = 1 - P_1$$

Let us define  $\eta \equiv E_0 - E_1$  and let  $F_\eta(\cdot)$  be the cumulative distribution function of  $\eta$ . Then, the probability that the individual is willing to pay for the improvement is

$$P_1 = F_\eta(\Delta V) \dots \dots \dots (6.2)$$

where  $\Delta V \equiv V(\text{SWM}_1(Y-B), S, M) - V(\text{SWM}_0, Y; S, M)$

In the probit model  $F_\eta(\cdot)$  is the normal cumulative distribution function. If we define the unobservable heads' actual WTP for improved SWM service as  $P_i$ , which has a linear relationship with the initial bid,  $B_i$  and the covariates then, the actual WTP for an individual WTP can be expressed as follows:-

$$\text{WTP}_i = 1 \text{ if } P_i \geq B_i \dots \dots \dots (7.2)$$

$$\text{WTP}_i = 0 \text{ if } P_i < B_i \dots \dots \dots (8.2)$$

With a closed-ended or dichotomous choice CV question format, the probability of yes/no answer can be modeled as follows:-

$$P_r(\text{yes to } B_i) = P_r\{P_i \geq B_i\} \dots \dots \dots (9.2)$$

$$P_r(\text{No to } B_i) = P_r\{P_i < B_i\} \dots \dots \dots (10.2)$$

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

$$\begin{aligned} \ln L^s(\theta) &= \sum_{i=1}^N \{d_i^y \ln \Pi^y(B_i) + d_i^n \ln \Pi^{\wedge}(B_i)\} \\ &= \sum_{i=1}^N \{d_i^y \ln[1 - G(B_i; \theta)] + d_i^n \ln G(B_i; \theta)\} \dots \dots \dots (11.2) \end{aligned}$$

Where  $G(B_i; \theta)$  and  $1 - G(B_i; \theta)$  the cumulative distribution function (Cdf) for the probability of yes and no.  $d_i^y$  and  $d_i^n$  are one if the response are yes and 0 if otherwise,  $\theta$  represents vector of parameters that index the distribution of WTP.

## 6. Empirical Results of Analysis

### 6.1 Socio-economic characteristics and Motivations of survey households

#### 6.1.1 Socio-economic characteristics of survey households

##### i. Gender and Age

The WTP for improved SWM in both sexes is lesser than those who opt for the current. A gender wise comparison reveals that males who pay for improvement are slightly below four fold of their female counterparts.

The magnitude for improved SWM is in consistent with age. The implication of less WTP for SWM improvements by older generations might have low altruistic value to future generations. The mean age of the heads households is 42 years of old.

**Table -1- Socio-economic profile and WTP for SWM improvement**

Socio economic profile	Environmental conditions			
		Current SWM	Improved SWM	% agreed for SWM improv't
Gender	Male	27	62	47.69 %
	Female	25	16	12.30 %
Age	20-35	16	14	10.76 %
	36-45	24	44	33.84 %
	above 45	10	22	16.92 %
Income	0-800	34	23	17.69 %
	801-1600	13	18	13.84 %
	above 1600	6	36	27.69 %
Education	Primary	20	12	9.23 %
	Secondary	15	12	9.23 %
	Tertiary	15	56	43.07 %
Employment	Unemployed	16	5	3.84 %
	Employed	32	77	59.23 %
Family size	≤ 2	11	17	13.07 %
	2 – 5	23	50	38.46 %
	> 5	12	17	13.07 %

## **ii. Income, Education and Employment**

The general consensus is that income rises with the level of education. This also ensures better awareness and concern for the environment. Though the higher income brackets constitute the lion share for the improvement (28%), the middle income groups (801 – 1600) have a lesser share (14%) than the low income groups (0 – 800) who prefer the improvement are above the mean income 1305 ETB.

Education being one of the major determinants has shown direct proportionality with SWM improvement. The average education level being High school (11 years) in the survey heads, 88.12% of the respondents constitute those opted for the improvement belong to the secondary and territory level of education.

As one expects the WTP for improvement declines with the level of unemployment as numerically displayed in table 1. The employed heads who chose for improvement are twice those who prefer the current situation.

## **iii. Family size and Marital status**

Those who are married are likely to have large family size than the unmarried ones. Households in the survey area have 4 people per household on average. Those with 2 – 5 people per household share 38.46% of the total households who chose for SWM improvement. This result indicates that large families care for solid wastes management since they generate more wastes.

## **iv. Starting bid values**

The frequency of responses for yes (WTP) decline with an increase in the initial bids. The frequency of the lowest initial bids exceed the highest by 34.94% with a range of 15 ETB. The mean of the starting bids is 12.63 ETB.

**Table -2- Frequency of response for offered bids**

Responses	Initial Bids			
	5	10	15	20
Yes	23	17	14	11
No	10	12	25	18
Percentage Yes	71.05	63.15	36.36	36.11

### **6.1.2 Motivational Characteristics of the Respondents**

65.38% of the heads believe that being common building resident favour for Solid Waste Management. 83.07% of the respondents are satisfied with the current solid waste service (CSWS) provision while 83.07% of the interviewed preferred a monthly payment system (PAYM). With regards to the type of SWS (TSWS) opted for recycling and separation while the rest chose collection and disposal. In examining their tendency for either inter personal or intergenerational motives, half of the heads inclined to SWM training for adults rather than children with (5 – 10) years of age.

**Table -3- Frequency of personal motivations used for examining peoples' preferences**

Motives	Responses	
	X	Y
Cond	85	45
Tsws	61	69
Csws	108	22
PAYmeans	108	22
Interg	68	62

**Cond<sub>x</sub>**: - who think common building residences ease SW problem COND<sub>y</sub> otherwise.

**Tsws<sub>x</sub>**: - preferred for recycling of SW, TSWS<sub>y</sub> preferred collection & disposal.

**Csws<sub>x</sub>**: - happy with the current SW service CSWS<sub>y</sub> otherwise.

**PAYmeans<sub>x</sub>**: - prefer monthly payment for improved SW service PAYmeans<sub>y</sub> otherwise.

**Interg<sub>x</sub>**: - support child training for SWM, Interg support adult training for SWM.

## **6.2 Estimation of Benefits for WTP for SWM**

### **6.2.1 Average and Aggregated Benefit Measured by Site**

The mean WTP from probit estimate using SBDC\* format is used to aggregate the benefits by site. The mean WTP was found to be 13.53ETB. The total WTP for the improved SWM in ETB is 81360.62 per year.

***Table -4- Average and aggregate benefit using mean of probit estimate***

<b>Sites</b>	<b>Population size</b>	<b>Mean WTP for improved SWM (ETB)</b>	<b>Total WTP for improved SWM (ETB)/Month</b>
Gulele	150	13.53	2029.50
Addis Ketema	45	13.53	608.85
Bole Gergji	<u>250</u>	13.53	<u>3375.00</u>
Total	<u>445</u>		<u>6013.35</u>

### **6.2.2 Total Willingness to pay Estimates for improved SWM**

The current estimated number of households in Condominium residences is about 2525. Prior to aggregation of benefits class boundaries for the results of the open ended questions are set. The mean of the class boundaries is used as a class mark for the WTP responses. The two columns under the sample distribution show the number and percentage of sample households. Whose maximum WTP for the respective intervals.

The total WTP for each class is the product of the total number of households and the class mark for WTP for each class.

\* Single-bound dichotomous choice

**Table -5- Total WTP estimate for improved SWM in Condominium Residences**

Class bound for WTP	Class mark for WTP	sample Dist <sup>n</sup>		Total No. of HHs	Total WTP
		No	%		
0 – 2	1	27	20.76	524	524
3 – 5	4	22	16.92	427	1708
6 – 8	7	17	13.07	330	2310
9 – 11	10	9	6.92	174	1740
12 – 14	13	22	16.92	427	5551
15 – 17	16	12	9.23	233	3728
18 – 20	19	9	6.92	174	3306
21 – 23	22	8	6.15	155	3410
24 – 26	25	2	1.54	39	1975
27 – 29	28	1	0.76	19	532
30 – 32	31	<u>1</u>	<u>0.76</u>	<u>19</u>	<u>589</u>
Total		<u>130</u>	<u>100</u>	<u>2525*</u>	<u>25373</u>

\* Sum of the common building residences from 10 sub – cities when survey is undertaken

### **6.3 Tobit Model: - Results and Discussion**

#### **Income of the head**

The variable has a positive impact on the willingness to pay amount as expected and is significant at 1%. 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 changes for provision of the service should take into account ability of the users in addition to their willingness to pay.

### **Starting Bid (Bi)**

The variable has a negative sign as expected showing that there is an inverse relationship between willingness to pay for improved SWM starting bid. This could be due to the simple law of demand. It's also insignificant at 1%.

### **Resident of Condominium (Cond)**

The dummy variable is found significant at 1%. This could be due to the fact that common building residents may motivate people to manage their solid waste around their premises.

### **Current Solid Waste Service (Csws)**

This dummy is found significant at 5% as the status of current solid waste service program. Being positive imply that people are willing to pay less as their current status of solid waste service deteriorates.

### **Location of the Condominium Site (Locashn)**

Common building residences built close to High ways are found to motivate house holds to care for their surroundings SWM than those near to feeder roads. However, the dummy variable is insignificant at 1% with positive sign implying direct relationship with WTP.

### **Frequency of the service (Freque)**

The sign of Freque is similar to the expected in that the WTP for improved SWM is directly related to the frequency of service provision. This implies that more frequent services per week increase people demand to pay. The variable is found insignificant.

### **Current payment (Cpay)**

Though found insignificant in determining WTP, it implied an inverse relationship with WTP. This is indicative of the fact that higher prices.

### **Life expectancy (Life exp)**

Life expectancy is found to insignificant in determining the WTP of the heads for improved SWM.

### **Intergenerational motives (Interg)**

Though the variable is insignificant in determining their WTP. The sign being negative implied the concern the heads have for old (current) generation than the young ones.

### **Type of solid waste service (Tsws)**

Even if positive relationship is registered, the Tsws failed to be determinant for WTP for improved SWM. It may be due to lack of awareness with regards to the various forms of SWM.

**Table -6- Maximum Likelihood Estimates for the Determinates of WTP (Tobit Model)**

Expl Var	Coefficient	Marg. Effect	Standard error
Constant	-0.335	-0.172	0.149
Income	0.334	0.965	0.218***
Cond	0.618	0.200	0.610***
Tsws	-0.880	-0.143	0.576
Interg	-0.297	-0.677	0.508
Csws	-0.408	-0.686	0.504**
Lifeexp	-0.340	-0.639	0.339
LoCashn	0.346	0.291	0.729
Freque	-0.831	0.215	0.891
Cpay	-0.127	-0.152	0.101
Bi	-0.147	-0.156	0.526

Source:- Own survey, 2007\*\*\* significant at 1%;\*\* significant at 5%;\* significant at 10%. The Stand. errors are for marg. effects.

#### 6.4 Probit Model: Results and discussion

Some variables are found to affect the probability of positive WTP for improved SWM. These include TSWS, Locash, Lifeexp Income and initial bid.

**Table -7- Variables which affect the probability WTP for improved SWM**

Variables	coefficient	marginal effect	standard * error	P[ z >z] P-value
Income	0.249	0.992	0.522	0.0298**
Cond	0.229	0.909	0.114	0.4180
Tsws	0.620	0.220	0.111	0.0429**
Life exp	0.615	0.245	0.730	0.0007***
Lo cash	0.724	0.282	0.121	0.088***
Freque	0.156	0.621	0.121	0.596
Csws	0.620	0.244	0.110	0.028**
Bi	-0.115	-0.460	0.115	0.0000***
Cpay	-0.368	-0.147	0.140	0.9907
Interg	-0.218	-0.865	0.115	0.4509

\*\*\* L% level of significance \*\*at 5%

\*The standard errors are for marginal effect

Of the list of variables **Cond** (Common building residences) was expected to be significant for WTP for SWM. However, the study thinks that the time of stay in the residences may be too small to make them care for their SWM. But it implied a direct relationship with their WTP.

The type of solid waste service **Tsws** influenced people's demand for the improvement. This may show awareness with regards to some forms of waste services like separation and recycling though positive relationship is registered.

As people are happy with the current SWS being provided (**Csws**) they would prefer to have better forms of services according to utility theory. As a result, the expectation is realized. I guess that they are not satisfied with the current service provision. (Status quo).

There was no previous expectation whether or not the number of SWS per week (**Freque**) influences WTP for improved SWM. Though found to be insignificant, it came out with the expected sign.

However, Life expectancy & Location are major determinants for the probability of positive WTP at 1% of significance. The former implies people's concern for altruistic values while the latter indicates the relevance of site location (residence being close or away from High way) affect the probability of yes to the initial bid by 6.14 and 7.24 respectively.

The theory suggests that the margin of Life expectancy (**Lifeexp**) will either be positive or insignificantly different from 0. (P. David 2001). The result confirms this (6.14). Hence we reject the null hypothesis which assumes the presence of strong altruism. So in this particular research head's of households in common building residences never attach altruistic value in their WTP for improved SWM for future generations.

Location of the sites (**Locash**) i.e.:- being close to or away from a Highway is found positive and significant. It implied that people living closer to a Highway are motivated to manage their solid wastes while those with a feeder road are less willing to do so.

Moreover, at a level of 5% of significance income of house hold head's is found to influence their WTP for improved SWM with a probability of 9.91 other variables being constant.

Current payment for SW Service (**Cpay**) is the only insignificant variable at 10% with a negative coefficient though it has shown that people base current market prices in their demand (WTP) for

improved SWM inversely. The initial bid (**Bi**) offered is found to be extremely significant in determining WTP for the improvement at 1% of significance level. It has also shown absence of starting point bias as its coefficient is negative.

More interestingly, the Altruistic motives (**Interg**) is significant at 10% of significance. Besides, negative coefficient implied that heads of house holds do care for training of adults (current generation) rather than (children) which may imply (intergenerational) altruism. This finding together with that of the empirical test for the existence of either strong or weak altruism through life expectancy has proved that house hold heads in common buildings residences of Addis Ababa seem to care for personal form of altruism.

#### **Mean estimation for WTP:**

To avoid fat-fail problem i.e.:- overestimation of mean WTP, the WTP is truncated by the highest bid from upper limit. (Mitchell 2001). The Mean WTP for improved SWM in common building residences in Addis Ababa equals ETB-13.53\*.

#### **Test statistics:**

The log-likelihood Ratio Test (LRT) is carried out to see the overall significance of the parameter estimates and check heteroscedasticity problem. It was shown that all the parameter estimates are simultaneously significant and heteroscedasticity is a problem.

Moreover, the log-likelihood Ratio Index (LRI) for goodness of fit test came out with inconclusive result for both estimates (Tobit and Probit)

\* Computational steps are revealed in the appendix

\* Calculated as the ratio of coefficient of constant term to the coefficient of the bid see appendix I

\*\* Rounded to 2 significant digit.

## **Summary, conclusion and policy implications of the study**

### **7.1 Summary**

The ever increasing demand for housing by urban population parallelly demands the case for sustainable SWM. Most researches done in this line have focused on testing the significance of socio-economic factors. Unlike these papers, this particular study has emphasized on personal motives in addition to some selected socio-economic factors.

The paper empirically tested the existence of Altruism through Life expectancy and also considered a proxy dummy Interg, which takes 1 for future generation and 0 for old (current generation) one. Moreover, personal motivations such as the frequency of the service per week (freque), current solid waste service (CSWS), current payment amount (Cpay), type of solid waste services (TSWS) and resident of common building residences (COND) were tested.

Sites from three sub-cities were selected namely Gergi (from Bole sub city) Addis Ketema (from Addis Ketema sub-city) and Gulele (from Gulele sub-city). These sites have a total population of 445 which share 17.8% of the currently living in the same housing facility in Addis Ababa. The main survey enabled to elicit information with regards to the current waste management, socio-economic behavior of the respondent and their WTP for improved SWM. This was possible through CVM, which offered heads of households with a hypothecs choice format followed by an open-ended question inquiring their maximum WTP.

A descriptive analysis of the survey indicate when the variables income, education, employment and family size rise in magnitude the head's WTP for better environmental quality increases .59.23% of the employed and 52.30% of the total educated (sum of secondary and tertiary) have chosen for improved for SWM. 38.46% who preferred the improvement have 2 – 5 household members.

Males have shown numerical dominance in their WTP for the improvement registering 47.69%.

The tobit model employed identified three explanatory factors that determine WTP, for improved SWM. These include income, resident of condominium and current solid waste service

The significant variables that determine the probability of positive WTP for improved SWM include the starting bid, Life expectancy and Location which are significant at 1% level of significance. Income, Tsws and Csws are found significant at 5% . Of the variables used as regressors starting bid and Interg have inverse relationship with WTP.

## **7.2 Conclusion**

The study enable to identify some motives that determine the amount of WTP for improved SWM in common building residence. As a result the motives Cond (being resident of common builds) and Csws (current solid waste service) have determined the WTP for improved SWM . Besides the socio-economic variable income is found significant in determining the amount of heads WTP for improved SWM. Unlike the tobit model, the probit model proved the significance of life expectancy of the heads for the probability of positive WTP.

If the coefficient of Life expectancy is significant we need to test for the presence of weak forms of altruism (Popp. D). So the study recommends further research to be carried out to test the existences of weak forms of altruism. i.e.: - a test for neither strong altruism nor pure self-interest holds.

## **7.3 Policy implications of the study**

Households wastes register the lion share of the total solid wastes generated in Addis Ababa. This requires an improved and continuous form of SWM. However, activities towards SWM are largely

carried out during special events or occasions. These actions demand the investigation of people motives in managing solid wastes.

Being resident of common building residences motivated household heads' WTP for improved SWM in the Survey areas. This may imply the role of infrastructural facilities in general and common building residences in particular in managing Solid Wastes in cities. Besides, due consideration be given to current Solid Waste Services by private solid waste service providers.

Life expectancy being a function of WTP suggest that people lack intergenerational altruism in the valuation of environmental amenities. So this requires government intervention in educating older generations with regards to the benefits of sustainable environment for future generations.

Besides, the design for improved SWM should incorporate the most significant economic element namely peoples monthly income as people's income increases their preference for safe and healthier environment also rises. As a result, the government should help low income groups by enabling them care for their environment. This may be through the provision of solid waste management facilities.

## **CONTINGENT VALUATION SURVEY HEADS 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 factors that influence the willingness to pay for an improved SWM in Common Building Residences in Addis Ababa.

The findings of this study may help to consider better housing conditions and motives behind people's demand for improved SWM in the Cities.

The information collected from the Survey will be kept confidential and name and personal information of the respondent will never be disclosed.

## QUESTIONNAIRE

Name of the interviewer: \_\_\_\_\_

Date of the Interview: \_\_\_\_\_

Time of the interview: From \_\_\_\_\_ to \_\_\_\_\_

The following four 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 (SWM)

1. How does your household dispose solid wastes?

\_\_\_\_\_

2. Is the solid waste collected from your house?

A. Yes

B. No

2.1 If "yes" which institution provides you the service? \_\_\_\_\_

2.2 How often do you get the service per week? \_\_\_\_\_

2.3 How much do you pay for the service per month? \_\_\_\_\_

3. Who is responsible in managing solid waste service in you household? \_\_\_\_\_

4. What do you do with items like (glasses, paper, plastics . . . )?

\_\_\_\_\_

5. How do you dispose used plastic bags?

\_\_\_\_\_

6. Rank your preferences of services in Solid Waste Managements

A. Recycling of solid wastes & separation of decayables from non-decayable ones

B. Solid waste collection service and disposal service

7. Are you concerned with environmental issues in your vicinity?

A. Yes

B. No

7.1 Why? \_\_\_\_\_

8. Does the location of your site affect your SWM?

A. Yes

B. No

How/why? \_\_\_\_\_

**SECTION 2. HEADS OF HOUSEHOLDS DEMAND AND AWARENESS FOR IMPROVED SOLID WASTE MANAGEMENT (SWM)**

9. What happens to solid waste disposes in open spaces and ditches in your surrounding?

\_\_\_\_\_

10. What do you suggest for currently used public Garbage Cans?

\_\_\_\_\_

11. Are you happy with the current SWM in your area?

A. Yes (go to 13)

B. No (go to 12)

12. What do you recommend for the SWM improvement?

\_\_\_\_\_

13. Can you tell us the environmental impacts of inappropriate solid wastes in your surrounding?

\_\_\_\_\_

14. Which body do you think is responsible for SWM in your area?

A. Government officials

B. The community

C. Polluters

D. All

E. If others specify \_\_\_\_\_

15. If local agencies want to provide a solid waste management service free of charge, which of the following services do you prefer?
- A. Collection of solid wastes from houses
  - B. Recycling solid wastes (recyclable solid wastes)
  - C. Proper disposal of solid wastes
  - D. Separation of decayable from non-decayable solid wastes

15.1 Please specify your reasons for Q – 14

---

15.2 If a local SW service provider intends to train your community, which segment of your community do you favor to have this opportunity?

- A. Young ones
- B. The old ones

Why \_\_\_\_\_ ?

16. Which bodies do you prefer for solid waste services?

- A. The Government
- B. The private sector
- C. The civil society
- D. If others specify \_\_\_\_\_

16.1 Please specify your reasons for Q – 16

---

17. Which of the following solid waste activities are you willing to voluntarily do for your community?

- A. Separation of decayable from non decayable solid wastes
- B. Recycling of solid wastes
- C. Collection of solid wastes

D. Paying a monthly fee accepted by the community

E. I am not willing to pay any thing (go to 17.1)

F. If others specify \_\_\_\_\_

17.1 Why? \_\_\_\_\_

18. Are you willing to separate your kitchen wastes from those recyclable one?

A. Yes

B. No

19. Do you think that being a Condominium resident solves solid waste management problem?

A. Yes

B. No

19.1 Why? \_\_\_\_\_

**SECTION -3- THE CONTINGENT VALUATION FOR HOUSEHOLD'S HEAD FOR IMPROVED  
SOLID WASTE MANAGEMENT (SWM)**

A private local solid waste service provider intends to improve the SWM in your area through the following provisions.

1. Collection of solid wastes from your compounds and ditches 3 times per week.
2. Install small solid waste cans in your vicinity to avoid ditches blockades and on proper disposals of solid wastes.
3. Prepares natural fertilizers from decayable wastes for horticulturalists in the city and supplies used plastic bags for recycling firms.
4. Provides practical trainings with respect to SWM for children and the youth and follow up their behavior.

20. Are you willing to pay for the improved SWM?

A. Yes (go to 21)

B. No (go to 23)



#### SECTION 4: SOCIO-ECONOMIC PROFILE OF THE HEAD OF THE HOUSEHOLD

27. Name of the Head \_\_\_\_\_
28. Address:  
Sub-city of the head \_\_\_\_\_  
Wereda \_\_\_\_\_ Kebele \_\_\_\_\_ House No. \_\_\_\_\_
29. The Gender of the Head  
A. Male                      B. Female
30. Age of the Head \_\_\_\_\_
31. Marital status of the Head  
A. Single                      B. Married
32. Family size of the Head \_\_\_\_\_  
Adult \_\_\_\_\_ Below 15 \_\_\_\_\_
33. Academic level of the Head \_\_\_\_\_  
A. Primary (1-8)              B. Secondary (9-12)              C. Tertiary (12 and above)
34. Occupation of the Head  
A. Government employee  
B. Self employee  
C. Private employee  
D. Currently unemployed
35. Monthly income of the Head \_\_\_\_\_ (ETB)



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### Appendix I

Computation of the Mean WTP for improved SWM in the common building residences of Addis Ababa using a LIMDEP software package gave the following:-

L1hs=p; rhs=one, bi\$

variable	coefficient	standard error	P-value	mean
constant	.707072	.592125	.1913	
Bi	-.115339	.288978	.0000	12.943

Calculating Mean WTP, the ratio of bid coefficient to the coefficient of the constant gives 13.53\* rounding to two significant digit.

### Appendix II

#### The test for overall significance

#### The Log-likelihood Ratio Test (LRT)

The overall significance of the probit estimates is tested with LRT which follows  $X^2$  distribution with degrees of freedom equal to the number of explanatory variables excluding the intercept. It is obtained by:-

$$\lambda_{LR} = 2[\text{Log}Lu - \text{Log}Lr]$$

Where LogLu – is the value of unrestricted log-likelihood function &

LogLr – is the restricted log likelihood function

The null hypothesis i.e.:- all the parameter estimates equal 0 is rejected if  $\lambda_{LR} \geq X^2(n)$ . . . tabulated chi-value at n degrees of freedom.

The result is as follows:-

$$\lambda_{LR} = 2[-54.576 - (-85.885)]$$

$$= 2(31.309)$$

$$\lambda_{LR} = 62.618$$

\* rounded two significant digit

The critical value of the chi-square at 10 degrees of freedom is 18.3 at 95% level. The value is found to be much lesser than the test statistic (the calculated value) implying the overall significance of the parameters as well as the existence of heteroscedasticity in the model.

Similarly, for the same degrees and level the tobit test statistic exceeds the critical value implying the non-acceptance of the null hypothesis

$$\begin{aligned}\lambda_{LR} &= 2[-88.88 - (-102.05)] \\ &= 2(13.17) \\ &= 26.35\end{aligned}$$

### **Appendix III**

#### **The test for goodness of fit**

#### **The log-likelihood ratio index (LRI)**

The goodness of fit for the probit model is computed through

$$LRI = 1 - \frac{\ln Lu}{\ln Lr}$$

Where  $\ln Lu$  – is the value of unrestricted log-likelihood function &

$\ln Lr$  – is the value of the restricted log-likelihood function.

The LRI has lower bound 0 when  $\ln Lr = \ln Lu$  and goes to 1 when  $\ln Lr$  gets very large or  $Lu$  goes to

1. The LRI of the perfect fit if it equals 1 and 0 is not a good fit. It's computed as follows:-

$$\begin{aligned}LRI &= 1 - [(-54.576)/(-85.885)] \\ &= 1 - 0.63545 \\ &= 0.36454\end{aligned}$$

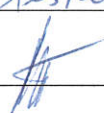
The LRI for tobit becomes

$$\begin{aligned}LRI &= 1 - [(-88.88)/(-102.05)] \\ LRI &= 1 - 0.87094 \\ &= 0.12905\end{aligned}$$


# 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: Seleshi Fantu Haile  
Signature:   
Date: \_\_\_\_\_

## Confirmed by Advisor:

Name: Mehmed Yesud  
Signature:   
Date: \_\_\_\_\_

Place and date of submission: \_\_\_\_\_.