ADDIS ABABA UNIVERSITY
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HOUSEHOLD'S WILLINGNESS TO PAY FOR IMPROVED SOLID WASTE MANAGEMENT: THE CASE OF MEKELLE CITY, TIGRAY REGION

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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)

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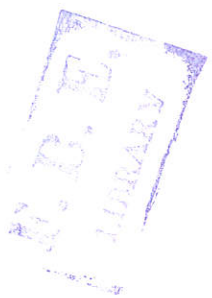

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Acronyms and abbreviations

CAC Command and control

CVM - Contingent valuation method

CV - Contingent valuation, compensated variation

EV - Equivalent variation

HPM - Hedonic pricing method

MSEs - Micro and small enterprises

MSW - Municipal solid waste

NOAA- National oceanic and atmospheric agency

OLS - Ordinary least squares

SWM - Solid waste management

TCM - Travel cost method

UNEP - United Nations Environmental program

US EPA - United States Environmental Protection Agency

WTA- Willingness to accept

WTP Willingness to pay

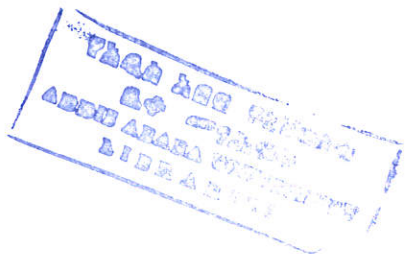
Abstract

The generation of solid waste has become an increasing environmental and public health problem everywhere in the world, particularly in developing countries. In Mekelle city, solid waste management is mainly provided by the municipality and it has been measured and evaluated always based on the role and performance of the service provider (supplier of the service) while demand side i.e. Willingness To Pay (WTP) of the residents is ignored. Therefore, the aim of this paper is to estimate the household's willingness to pay for one aspect of better environmental quality (improved solid waste management) in Mekelle city.

In this study, contingent valuation method (CVM) is used as a method of valuation. The empirical models adopted by this study to determine the factors that influence WTP of household heads for improved solid waste management are, Tobit and Porbit models.

The results of the Probit model revealed that probability of WTP of households for improved solid waste management are significantly related to three explanatory variables and all of the signs of these three variable coefficients (coefficients of income, awareness of environmental quality and age) make intuitive sense and significant at 1%, 5% and 5% respectively. In the Tobit model, 8 out of 12 variables have statistically significant impact on the amount of WTP for improved solid waste management system.

The current payment for sanitation is below the WTP of the residents and the mean WTP found in this study can be used for decision making in determining the service fee for improved solid waste management.



CHAPTER ONE

INTRODUCTION

1.1 Background

In many rapidly growing cities in developing countries solid waste is a major source of concern due to lack of appropriate planning, inadequate governance, resource constraint and ineffective solid waste management. According to UNEP (2004), the generation of solid waste has become an increasing environmental and public health problem everywhere in the world, particularly in developing countries. The fast expansion of urban, agricultural and industrial activities stimulated by rapid population growth has produced vast amounts of solid and liquid wastes that pollute the environment and destroy resources.

The changing economic trends and rapid urbanization complicate solid waste management (SWM) in developing countries. Consequently, solid waste is not only increasing in quantity but also changing in composition from less organic to more paper, packing waste, plastics, glass, metal wastes among other waste, a fact leading to the low collection rates (Bartone & Bernstein (1993).

In order to cope up with these challenges and because of the critical role in protecting the environment and public health, accomplishing effective municipal solid waste should be a priority for emerging cities.

However, in the past most attempts to improve solid waste management in cities have focused on the technical aspects of different means of collection and disposal (World Bank, 1992). Recently, more attention has been paid to enhancing institutional arrangements for service delivery, with a special emphasis on privatization. But in Mekelle city, solid waste management service is mainly provided by the municipality. In the city solid waste management has been measured and evaluated always based on the role and performance of the service provider while demand side is ignored.

The involvement of the service receivers especially households who are the primary producers and generators of significant proportion of solid waste and may be main victim of the effect of solid waste, should allow to determine their providers and participate in making of sound policy decisions including designing of effective joint solutions of solid waste management. This would help the providers to understand households' willingness to participate and pay. Therefore, the key question here is that: What policy recommendations, if any, can be suggested to ensure efficient delivery of solid waste services particularly to residential areas.

1.2 The study area

Mekelle is the capital city of Tigray National Regional State and it was established in 1872 during the regime of Yohannes IV and its municipality was established in 1934 E.C. It is located in South Eastern of Tigray National Regional State at 783 km from Addis Ababa. Its geographical location is between $13^0$32 North Latitude and $39^0$28 East Longitude. The altitude of Mekelle varies from 2150 to 2270 m.a.s.l and it enjoys a mild climate that can be described as 'woina dega' (medium high land) with an average temperature of 25^0c. The average annual rainfall is about 579 mm. Based on Promise consultant (2005), the size of the city in 2004 was around 100 square kilometers

Wind and dust: - The wind blown dust is a serious health and sanitation problem in the city because of: high wind speed & force for a long period of time in the dry season, lack of wind break trees in the town and periphery areas, and less asphalted road coverage (only 41.6 km).[1]

Population and unemployment: - The current population of Mekelle is about 257, 290 with annual growth rate of 5.4 percent[2]. The average family size in the city is 5. One of the problems in the city is unemployment. According to a study conducted between November 2002 and February 2004 by Addis Anteneh and Associates (sited by Teklay 2004) indicates that the overall rate of unemployment in the city has reached 21 %. Another source i.e. strategic plan for 1996-1998 E.C of Mekelle city explains that the unemployment rate of the city has reached 30 percent.

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[1] Mekelle city administration, annual report for 2000 E.C. presented to city council
[2] strategic pan of Mekelle city for 1996-1998 E.C

Infrastructure: - The city's water supply is dependent on ground water sources. Due to the persistent drought in the region, the ground water is getting depleted from time to time. As a result the city's water supply is at risk. During dry season residents are forced to ration water on a shift basis. On average, coverage of clean water in the city is only 51 percent[3]. With respect to Electricity and telephone service, the city is getting 24-hour hydroelectric power service and digital telephone services.

1.3 Statement of the problem

Urbanization and urban population in Ethiopia has been increasing in the last few years. The rapid growth of population in urban areas due to rural-urban migration and high level fertility (urbanization) would presuppose an increase in the provision of required infrastructure and public services. This has not been the case, as many towns in Ethiopia lack the financial resources and institutional capacity to provide the most basic infrastructures and services. One of the basic services in urban areas is solid waste management.

With increasing urban population and urbanization, it is logical to assume an increase in the amount and level of the solid waste in the towns.

> *The increasing level of solid waste is, nowadays, a serious problem in the urban areas of the world. High rates of growth of population and increasing per-capita income have resulted in the generation of enormous solid waste posing a serious threat to environmental quality and human health. This is more so in the case of developing countries where large quantities of solid waste are dumped haphazardly, thereby, putting pressure on scarce land and water resources and at the same time adversely affecting the health of human beings, mostly that of the poor persons who have greater exposure to it* (Indian Statistical Institute, 2003).

Due to the increasing volumes of solid waste, the Mekelle city administration cannot be able to satisfactorily collect and dispose the waste. The coverage of solid waste collection

[3] Mekelle city administration, annual report for 2000 E.C. presented to city council

is very low (below 40% most of the time). If waste is not collected, residents of the city can be exposed to different diseases. "Uncollected waste in developing countries creates serious public health problems in many cities causing many diseases including often fatal water borne diseases such as cholera and dysentery"(Sandhya ,1994).

The disposal of solid waste in Mekelle city is not appropriate and is disposed near farmlands on an open space. Due to the inappropriate disposal, plastic bags taken by wind from the waste disposal site are polluting the farmland of the farmers residing near Mekelle. The problems are likely to become even more pronounced as the level and pace of urbanization continue to grow rapidly. The above-mentioned problems have motivated the researcher to study on this area.

1.4 Objective of the study

Generally, the objective of this study is to estimate the household's willingness to pay for improved solid waste management using contingent valuation methods in Mekelle city.

Specific objectives

- To examine whether households are willing to pay for improved solid waste management service;
- To identify the factors that may affect WTP of households for improved solid waste management service
- To estimate the households' mean WTP for improved environmental quality (improved solid waste management)
- To suggest alternative solutions for the existing problems in solid waste management (provide information for policy makers)

1.5 Scope and Limitation of the Study

The scope of the study is limited to the analysis of demand for improved Solid Waste Management (SWM) service in Mekelle city. This study mainly used one of the most known methods of non market valuation, contingent valuation method (CVM).

The study is restricted only on residential solid waste of the city (excluding commercial and industrial waste) which makes it difficult on estimating the benefit of solid waste management improvement.

The sample taken for this study (226 households) may not be sufficient due to financial and time limitation even though secondary data has been used as complementary.

1.6 Significance of the Study

In Mekelle city the demand side in solid waste management is not considered and this study can be used as starting (initial) for studies to be conducted in the future in WTP of the residents in improved solid waste management since this issue is becoming more complex as the size of the city increases.

1. 7 Methodology

1.7.1 Data collection & sampling design

Both primary and secondary data had been collected to analyze solid waste management system (existing) supply side of the service from bureau of health and municipal authority of Mekelle town. In addition field observations are also carried out to observe how and where the solid waste is dumped and disposed.

Sample selection: samples had been selected from all local administration of Mekelle randomly and sample of 226 are selected for the survey

Face to face (personal interview) was employed as a method of data collection in the primary data. Before the main survey, focus group discussion and pilot survey had been conducted for better understanding and to determine the initial bid.

1.7.2 Questionnaire design:

Questionnaire has been developed based on the objective and problem. Training was given for enumerators before the survey is started on how to convince the respondents and how to fill the questionnaire

Questionnaire have 4 parts (part I questions related to respondents awareness and current situation of solid waste in the city, part II questions related to the environmental problem and description of scenario, part III questions related to WTP, and part IV questions related to socioeconomic conditions of the households)

1.7.3 Valuation method:

Contingent valuation method (CVM) is the main method of valuation. In this study Tobit and probit models will be employed. Tobit model is used to identify factors that affect the amount of willingness to pay (WTP) of heads of households for the proposed improvement in solid waste management and Probit model will be used in this study to estimate the probability of "yes" response for the WTP and mean and median WTP for improved solid waste management. .

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical foundation of environmental valuation

Theory of environmental (non market) valuation has made considerable advances over the past three decades, both in intensity and scope as economists attempt to value an increasing number of environmental goods and services from around the world. Increasing complexities, in estimation, designing procedures, and analytical structure, have enhanced the optimism of economists about using non-market valuation as a viable tool to assist decision-making. But as non-market valuation advances, new controversies and debate had come. Particularly, non-market valuation faces a critical challenge in understanding how people perceive these services and how they value changes on the genetic, species, regional and global scale. (Hanley et. al, 1997)

In this chapter, we consider concepts of economic value and non-market valuation including the controversies, importance of environmental valuation, valuation methods focused on contingent valuation method, environmental demand and welfare measures, and finally solid waste related issue.

2.1.1 Concepts of economic value

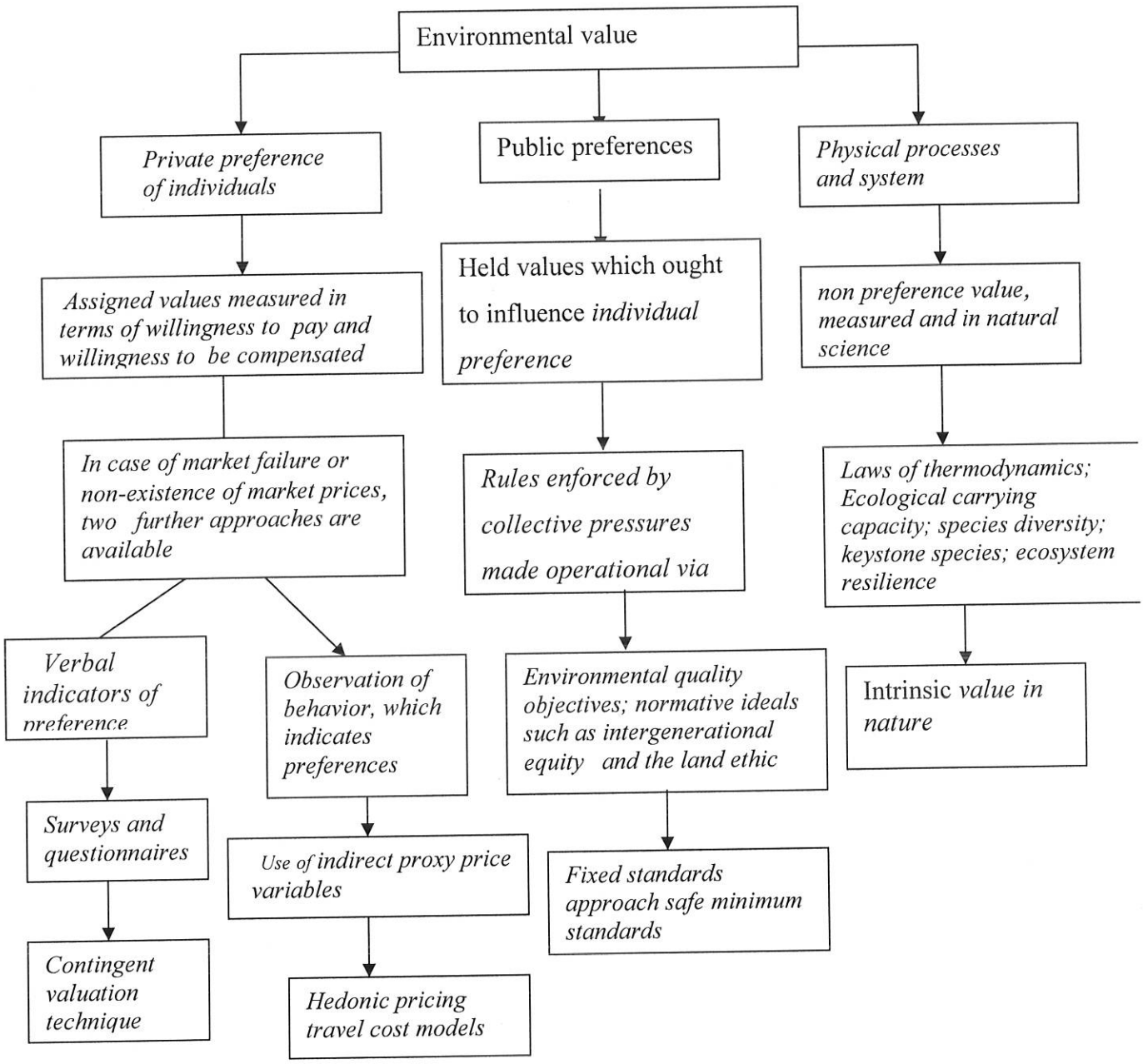
The concept of value has been the subject of considerable debate throughout much of the history of economics. The intention has been to establish objective and reliable criteria by which to judge alternative pattern of resource use. The central principles of valuation in economics are that it should be based on individual preferences. This means that economists are concerned to identify the way in which changes to the environment influence the welfare of all individuals who may be affected by them from their own point of view (Ian Hodge, 1995).

When markets do not exist in relation to most types of environmental changes and environmental goods and services, the basic approach is to value based on individuals' willingness to pay to acquire benefits, and hence their willingness to give up other things which they could otherwise have had. However, according to Hodge, changes in the environment are often unwanted i.e. they represent environmental damages, so that individuals will not be willing to pay to get them. On the contrary, they want compensation for having to put up with them and this represent appropriate measure of the value of environmental damage. Therefore, changes in the environment could be either positive or negative.

According to Pearce and Turner (1990) economic valuation in this case means money valuation. The justification for monetary valuation lies in the way in which money is used as a measuring rod to indicate gains and losses in utility or welfare. The reason money used as measuring rod is that all of us expressed our preferences every day in terms of these units- when buying goods we indicate our willingness to pay (WTP) by expressing money for the goods and services, and, in turn our WTP must reflect our preference (Pearce and Turner, 1990)

The term value has been variously interpreted but three environmental relationships seem to underlie the policy and ethics adopted in industrialized societies: values expressed via individual preference, public preference value, and functional physical ecosystem value (Pearce and Turner, 1990).

Figure 1 Environmental value relationship



Source: adopted from Pearce and Turner (1990)

The total economic value includes option value and existence value. An environmental asset is considered to have both "use" and "non use" value (Clinch 2000).

Use value: - use value can be broken down to ***actual use value*** and ***option vale***. The actual use value is derived from use of the asset, and is composed of direct use value and indirect use value.

Krutilla (1967) as sited in Clinch (2000) defined option demand as "willingness to pay for retaining an option to use an area of facility that would be difficult or impossible to replace and for which no close substitute is available. More over, such a demand may exist even though there is no current intention to use the area or quality in question and the option may never be exercised".

Option value can be broken down into a number of components: the value individuals place on the preservation of an asset so that they may have the option of using it in the future (value of future options for the individual), the value they attach to preserving the asset because it can be used by others ('vicarious value') and the value they attach to preserving the asset so that the future generations have the option of using it ('bequest value').

Therefore, we can define total economic value as:

Total economic value = direct use value + indirect use value + option value

Non-use Value

Non-use values are 'existence' or 'passive use' value. The existence values reflect the benefit to individuals of the existence of an environmental asset although those individuals do not actually use the asset.

The idea of putting money on environmental damage strikes writers as illicit, even immoral. Many commentators on environmental economics observe that there is a multiplicity of values; - we cannot subsume duty, obligation, keeping promises, love, and natural justice under economic values. Each type of value has a different moral standing according to the viewpoint of the individual. Some see duty as a dominant moral rule; others see consistency; still others see natural justice as important rule (Pearce and Turner 1990).

2.1.2 Why do we value the environment

According to Braden and Kolstad, environmental commodity will be considered as different from either a private good or a conventional public good in two ways. An environmental commodity is defined as having at least one of the following two characteristics: either it is a negative good - a "bad" – which carries no price and thus is inefficiently allocated by the market; or it is a public good endowed upon society rather than purchasing

Environmental valuation methods are used to measure the benefits of environmental improvements and the costs of environmental degradation. "...the valuation we use as humans can put on the environment is by definition ***human values*** and the only 'central' value we can put on the environment is some human approximation of that value" Clinch (2000)

In order to make a comparison between things, we need to describe them in the same units. In environmental goods and services, there is no market price that estimates the value of these goods. If we want to establish the significance of losing elements of the environment, we would want a measure of their value and we would want to describe this value in monetary terms. This enables us to compare the significance of environmental loss with the significance of other non-environmental costs and benefits.

The environment is traded off against other goods regularly and if we protect the environment we will often be foregoing some other aspects of our quality of life. The important thing is to ensure that environmental goods we are foregoing or improving are correctly valued so that the trade-off makes sense.

In a market economy most goods are allocated by price mechanism. This price reflects people's willingness to pay for these goods. The market price can therefore be used as a measure of its value (with possible adjustment for market distortions).

In the case of environmental goods, market rarely exists and so there is no price to reflect the loss to the society from damage or use of the environment or the gain from improvements in

the provision of environmental resources. Therefore we require non-market valuation methods to value such improvements or damages.

To ascertain whether the policy is environmentally effective, it is necessary to have some method of valuing the improvement. For it to be economically effective, we need to know whether the improvements are being made at least cost and whether the benefits of the policy outweigh its costs.

> *To fully assess the economic desirability of environmental policies, analysts must estimate the value of non-market commodities. Overlooking or ignoring the services provided by non-market commodities in cost-benefit analyses and other empirical economic studies severely undermine the accuracy and relevance of the results (Carson el at, 2000).*

According to Navrud (2006), Environmental valuation studies have four main types of policy use:

i) *Cost-benefit analysis (CBA)* of investment projects and environmental policies

ii) *Environmental costing* in order to map the marginal environmental and health damages of e.g. air, soil and water soil pollution from energy production, waste treatment and other production and consumption activities. These marginal external costs can be used in investment decisions and to design optimal environmental taxes

iii) *Environmental accounting* at the national level (i.e. green national accounts)

iv) *Natural Resource Damage Assessment (NRDA)/Liability for environmental damages;* i.e. compensation payments for natural resource injuries from oil spills and other pollution incidents (Navrud 2006)

"We may wish to do this *ex ante*, i.e. before deciding on a type of environmental regulation or we may wish to it *ex post*, i.e. after a regulation has been imposed, to see if the regulation has got us near to the optimum" (Pearce and Turner, 1990)

From the above, we can see that environmental valuation or monetary measure of environment is very important to provide a check on the economic rationality of investing in ***environmental improvement,*** to decide environmental regulation and policy, to estimate environmental damages for compensation claims, and for environmental national account.

2.2 Valuation methods

Environmental valuation methods are used to measure the benefits of environmental improvements and cost of environmental degradation. In measuring non-market economic value of environmental benefits, we can use different methods. According to Mitchell and Carson (1993), classification of methods for estimating values is based on two characteristics of the methods. The first characteristic is whether the data comes from observation of people acting in real world settings where people live with the consequence of their choice; or come from people's response to hypothetical questions of the form "would you be willing to pay...?" The second characteristic is whether the method yields monetary values directly or value must be inferred through some indirect techniques based on a model of individual behavior and choice (Mitchell and Carson, 1993).

Thus according to Pearce and Tuner (1990) the economic measurements of environmental benefits have been broadly classified as direct and indirect techniques.

2.2.1 Indirect (revealed preference) methods of valuation

Indirect procedures for benefit estimation do not seek to measure direct preferences for the environmental good in question. The indirect (inferential) approach involves inferring about the unobservable demand for and hence value of environmental goods and services based on the observable demands for the related marketable goods and services.

The indirect method includes Travel Cost Method (TCM), Hedonic Pricing Method (HPM) averting expenditures and household production functions. Most of the time, the TCM and HPM are unlikely to estimate non-use value because of their dependence on the actual market situation.

2.2.2 The stated preference (direct) method

The direct (stated preference) method considers environmental gains as an improved scenic view, better level of air or water quality etc and seeks directly to measure the monetary value of those gains (Pearce and Turner, 1990).

According to Clinch (2000) this method is direct valuation which asks people in a survey to place a value on the environmental asset in question either by rating (contingent valuation) ranking (contingent ranking) or choosing tradeoffs between various policy alternatives (choice procedures). These direct methods by the use of questionnaires are the only approaches that can be used to estimate the existence value. This includes Contingent Valuation Method (CVM) and choice experiment model (contingent ranking) (Clinch 2000).

2.3 Contingent Valuation Method

Description of the method: -

> Contingent valuation (CV) method is a survey technique that has been used to elicit peoples' preferences by asking them directly to report their willingness to pay (WTP) to obtain a specified good or service, or willingness to accept (WTA) to give up a good or service, rather than inferring these values from observed behaviours in regular market places. It is called "contingent" valuation because it uses information on how people say they would behave given certain hypothetical situations" (http://www.caa.co.uk/docs/5/ergdocs/baademandsurveyannexfeb).

Ciriacy-Wantrup (1947) first suggested the use of "direct interview method" to measure the values associated with natural resource. The first CV study has been under taken by consulting company in 1958 in which people were asked their WTP for entering national parks. Robert. K. Davis's (1963) Harvard dissertation is said to be the first significant application of the CVM, which was used to estimate the benefit of outdoor recreation (lecture note of environmental economics and policy, 2007)

Contingent valuation method (CVM) was proposed and first used in developed countries for valuation of public goods like access to parks, clean air or water, endangered species or unobstructed views. Nowadays, CVM in developing countries has been used most often for valuation of publicly or privately provided goods, such as water supply and sewerage in areas without existing services. In these cases CVM has been used as a type of market analysis, to guide systems design and setting of tariff rates. (Pearce and Turner, 1990)

Stages of CVM analysis

Hanley (1990) identifies six distinct phases involved in the practical application of CVM as follows:

Stage 1: Preparation

i. Set up the hypothetical market: individuals may be presented with two basic variants:
   - How much are you willing-to-pay (WTP) for a welfare gain or improvement in environment?
   - How much are you willing to accept (WTA) in compensation for a welfare loss (in case of environmental damage)?

ii. Define the elicitation method.

   The major alternatives are:
   - Open ended; "how much are you willing to pay?" This approach produces a continuous bid variable and may therefore be analyzed using least squares approaches (OLS).
   - Take-it-or-leave it (dichotomous choice); "are you willing to pay $ X?" The amount, X being systematically stepped across the sample, is to test individuals' responses to different bid levels. This approach produces a discrete bid variable and requires logit-type analysis.
   - A recent variant upon the dichotomous approach is to supplement the initial question with an iterative second round (double-bound) question. For example if the respondent answers yes to the $X bid then they are asked if they are WTP $2X (or $0.5X if they answered no to the initial question)

- Other elicitation methods include the use of payment cards and bidding games with suggested starting points.

iii. Provide information regarding:

- The quantity/quality change in provision of the good
- Who will pay for the good?
- Who will use the good?

iv. Define the payment vehicle, for example: higher taxes, entrance fees or service fee, donation to a charitable trust etc.

Stage 2: Survey

Interviews can be either on-site (face to face; users only), house to house (face to face; users and non-users) or by mail or telephone (remote; users and non-users).

Stage 3: Calculation

Calculate the mean WTP (or WTA) from responses. In a dichotomous choice format experiment, the mean is obtained by calculating the expected value of the dependent variable (WTP or WTA)

Stage 4: Estimation

A bid curve can be estimated to investigate the determinants of WTP bids. For a continuous question format OLS estimation techniques are often employed. Typically, in WTP scenarios, the bid curve will relate bids (WTPi) to get improved environmental service (Qij), income (Yi), social factors such as education (Si), and other explanatory variables (Xi). A parameter of the environmental quality of the site or the service (Ej) may also be included.

WTPi = f(QijYi, Si, Xi, Ej)

There is no theoretical correct form of this function. However, if a log-log function is chosen, then the coefficients are elasticities. In such a case the bid curve allows us to estimate changes in mean WTPi arising from changes in Ej. Indeed if the other relationships are sufficiently stable, then we can use this curve to evaluate changes to other strongly related environmental goods.

If a dichotomous payment format has been used, then a Probit approach (alternatively a Logit approach may be used) is required, relating the probability of a yes answer to each suggested sum to the explanatory variables listed above.

Stage 5: Aggregation

This is required in order to move up from mean WTP to total value. This entails decisions about, for example, moving between household and individual data, and distinguishing the relevant population to be used in aggregating the benefit.

Stage 6: Appraisal

Was the CVM successful? To answer this question, it needs to consider the technical acceptability of the evaluation estimates produced by CVM (Hanley, 1990, Bateman and Turner, 2000). These six steps are the main steps of CVM application.

Advantages and Criticisms of CVM

Advantages:

- Contingent valuation is enormously flexible in that it can be used to estimate the economic value of virtually anything. However, it is best able to estimate values for goods and services that are easily identified and understood by users and that are consumed in discrete units
- CV is the most widely accepted method for estimating total economic value, including all types of non-use or passive use values. CV can estimate use values, as well as existence values, option values, and bequest values.
- Though the technique requires competent survey analysts to achieve defensible estimates, the nature of CV studies and the results of CV studies are not difficult to analyze and describe.
- CV has been widely used, and a great deal of research is being conducted to improve the methodology, make results more valid and reliable, and better understand its strengths and limitations. (http://www.ecosystemvaluation.org/dollar_based.htm)

Despite its advantages and wide range of applicability, CVM has many criticisms. The most criticisms of CVM fall mostly in the following biases:

Strategic bias: - incentive to free ride problem

Design bias: - which includes starting point bias, Vehicle bias and informational bias

Hypothetical bias: - are bids in hypothetical markets different to actual market bids? Why should they be?

Operational bias: - how are hypothetical markets consistent with markets in which actual choices are made? (Pearce and Turner, 1990)

Even though CVM has the above mentioned limitations, it is widely applicable in valuation of all environmental goods and can value including the non use value. "It should be noticed, however, that this same disadvantage must inhere in any method of assessing damages from deprivation of passive-use. It is not special to the CV approach, although there are currently no other methods capable of providing information on these values". (Arrow el at, 1993) Therefore, contingent valuation method is used in this study to estimate the benefits from improved solid waste management service and the limitations (biases) of this method can be eliminated or minimized by appropriately designing of the survey questionnaire based on the guidelines suggested by the NOAA Panel.

2.4 Environmental demand and welfare measures

Much of empirical environmental economics is concerned with the economic benefit of changing the level of environmental quality. In estimating monetary values for environmental resources economists are concerned with how changes in the provision of environmental public goods impact upon individual's utility. The most common measure of welfare gain or loss from such changes of provision have been approximated by change in consumer surplus is the area under the ordinary (Marshallian) demand curves and above the price level.

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The Marshallian demand curve tracks the 'full price effect' which occurs when the provision of a good changes. Typically it has been used to show how much the quantity consumed of a normal good increase when its price falls. "In the case of environmental public goods, the individual is usually faced with a quantity rather than a price constraint, the good often being un-priced. Furthermore, these goods often have much higher income elasticities than those associated with many market goods (Bateman et al., 1992)".

According to Bateman and Turner the large income effect arising from a change in quantity provision may undermine the consumer surplus measure of welfare change. In order to move from the ambiguity of consumer surplus to a theoretically more accurate measure of welfare change, we therefore need to compensate for the income effect by holding real income constant, i.e. moving from using the ordinary Marshallian demand curve to the compensated (Hicksian) demand curve.

> *The Hicksian approach evaluates welfare change as the money income adjustment necessary to maintain a constant level of utility before and after the change of provision. Two such welfare change measures are feasible for such an approach. The 'Compensating Variation' (CV) is the money income adjustment (welfare change) necessary to keep an individual at his initial level of utility (U_0) throughout the change of provision, while the 'Equivalent Variation' (EV) is the money income adjustment (welfare change) necessary to maintain an individual at his final level of utility (U_1) throughout the provision change* (Bateman and Turner, 2000)

Compensating and equivalent variation are the integral (for two different utility levels) under Hicksian or compensated demand function. Similarly the derivatives of these benefit measures are the corresponding demand functions. As R.T Carson, depending on the property right assigned, the preferred Hicksian welfare measure can be expressed in terms of either willingness to pay or willingness to accept compensation.

Furthermore these changes can be either positive (a welfare gain) or negative (a welfare loss) giving us four possible scenarios. For a proposed welfare gain i.e. a change in provision which increases utility, the CV measure tells us how much money income the individual should be willing to give up (WTP) to ensure that the change occurs while the EV measure tells us how much extra money income would have to be given to an individual (WTA) for them to attain the final improved utility level in the absence of the provision change occurring. For a proposed welfare loss i.e. a change in provision that decreases utility, the EV measure will now show how much an individual is WTP to prevent the welfare loss occurring while the CV measure now shows individuals WTA compensation for allowing the welfare loss to occur.

If an organization is considering an improvement in environmental quality and desires a measure of WTP, i.e. Hicksian compensated surplus where a participant is asked to respond by giving the difference of two expenditure functions.

$$e(p,\ q_o U_o, Q, T) - e(p,\ q_i U_o, Q, T) \qquad \ldots \quad 2.1$$

Where p is vector of prices for the marketed goods, q_i is the environmental amenity being changed, U_o is the initial or status quo levels of utility to which the respondent is assumed to be entitled, Q is the vector of other public goods that are assumed not to change, and T is a vector of participant's taste parameters (Deaton and Muellbauer 1980) cited in Carson (1991). The value of the first expenditure function is Y_o, the participant's current income; the value of the second expenditure function is the level of income that solves for U_o given p, q_i Q and T. Then WTP is defined as the difference between Y_o and Y_i.

Willig (1976) cited in Carson (1991) has shown that equation 2.1 can be expressed in an equivalent form known as income compensation function. If WTP is the desire benefit measure, then WTP function is given by:

$$WTP(q_i) = f(p, q_o, Q, Y_o, T) \quad \ldots \quad 2.2$$

Where, q_o is now the base line level of the public good of the interest. This equation forms the basis for estimating a valuation function that depicts the monetary value of a change in economic welfare that occurs for any change in q_i. (Carson, 1991)

2.5. Empirical Review

Contingent valuation method (CVM) was proposed and first used in developed countries for valuation of public goods like access to parks, clean air or water, endangered species or unobstructed views. Nowadays, CVM in developing countries has been used most often for valuation of publicly or privately provided goods, such as water supply and sewerage in areas without existing services. In these cases CVM has been used as a type of market analysis, to guide systems design and setting of tariff rates (Pearce and Turner, 1990).

In this part, solid waste management studies in Ethiopia particularly those that used the Contingent Valuation Method have been reviewed. In Ethiopia, particularly in Addis Ababa, CVM and Choice Model based studies have been made on improvement of solid waste management services, improved water and sanitation services and other improvements in environmental amenities in the last few years.

Yitbarek (1998) in (Solomon, 2007) had undertaken a CV survey on solid waste collection in Addis Ababa. He employed a face-to-face interview method and used an open ended questionnaire to elicit respondents' WTP using 210 sample households selected randomly. In his paper, linear and log-linear models (OLS) were used to analyze the significance of the independent variables: respondents' interest in environmental problems, awareness of solid waste problems, perceived level of existing solid waste collection system, responsibility for various solid waste problems, age, sex, family size, level of education, and household income of which awareness of solid waste management problem, household income and interest in environmental problems were found significant determinants of respondents' WTP values.

Aklilu (2002) used CVM based on a closed ended with a follow-up elicitation format to estimate WTP for improved SWM of households of Addis Ababa, by using 430 sample households selected at random. He employed Tobit model for the analysis and results showed that income of households, time spent in the area, quantity of waste generated, responsibility of SWM, educational dummies, ownership of the house and number of children had a positive and significant impact on WTP of households.

Walelegne[4] (2003) conducted a WTP study on valuation of improved SWM in Addis Ababa with the sample of 500 households by using two stage stratified sampling followed by random sampling applied to each stratum. Different characteristics of the households obtained from the survey was used to test the model that explains WTP for improved solid waste services as a function of income, age, sex, education, number of children, wealth interest in environmental issues, service provider dummies and starting bids. The results of this model using OLS showed that, income, education, wealth and type of service provider (private vs. public) were significant while the rest were found insignificant in influencing WTP of households for improved solid waste management services.

Seleshi (2007) used CVM survey to estimate WTP of residents of common building in Addis Ababa and employed single bounded format followed by an open ended question and gathered information from the randomly selected sample of 130 households. For the analysis he employed Tobit and probit models. The results of the Tobit model show that only age, sex and income had significant influence on WTP of households and the mean WTP is found to be Birr 13.53 per month per household. In the probit model, income, type of solid waste demanded, location, starting bid and current payment were found significant.

Solomon (2007) used Choice Model to analyze households WTP for improved solid waste management options in Yeka sub-city, Addis Ababa. For his analysis, he selected 254 sample households and used face-to-face interview to collect the data. For the empirical analysis, he employed two models: baseline model and Choice Model with socio-economic factors. He

[4] Walelegne is cited in Solomon 2007

used Multinomial Logit for the baseline and Extended Multinomial Logit model for the Choice model with socio-economic characteristics. His finding shows that mean WTP per month per household was Birr 12.95 for collection frequency to be increased from once per week to twice per week and Birr 43.69 per month per household if collection will change to twice per week and sorting at source introduced. He concluded that the attributes collection frequency and sorting at source are some of the determinants of solid waste management service.

In Mekelle city, some solid waste management studies have been undertaken. These include: Gebretsadkan (2002), Tklay Tesfay (2003), Promise consultants (2005), and Tewodros, Ruijs, and Fitsum (2008).

Gebretsadkan (2002) estimated the solid waste generation of the city and he estimated per capita MSW generation per day is 0.33 kilogram in terms of weight. Teklay's (2004) work was related to integrated approach to solid waste management in Mekelle city and he identifies different problems in waste collection, management and disposal as explained in chapter three and the work of Promise consultant is related with designing appropriate solid waste disposal and estimation of solid waste generation. Three of these studies are not related to demand estimation and demand factors.

Another study undertaken by Tewodros, Ruijs, and Fitsum (2008) investigated the effects of demographic factors, economic and social status, waste and environmental attributes on household solid waste disposal using data from household survey. They analyzed the household level data using multinomial logit estimation to determine the factors that affect household waste disposal decision making. Results show that demographic features such as age, education and household size have an insignificant impact over the choice of alternative waste disposal means, whereas the supply of waste facilities significantly affects waste disposal choice. The paper also suggests that inadequate supply of waste containers and longer distance to these containers increase the probability of waste dumping in open areas and roadsides relative to the use of communal containers. They also found that higher household income decreases the probability of using open areas and roadsides as waste destinations relative to communal containers. They finally suggest that measures to make the

process of waste disposal less costly and ensuring well functioning institutional waste management would improve proper waste disposal (Tewodros, Ruijs, and Fitsum, 2008).

From the above, we note that most of the studies undertaken in WTP estimation are in Addis Ababa. The studies undertaken in Mekelle are not demand estimations and therefore conducting a study on WTP of households in Mekelle is very important to solve the existing solid waste management problem with participation of residents.

2.6 Concepts and classification of solid waste and solid waste management

2.6.1 Definition and concepts of solid waste & solid waste management

Solid waste is defined according to Tchonobanglous (1993) cited by Seleshi (2006) as all wastes 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.

In this case, the area of interest is Municipal solid waste (MSW) and different writers on this area define it in similar way. Martin Medina defines municipal solid waste as "...the materials discarded in the urban areas for which municipalities are usually held responsible for collection, transport and final disposal. MSW encompasses household refuse, institutional wastes, street sweepings, commercial wastes, as well as construction and demolition debris."

Another writer defined municipal solid waste as " ... material for which the primary generator or user abandoning the material within the urban area requires no compensation after abandonment. In addition, it qualifies as an urban solid waste if it is generally perceived by society as being within the responsibility of the municipality to collect and dispose of" (Cointreau, 1982, cited by Teklay 2004)

Solid Waste Management (SWM) is defined as the control, generation, storage, collection, transfer and transport, processing and disposal of solid waste consistent with the best practices of public health, economics & financial, engineering, administrative, legal and environmental considerations. Othman (2002)

2.6.2 Classification of Solid Waste and Solid Waste Management

Classification of Solid Waste

Enger and Smith (2006) categorized solid waste in to four broader kinds based on the sector of the economy responsible for producing them. These include mining, agricultural, industrial, and municipal solid waste. Solid wastes that come from activities related to mineral extraction and mills operating in mining are defined as mining waste while wastes that come from animal rearing, harvesting & processing of crops and trees are defined as agricultural wastes.

Similarly, wastes such as demolition waste, foundry sand, and scraps from manufacturing process, sludge, ashes from combustion and other similar materials are classified as industrial solid waste. Wastes which are no longer needed by people because they are broke, spoiled, or have no longer use including waste from household's commercial establishments, institutions, and some industries are classified under municipal solid waste.

Since the main area of interest is municipal solid waste, let us consider further classification of municipal solid waste. Municipal solid waste is classified in different ways. Different literatures used the point of origin, nature of material, kind of materials and heat contents of the materials to classify municipal solid waste (Cornwell 1998). Rand et al (2000) classified municipal solid wastes based on points of origin of the materials. According to Rand et al (2000) there are six types of municipal solid wastes namely: domestic waste, commercial waste, industrial waste, institutional waste, street sweepings and constructions & demolition wastes.

Wastes such as old clothes, furniture obsolete utensils, equipment, packing materials, newsprints, fuel burnings and other wastes from households are classified as domestic waste.

Domestic waste (household waste derived from residential neighborhoods) is the largest component of municipal solid waste. On the other hand commercial wastes include waste from shops, offices, restaurants, hotels, and similar commercial settings.

Wastes from hospitals, clinics, government offices, military bases and etc are included under institutional and waste generated by industries that have similar materials with domestic waste and commercial waste is classified into industrial waste. Finally, wastes that come from street such as dust & soil, and wastes from buildings are categorized in to street sweepings and construction and demolition wastes respectively.

It is also possible to classify municipal solid waste based on the nature of waste materials. According to Cornwell (1998) solid waste can be classified as organic, inorganic, combustible, putrescible and non-putrescible factions. But Cornwell regarded waste classification made based on the kinds and heat content of the waste materials as the most useful.

Although municipal solid waste is classified in to different categories, the composition of waste materials in each category varies based on the level of economic development. For e.g. domestic solid waste is dominated by food waste and ash in low-income countries where as in middle income and higher income countries, it is dominated by paper, metal, glass, plastic, discarded items and hazardous matters.

Classification of municipal solid waste management

According to SIDA (Swedish International Development Cooperation Agency (2006) Solid waste management has three main components: collection and transportation; reuse or recycling; and treatment or disposal.

To address the increasing volume of municipal solid waste that are generated on a daily basis, the US Environmental Protection Agency (EPA) recommends using integrated, hierarchical approach to waste management with four components: source reduction, recycling, combustion, and land filling. EPA has ranked the most environmentally sound strategies for municipal solid waste. Source reduction including reuse is the most preferred method,

followed by recycling and composting, and lastly, disposal in combustion facilities and landfills. (www.epa.gov)

Source reduction

US EPA defines source reduction as "any change in the design, manufacture, purchase, or use of materials or products (including packaging) to reduce their amount or toxicity before they become municipal solid waste." EPA further elaborates that " source reduction, including reuse, can help to reduce waste disposal and handling costs. Source reduction also conserves resource and reduces pollution including greenhouse gases that contribute to global warming." (www.epa.gov)

Recycling

Municipal solid waste recycling refers to the separation and collection of wastes, their subsequent transformation or remanufacture in to usable or marketable products.

Composting

Composting is another form of recycling. According to US EPA, it is "the controlled biological decomposition of organic matter such as food and yard wastes, into humus, a soil like material. Composting is a nature's way of recycling organic wastes in to new soil used in vegetable flower gardens, landscaping, and many other applications." *(www.epa.gov)*

Land filling

Land filling is one method of municipal solid waste management and it is mostly used in low and middle-income countries.

Combustion (incineration)

It is a method of decreasing organic solid waste by burning of the solid waste. Uncontrolled burning of solid waste is detrimental to health and the environment. This method is the last in the hierarchy of solid waste management.

2.6.3 Use of economic instruments for improved solid waste management

The definition of economic instruments varies in the literature. However, there appears to be some general consensus in the definition of an economic instrument as a policy, tool or action which has the purpose of affecting the behaviour of economic agents by changing their financial incentives in order to improve the cost-effectiveness of environmental and natural resource management. (IDB, 2003)

Generally, economic instruments introduce more flexibility, efficiency and cost-effectiveness into solid waste management measures. Furthermore, they can stimulate development of pollution control technology and expertise in the private sector; provide government with a source of revenue to support waste management programs; and eliminate a government's requirements for larger amounts of detailed information needed to determine the feasible and appropriate level of control for each plant or product. Specifically, in solid waste management, economic instruments can be used as a tool to: - reduce the amount of waste generated, reduce the proportion of hazardous waste in the waste generated, segregate hazardous waste for special handling and disposal, encourage recovery, reuse and recycling of wastes, support cost-effective solid waste collection, transport, treatment and disposal systems, minimize adverse environmental impacts related to solid waste collection, transport, treatment and disposal systems, and Generate revenues to cover costs. (IDB, 2003)

Clinch defined economic instruments as "incentive mechanisms to encourage people to act in a socially responsible manner in relation to the environment. Ideally, environmental valuation would be used to calibrate these instruments" (Clinch, 2000).

Command and control *(CAC)* strategy involves direct regulation along with monitoring and enforcement systems. It generally requires the government to formulate the waste standards, to specify schedules for meeting the standards, permitting and enforcement procedures for facilities, liability assignment, and penalties for non-compliance. The major advantage of the

command and control approach is that the regulator has a reasonable degree of predictability about how much environmental impact such as pollution levels will be reduced.

Economic instruments have various uses in the environmental and natural resource management arena, and according to UNEP (2004), economic instruments have advantages or benefits over CACs. These advantages include: -

1. Provide flexibility in the overall cost of reducing emissions;
2. Act as incentives for the use of innovative abatement technologies;
3. Allocate environmental and natural resources to parties who value them most;
4. Guarantee self-enforcement by aligning public and private interests;
5. Increase transparency in resource use and allocation;
6. Help in cost-recovery of publicly provided services;

Therefore, we can see that introducing economic instruments in solid waste management can improve the performance of solid waste management and enables to reduce environmental impacts.

CHAPTER THREE

EXISTING SITUATION OF MUNICIPAL SOLID WASTE MANAGEMENT IN MEKELLE CITY

3.1 Solid Waste Generation

Solid waste generation increases in the city as the life style changes and economic activities increases. "Globally, the per capita amount of municipal solid waste generated on a daily basis varies significantly; Economic standing is one primary determinant of how much solid waste a city produces" (World Resources Institute, 1996).

In Mekelle, there have been two studies undertaken to estimate the municipal solid waste generation. Gebretsadkan (2002) cited by Teklay (2004) estimated per capita MSW generation per day is 0.33 kilogram in terms of weight. Another recent study on municipal solid waste generation by Promise Consultants on 2005 resulted in 0.268 kg per day per person. In this regard, since current population of the city is 257, 290 (Mekelle city administration, 2000 E.C. annual plan) solid waste generation on average per day of the city is estimated 76,929.71 kilogram by taking the average of the two studies. From this the annual solid waste generation for the city is 28,098,577 kilogram. Promise consultants also estimated the solid waste generation in the city in terms of volume and the average volume of generation of residential solid waste is 0.924 liter per day per person.

Compared to other low-income countries, the solid waste generation in the city is very low. For example waste generation of some Asian low-income countries is 0.50, 0.50, and 1.00 kg per capita per day for Nepal, Bangladesh and Cambodia respectively (Zurbrügg, 2002).

3.2 Handling and collection of solid waste in the city

Theoretically, methods of handling and storage at the source of generation depend upon the quantity, type, and composition of the waste, the available municipal service and type of urban activity and establishment. Techniques of handling and storage of hazardous and special wastes are quite different from other forms and categories of municipal solid waste.

Study conducted on handling of MSW on the city by Promise consultants indicates that most of the residents (63.56%) regardless of their income use sacks for primary storage (it is also true as observed by the researcher in some households), followed by plastic bags (16.73%), metal vessels (13.37%), and card boxes (6.35%). (Promise consultants, 2005)

Almost all the receptacles (temporary container) used by the residents for primary storage are out of the standard set by the regional state in the hygiene regulation which states that the waste storage facilities should be water proof, washable, and insect proof cover with a lid and it can be made up of iron sheet or plastic.

As far as regulation is concerned, except service-providing institutions like cafeterias, restaurant, hotels, and the like which are some times inspected by the health department of the city, others like households, educational institutions, offices and the like are not inspected whether the primary storage receptacles they use and the way they handle it are as to the required standard set in the regulation or not.

In relation to solid waste handling at municipal levels, there are waste bins and communal storages made available by the service provider i.e. the municipality in key places in the city. But there is no permanent and continuous follow-up and maintenance to these facilities.

Collection

In the solid waste collection, the municipality plays a predominant role. The operational modes of primary collection in the city includes hand carts system by Micro and Small Enterprises (MSEs) and private firm, horse cart system by private firm, manual adult labour

(own force and hired), manual child labor by households, street sweepers wheel barrow system by MSEs.

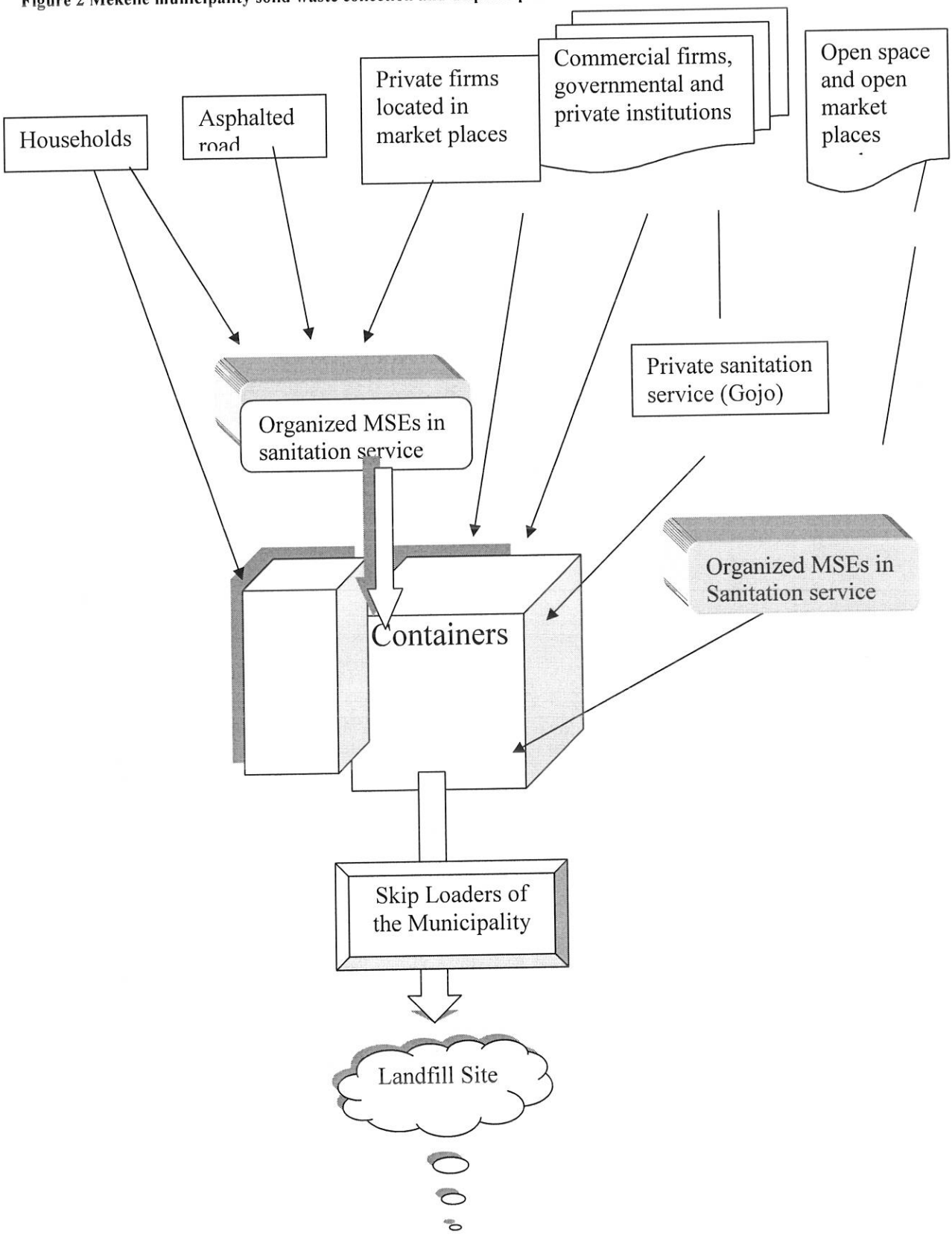
Currently, the municipality collects the solid waste by using 14 cooperative MSEs of which, 11 cooperative engaged in door to door collection, 2 cooperatives in street sweeping (only asphalt), and 1 cooperative in collection from open space and near the communal containers. The cooperatives bring the waste to the communal containers located near the area. The municipality pays for the cooperatives Birr 33.30 per meter cube they collect.

There are 64 communal containers distributed in the city (1 container per 54 hectare on average) (promise consultants). From the communal containers the municipality transports the collected solid waste to the landfill site by using 3 skip loaders with capacity of 8 m^3 each.

Collection coverage according to promise consultant (2005), was only 34.2% but the 6 month municipal report 2000 E.C. indicated the collection coverage improved to 53.11% due to current use of door to door collection by the MSEs. But there are many problems related to collection of solid waste in the city

The following diagram can summarize the current collection system of the municipal solid waste in Mekelle city.

Figure 2 Mekelle municipality solid waste collection and disposal process



The main problems in solid waste collection in the city are:

- ***Discontinuity of the service***: The collection service is always disrupted due to inadequate facilities i.e. the skip loaders are few and they are old – take long time on maintenance. Due to this problem the solid waste over piles and is splattered around the container.
- ***Capacity of the municipality***: The municipality lacks capacity to cover the entire city in solid waste collection in terms of finance, machineries, and skilled manpower.

Communal containers: Numbers of communal containers currently in use are inadequate and as a result people have to travel some distance to get the container and some people are dumping the garbage on open place during the night. "Inadequate supply of waste containers and longer distance to those containers increase the probability of waste dumping in open and roadsides relative to the use of communal containers" (Tadesse , Ruijs , and Hagos , 2008). In addition to the above, the containers are open type, which means they are not protected from rain or sun making the waste to produce bad smell; cause unsightly scene and deterioration of neighborhood. The site where the containers are placed is also easily accessible to animals like dogs, cats, and others that during scavenging the garbage scattered in the surrounding area.

- ***Problem of awareness in the society:*** people in the city throw garbage on open space, near resident of neighbors, even near the communal container due to less awareness about the consequence of the waste on the environment and public health including the polluters themselves.

Figure 3 Solid waste dumped on an open space near residential houses (kebele 03)

3.3 Solid waste disposal

The municipality uses 3 skip loaders to transport the collected garbage from the communal containers to the 'landfill sites'. Since the landfill is not standard, Teklay (2004) calls it 'uncontrolled dumping site'. In transportation to the dumping site, since the containers are over filled and open, the waste usually spills on the road.

The municipality uses 4 different dumping sites as waste disposal sites. One of these sites is located at the top of Messobo escarpment on the left side of Mekelle-Wukro road. This site is now stopped due to opposition of the farmers residing around it. The other one is located 5 km North of Quiha Sub city and the other two actively used sites are located around Ainalem which is the ground water source of Mekelle city.

"The practice of dumping waste in sites in an uncontrolled manner is already creating hostilities with the farmers living in the locally as well as with the local administrators especially the bigger site" (Teklay, 2004). Farmers explained that they had severe opposition when the site was selected and they claimed that the authorities of the city administration promise them to give compensation and the site is only temporary, but none of these has been implemented.

The main problems in disposal of municipal solid waste in Mekelle includes: -

- The dumping sites are not properly constructed and managed. There are no standards and requirements set to manage the sites so that they do not pose any threat to public health and the environment.
- There is improper utilization of the site i.e. when the capacity is exhausted, the municipality dumps over it, consequently plastic bags are being blown by the wind everywhere in the farmers farmland and chewed by their cattle. A number of cattle have already died due to this complexity and it is also causing land pollution (Teklay, 2004).

- Large numbers of hyenas come to the dumping sites to scavenge animal remains like bone thrown with the waste. In addition, they create serious threat to the farmers, their children, and their livestock.
- Since the dumping sites are not fenced, children and domestic animals from the surrounding community enter to the sites (garbage), which is dangerous to their health.
- The farmers living in the area explained that due to the dumping site, they are suffering from bad smell, disease for themselves and their cattle, plastic and other garbage pollution to their farm and grazing land.

"Human activities create waste, and it is the way these wastes are handled, stored, collected and disposed of, which can pose risks to the environment and to public health." (Christian Zurbrügg, 2002)

We can see what the dumping sites looks like from some of the disposal sites in the following figures.

Figure 4 One of the disposal sites currently in use around Aynalem

The problems of waste disposal sites have been recognized by the authorities of the city administration and to solve these problems, construction of new sanitary landfill site is started at the west side of the city.

3.4 Reuse and Recycling

As discussed in the literature part, reusing and recycling are very important and first in the hierarchy of solid waste disposal proposed by UNEP and USEPA. But in Mekelle municipality none of the modern solid waste management is implementing and still there is no recycling activities by the municipality in organized manner. Solid waste is not separated or sorted at source and after collection it is simply dumped together.

But traditionally people in the city have the tradition of using containers or other products more than once for different purposes than they were originally produced. For instant, powder milk thin could be used for purposes of drinking water or as a container for sugar, salt, coffee, and the like by households. Likewise many low-income families use plastic containers or

bottles for storing liquid matters. This may be considered in a way as a source reduction because it at least delays generation of waste (Teklay, 2004).

There are also a considerable number of individuals who move door-to-door to collect materials such as used shoes, closes, bottles, and the like. These individuals give plastic products and plates in exchange for the worn out items they collected from the generators. Apart from these activities there is no other formal recycling and reusing projects introduced by the municipal or environmental protection authorities in the city.

3.5 Cost Recovery Conditions

Residents of the city pay service fee for the waste management service given by the municipality. The amount of the service fee charged to the residents is based on the category of the particular place and number of rooms available and accordingly the annual sanitation fee per house per annum is Birr 2.00-26.00(Regulation No.6/1990). This fee is charged only for those who have their own residential house. The payment is not based on generation of waste or based on the service the residents receive. For instant if individual is living in rental house, since the owner of the house pays once for it, he/she does not pay for the service even though he/she generates waste. If the rented house is government owned, no body pays for it. Revenue collected from sanitation fee in the last five fiscal years is presented in table1 below.

Table 1 Revenue collected for sanitation service

Ethiopian fiscal year	Revenue collected (Birr)	Expenditure
1995	230,401.00	Not separated
1996	184,285.00	"
1997	139,834.00	"
1998	209,127.00	"
1999	139,181.00	"
Average	180,566.00	

Source: Compiled from Mekelle Municipality report

We cannot find expenditure for five years to make comparison. The only data that we found separately expense of solid waste management is the 6 months of fiscal year 2000 E.C. Before that the expense was not separately recorded. In the first half of year 2000 E.C, the total amount of expenditure on solid waste management is Birr 953, 421.81.

On average the revenue for 6 month is only Birr 90, 283.00 but expenditure is Birr 953 421.81. The revenue covers only 9.5 percent and the rest 90.5 percent is covered from other sources.

To sum up, collection coverage is very low. This implies, solid waste is thrown everywhere in the city such as open space, green areas, rivers, canal ditches etc. Due to this, waste is spread to all residential houses in the form of dust by the high wind in the city and causes disease. Canal ditches and sewerage system filled by waste and causes flood overtop on the streets.

Disposal problem is the main problem and it seems like collecting from urban and dumping on the residents of peripheral area. The most important methods of solid waste management such as recycling and composting are not started in the city. Finally, since the approach the municipality used to solve the problems was only supply side, assessing demand side of the service is important to improve the solid waste management of the city.

To improve the solid waste management service it needs to find sustainable means of funding to the solid waste management. One way of financing the service is community involvement in financing to the service improvement and therefore estimation of households' WTP is important.

CHAPTER FOUR

METHODOLOGY AND MODEL SPECIFICATION

4.1 Methodology

4.1.1 Data source and type

The study mainly depends on primary data collected for this purpose. Primary data is collected from the randomly selected 226 heads of households from the city. In addition observation of disposal sites and open space dumping and dirty corners of the city has been conducted by the researcher. Discussion with the head of department of sanitation, beauty and park development and with head of sanitation division has been undertaken to obtain information on the current status of solid waste management.

Other source of data used in this study is secondary data mainly from annual reports of the municipality and studies previously undertaken. The survey was conducted during the period of March- may 2008.

4.1.2 Sampling design and procedure

Sample for the study was drawn from household heads of six[5] local administration of the city. They are selected from list of household heads of respective local administration who resides one year and above in the area. Proportionate random sampling is applied and based on this 240 household heads are drawn proportionally from the local administrations except Quiha and 226 questionnaires are completed.

[5] Kedamay Woyane, Adi Haki, Hadnet, Hawelti, Semen, and Ayder Local adminstrations

4.1.3 Design of survey questionnaire and elicitation format

The survey instrument was designed and structured based on the recommendations of NOAA panel and Carson el at 2000. According to Carson et al (2000) a CVM survey questionnaire should include: (1) an introductory section which helps set the general context for the decision to be made; (2) a detailed description of the good to be offered to the respondent; (3) the institutional setting in which the good will be provided; (4) the manner in which the good will be paid for; (5) a method by which the survey elicits the respondent's preferences with respect to the good; (6) debriefing questions about why respondents answered certain questions the way that they did; and (7) the collection of a set of respondent characteristics including attitudes, debriefing questions, and demographic information (Carson el at, 2000).

The questionnaire in this case consisted of four sections. Section I questions related to respondents awareness and current situation of solid waste in the city, section II questions related to the environmental problem and description of scenario (i.e. the proposed SWM improvement scheme), section III questions related to WTP, and section IV questions related to socioeconomic conditions of the households.

The scenarios described in the survey explained in detailed about the services to be provided in terms of its uses and reliability, the current condition of waste management problems in the city, the hypothetical improved condition and the way in which each consumer would pay for the improvement (payment vehicle).

The survey employed is Contingent Valuation Method (CVM), with a single bounded dichotomous choice elicitation format followed by open-ended questions in the WTP section for its advantages.

4.2.2 The field survey

First, for better understanding of the respondents and enumerators, the questionnaire is translated in to local language 'Tigrigna'. Six Data collectors (one from each local administration) were employed based the experience they had on data collection and their educational level and all of them have college diploma and above. One-day training was given

to the enumerators to well understand each question and on how they interview and approach to the respondents to get valid information. On the training session, emphasis was also given to consent of respondents.

Pilot survey on 12 household heads was conducted before the actual survey. The purpose of this pilot survey is to determine the initial bid and to have better understanding how the actual survey will be conduct. This pilot survey is conducted together with the researcher and the enumerators.

4.3 Description explanatory variables and hypothesis

AGR: age of the respondent. It is a continuous variable with a negative expected sign because the aged people are adapted to traditional way of living with no payment for SWM and therefore as people are aged they are less willing to pay for environmental improvement.
SER: sex of the respondent. It is assumed that women could express more preference for improved solid waste management and could be more willing to pay than men because women are around the house with more responsibility to collect and dispose the waste generated by the house hold.

MSR: Marital status of the respondent. This is a dummy variable 1 for married 0 otherwise. Married people are expected to have more children and will have more responsibility to care for their children's health and risk involved due to poor SWM and sanitation. Therefore the variable is expected to have positive sign.

FSR: Family size of the respondent. Generally large family size can generate more solid waste than the small family size and then it is believed that large family size will have higher demand for improved solid waste management and expected a positive relationship with WTP.

EDLR: Educational level of the respondent. It is expected that household heads with higher educational level are more aware about benefits of improved environment and due to this a positive relationship with WTP is expected.

Income: Monthly income of the household head in Birr. In this case the existing literature explains that the higher the income is the higher will be the demand in general and also the demand for improved environmental goods and therefore it is expected that a higher-income consumer apparently has a greater demand for the waste-management amenity and is, therefore, more willing to pay for it.

Start_price: or starting bid. In the absence of starting bid bias, Starting bid is expected to have a negative relationship with WTP for improved SWM system.

ASGH: Amount of solid waste generated by the household per week. It is believed that the larger the household produces solid waste, the larger will be its WTP for improved solid waste management.

EAR: Environmental awareness of the respondent. Theoretically, those households with higher perception (awareness) of environmental quality tend to provide positive WTP values and expected a direct relationship.

4.4 Analytical Framework

The contingent valuation method (CVM) was selected for the analysis. Compared with other economic valuation techniques, it is considered very flexible and adaptable to some valuation tasks that alternative economic valuation techniques cannot handle. It is one of the most widely used and generally acceptable techniques for estimating the total economic value of many classes of public goods and services that other economic techniques cannot accommodate.

In addition to the above its results are also relatively easy to understand, interpret, and to use for policy purposes. Monetary values are generally presented in terms of mean or median per household or aggregate values for the target population.

4.5 Empirical Model

The main objectives of estimating parametric Model in WTP survey are to calculate mean WTP and to allow inclusion of respondents' socio-economic factors in to WTP function. Because incorporation of individuals' socio-economic variables in to the CVM helps the researcher to gain information on validity and reliability of the CV results and increase confidence in application of results obtained from the CV empirical analysis (Haab and Mc Connell, 2002)

Depending on the nature of available data, two models are used to analyze the WTP of household heads. First, since the dependent variable (i.e. WTP) is not fully observed we used Tobit Model. The other model employed in this study is Probit Model. Since we do not know the random part of preferences and can only make probability statements about "yes" or "no", we use the Probit model to estimate the probability of WTP.

4.5.1 The Porbit Model

The building block for this model starts with the specification of an indirect utility function for each CVM respondent (Haab and McConnell, 2002). In this study we assume that households gain utility from the improvement in SWM and the two possible levels of environmental quality, the status quo represented by q^0 and a specific level of improvement represented by q^1.

If an individual wants to remain at status quo (no improvement) his utility function will be:

$$u_o = u(y_i, z_i, q^o, \varepsilon_0) \qquad \ldots\ldots\ldots \quad 4.1$$

and if an individual is willing for improvement his utility function will be

$$u_1 = u(y_i, z_i, q^1, \varepsilon_1) \quad \ldots\ldots\ldots \quad 4.2$$

We can rewrite this in to one equation as:

$$u_{ji} = u_j(y_i, z_i, q_i, \varepsilon_j) \quad \ldots\ldots \quad 4.3$$

Where j=0,1 refers to the two different states of the environment and i=1,2,...n refers to individual i and U_{0i} and U_{1i} represent, respectively, indirect utilities at the status quo and the hypothetical improved scenario, y_i is the i^{th} utility maximiser's (individual consumer $_i$) discretionary income, z_i represents a vector of household socio-economic, demographic, environmental and design variables (i.e., starting prices etc.), q_i refers to the quality of the good being valued (environmental improvement), and ε_j represents other variables known to the utility maximiser but not observed by the researcher or commonly the error term.

When the quality of good q (environmental improvement) changes from q_0 to q_1 (as a result of a policy change), the individual's utility also changes from:

$$u_{0i} = u(y_i, z_i, q^0, \varepsilon_{0i}) \text{ to } u_{1i} = u(y_i, z_i, q^1, \varepsilon_{1i}).$$

On the basis of this, utility maximiser i answers yes to the yes/no CVM question at offered price (bid) bi if his utility at the improved level, net of the required payment, exceeds status quo utility as follows:

$$u_1(y_i - b_i, Z_i,, q^1, \varepsilon_{1i}) > u_0(y_i, z_i, q^0, \varepsilon_{0i}) \quad \ldots\ldots \quad 4.4$$

However, because we typically do not know the random part of preferences and can only make probability statements about "yes" or "no", the probability of a utility maximiser answering yes to the valuation question is consequent upon $U_1 > U_0$ (i.e., the utility maximiser

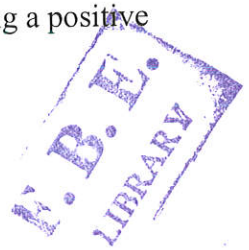
is better at q^1 even with the required payment bi). For utility maximiser i, the probability is given by:

$$Pr(yes) = pr[u_1(y_i - b_i, z_i, q^1, \varepsilon_{1i}) > u_1(y_i, z_i, q^0, \varepsilon_{0i})] \quad \ldots\ldots 4.5$$

For parametric estimation, the following modeling decisions must be made (Haab and McConnell, 2002). First, we need to choose a functional form for $U(y_i, z_i, q^1, \varepsilon_{1i})$, and secondly, we must also specify the distribution of ε_{ji}. Generally, in most empirical applied research work employing either the Random Willingness to Pay Model (Cameron and James, 1987) or the Utility Differential Model (Hanemann, 1984), researchers begin their specification by assuming a utility function that is additively separable in systematic and stochastic components of preferences as follows:

$$u_j(y_i, z_i, \varepsilon_{ji}) = v_j(y_i, z_i,) + \varepsilon_{ji} \quad \ldots\ldots\ldots \quad 4.6$$

On the basis of this specification, the probability of the i^{th} utility maximiser giving a positive response to the valuation question becomes:



$$\mathbf{Pr(yes) = pr[v_1(y_i - b_i, z_i, q^1) + \varepsilon_{1i} > v_0(y_i, z_i, q^0) + \varepsilon_{0i}]} \quad \ldots\ldots \mathbf{4.7}$$

$$= pr[v_1(y_1 - b_i, z_i\, q^1) - v_0(y_i, z_i, q^0) > \varepsilon_{0i} - \varepsilon_{1i}$$

The probability of the i^{th} consumer (utility maximiser) giving a negative response (rejects the improvement) will become:

$$Pr(no) = 1 - pr(yes)$$

This equation is still too general for parametric estimation. However, when the systematic part of the preference function is assumed linear in income and other covariates, the model can be simplified as:

$$v_{ij}(y_i) = \alpha z_i + \beta(y_i) \quad \ldots\ldots\ldots \quad 4.8$$

Here, y_i represents the individual consumer's (utility maximiser i) discretionary income, z_i represents an m-vector of household socio-economic, demographic, and environmental and design variables and α_i is an m dimensional vector of parameters. For the new SWM CVM scenario, in which the DC question will require a 'yes' or a 'no' response at some offered price bi, the probability of the i^{th} respondent answering yes to the valuation question is given by:

$$pr(yes) = pr[\alpha z_i + \beta b_i + \varepsilon_i > 0] \quad \ldots. \quad 4.9$$

To estimate equation (4.9), we assume that the error term is normally, independently and identically distributed with mean zero and variance equal to 1. The result is a Probit Model (Cameron and James, 1987) cited by Fonta et al, 2000).

Let us assume that $\eta = \varepsilon_{0i} - \varepsilon_{1i}$ and let F_η ( ) be the cumulative distribution function of η then the probability that the individual is willing to pay for the improvement is:

$$Pr(yes) = F_\eta(\Delta v) \quad \ldots\ldots\ldots \quad 4.10$$

$$Pr(no) = 1 - F_\eta(\Delta v) \ldots\ldots\ldots$$

Where $\Delta V = V_1(y_i - b_i, z_i, q^1) - V_0(y_i, z_i, q^0)$

The main purpose of the analysis is to estimate WTP and from the assumed utility function can drive a WTP function. Assume that P_i is unobservable individual household's actual WTP for improved SWM service, then

$$p_i = \alpha z_i + \beta(y_i)$$

$$\alpha_0 z_i + \beta y_i + \varepsilon_{0i} = \alpha_1 z_i + \beta(y_i - b_i,) + \varepsilon_{1i}$$

$$= \alpha_1 z_i + \beta(y_i - WTP_i,) + \eta_i$$

Where Pi is unobservable individual household's actual WTP for improved SWM service

By solving this individual i's WTP can be:

$$WTP_i = \frac{\alpha z_i + \eta_i}{\beta} \quad \ldots\ldots \quad 4.11$$

In the Probit Model F_η (..) is the normal cumulative distribution function. As we define above, the unobservable individual household's actual WTP for improved SWM service is P_i with linear relation with the initial bid, b_i and the covariates, then the actual WTP for an individual can be presented as follows:

$$WTP_i = 1 \text{ if } P_i \geq b_i \quad \ldots\ldots\ldots \quad 4.12$$
$$WTP_i = 0 \text{ if } P_i < b_i$$

In a dichotomous choice CVM elicitation format the i^{th} respondent (utility maximizer) is asked if he/she would be willing to pay the initial bid (b_i) to get a given improvement in environmental quality or both quality and quantity in this case solid waste management improvement.

This is a random variable from the viewpoint of the researcher. The probability of yes or no response can be presented as:

$$\Pr(\text{yes to } b_i) = \Pr(P_i \geq b_i)$$
$$\Pr(\text{no to } b_i) = \Pr(P_i < b_i)$$

The log likelihood function of this single bounded CV survey response is:

$$\ln L(\theta) = \sum_{i=1}^{N} \{d_i^Y \ln \Pi^Y(b_i) + d_i^n \ln \Pi^\Lambda(b_i)\}$$

$$= \sum_{i=1}^{N} \{ d_i^Y \ln G(b_i,\theta) + d_i^N \ln[1-G(b_i,\theta)]\} \ldots\ldots$$

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

$G(b_i\ \theta)$ and $1\text{-}G(b_i,\theta)$ are the cumulative distribution function (cdf) for the probability of yes and no responses; and θ represents the vector of parameters that index the distribution of WTP.

4.5.2 The Tobit Model

In certain application when the dependent variable is zero for a substantial part of the population, the dependent variable in this case the WTP is not fully observed. The alternative to OLS when dependent variable response is zero for a significant fraction of the observation is the Tobit model (Verbeek, 2000).

Generally the standard Tobit model can be summarized as follows (Greene 1994):

$y_i^* = \beta X'_i + \varepsilon_i$, i= 1,2, …,N

$y_i = y_i^*$ if $y_i^* > 0$

$= 0$ if $y_i^* \leq 0$

Where ε_i is assumed to be NID $(0, \sigma^2)$ and independent of x_i

Let MWTP be latent variable which is not observed when it is less than or equal to zero but is observed if it is greater than zero. Following Verbeek (2000) the Tobit model for the observed maximum willingness to pay (MWTP) for this particular study is given by:

$$MWTP_i^* = \alpha + \beta X'_i + \varepsilon_i$$

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

$$= 0 \text{ if } MWTP_i^* \leq 0$$

Where $MWTP_i$ is the unobserved maximum willingness to pay of an individual for improved solid waste management

$MWTP_i^*$ is the actual maximum willingness to pay of an individual for improved solid waste management

X' is vector of independent variables

β is vector of coefficients

α is the intercept and

ε_i is disturbance term, which is assumed to be NID $(0, \sigma^2)$ and independent of x_i

Assume that Censoring point is zero

$$MWTP = \alpha+\beta_1 ASWG+\beta_2 Income +\beta_3 Bid+\beta_4 SER +\beta_5 AGR +\beta_6 EDLR +$$
$$\beta_7 EAR +\beta_8 Fam\_Sz +\beta_9 Marriage +\beta_{10} PERCEPT +\beta_{11} House$$
$$+\beta_{12} TSWSD+ \varepsilon_i \quad \text{if } MWTP_i^* > 0$$
$$= 0 \text{ otherwise (if } MWTP_i^* \leq 0 \text{)}$$

CHPTER FIVE

EMPIRICAL RESULTS AND ANALYSIS

5.1 Descriptive analysis

5.1.1 Socioeconomic Characteristics of the Sample Households

Table 2 provides the socioeconomic characteristic of the sample households corresponds with WTP for improved SWM system, whereas table 3 reports description of variables used in the analysis including means and standard deviation. As shown in table 2, 92 percent (208 of the respondents) had positive WTP values for the SWM improvement.

In terms of the sample household Characteristics, 51.33 % (116 of the sample are females)[6] while the rest 48.67% (110 of the sample) are males. As shown in table 2, 95.69 % from female respondents had positive WTP for improved SWM and 88.18 percent from male respondents had positive WTP for SWM improvement. This might be due to the reason that traditionally females are more responsible for solid waste management.

As indicated in table 3, the average monthly income of heads of household that participated in the survey was found Birr 1495.85 with minimum monthly income of Birr 200.00 and maximum of Birr 12776.00 and the average family size is 4.76. From the descriptive data presented in table 2 we can see that as the level of income increase the percentage of yes response for the improved SWM system also increased.

The survey data indicates that 13.72 percent (31 respondents) either can't read & write or attended informal education while 26.99% (69 respondents) has attained primary level of education. The rest 30.53% and 2.96 % of the respondents had attended secondary and tertiary

[6] Not all of the females are heads of households, some of them are wives and others are elders interviewed when the head of the household is not found during the interview.

levels respectively. Comparing the educational level of respondents with WTP, the percentage of positive response for environmental improvement increases with the level of education as indicated in table 2.

Table 2 Socioeconomic characteristics of sample households and WTP

Socioeconomic condition of households		WTP for improved environment (solid waste management)		
		Yes	No	Percentage of yes response
Gender	Male	97	13	88.18
	Female	111	5	95.69
Age of respondent in years	20-40	122	-	100
	41-60	81	15	84.38
	Above 60	5	3	62.50
Educational level	Illiterate	20	11	64.52
	Elementary	55	6	90.16
	Secondary	68	1	98.55
	Tertiary	65	-	100.00
Income	< 600 Birr	34	11	75.56
	600-1200	75	5	93.75
	1201-2000	42	2	95.45
	Above 2000	57	-	100.00
Family size	≤ 2	31	-	100.00
	3- 6	145	15	90.63
	> 6	32	3	91.43
Marital status	Married	154	9	94.49
	Single	25	1	96.15
	Widow/widower	7	6	53. 85
	Divorced	22	2	91.67
Employment	Civil servant and company employed	77	2	97.47
	Traders	84	5	94.38
	Self employed and daily laborers	24	3	88.89
	Unemployed	12	4	75.00
	Others*	11	4	73.33

Source: survey of this study

* Others include retired and board

Concerning age of respondents 122 are between 20 and 40 years 96 are between 41 and 60 and 8 respondents are above 60 years and the mean age is 39.5 years. In this descriptive data, as age of respondents increase yes response for improved environment decrease.

Regarding the housing condition of the respondents, 53.54 % of them are currently living on their own house and the rest 46.46% of them rented either from public or private owners.

Table 3 Description statistics of variables used in the WTP analysis

Variables	Description	Mean	Standard deviation	Min	Max
WTP (dep. var. in Probit Analysis)	1 if WTP>0 and 0 otherwise (i.e. 1 for a yes answer to the offered starting bid and 0 otherwise)	.920354	.271345	0	1
Maximum WTP	Monthly Maximum WTP in Birr of the respondent	7.878319	5.21255	0	30
Starting bid (bi)	The initial bids offered to the respondents DC question in Birr monthly 2.50, 5.00, 10.00, 15.00	7.47549	4.161797	2.50	15.00
Age (AGR)	Age of respondent in year	39.5354	10.8538	20	70
Sex (SER)	Gender of respondent coded as 1 if respondent is female and 0 otherwise	.5132743	.5009332	0	1
Perception	Perception of the respondent on the current solid waste management =1 if respondent perceives current solid waste management as fair and 0 otherwise	.4867257	.500933	0	1
Household waste	Household weekly generation of solid waste measured in sack	0.436946	0.25420	.25	2
EDLR (education)	Educational level of respondents represented as 0 for illiterate and informal education 1 for elementary 2 for secondary and 3 for tertiary	1.743363	1.02223	0	3
Fam_Sz	Family size of the household	4.756637	1.94777	1	11
Marriage	Marital status of the respondent, 1 for married and 0 otherwise	.7212389	.449385	0	1
Income	Monthly income of the head of the household in Birr	1495.854	1325.04	200	12776
Awareness (EAR)	Environmental awareness of the respondent, 0 for not aware, 1 for fairly aware and 2 for much aware	1.287611	.680866	0	2
House ownership	House ownership of the respondent, 1 for own house and 0 otherwise	.5353982	.499852	0	1
Type of solid waste service (TSWSD)	Type of solid waste service demanded by the household, 1 for collection, recycling and disposal and 0 otherwise	1.41592	.493975	1	2

Source: result of this survey

WTP and starting bids: In the study four starting bid prices were used. These starting bids are determined based on the pilot survey and assessment of the current practice in the city. From all of the respondents only 24 individuals (10.6%) said no for the initial bid. The frequency of no response for WTP increases with an increase in the initial bids. The mean of the starting bids is Birr 7.25 per month.

Table 4 WTP response against starting bids

	Initial Bids			
Response to initial Bids	2.50	5.00	10.00	15.00
Yes	16	99	64	23
No	24	40	139	203
Percentage of No response	10.62	17.70	61.50	89.82

5.1.2 Current solid waste management condition of the sample households

From the sample it is reported that 116 respondents (53.33%) considers the current SWM as not good and 110 respondents (48.67%) perceived the current SWM system as fair. Far there more, 58.4% (132 of the respondents) demanded only collection and disposal services of solid waste while 41.6% (94 of the respondents) are demanded recycling in addition to the above. The sample households reported that their weekly solid waste generation is 0.44 sack on average with minimum 0.25 and maximum 2 sacks per week.

Respondents were asked where they dispose their solid waste and they reported that around 40% (90 respondents) are dispose their solid waste on the nearby container, 12% (27 respondents) on an open space, 2.6% (6 respondents) on river near their home, and 45.6% (103 respondents) collected from their home by the organized micro and small enterprises employed by the municipality on contract basis. All most all respondents (99 percent) reported that they dispose their solid waste together whether it is organic, plastic or galas (i.e. there is no waste separation at source)

90.26% (204 respondents) agreed that women are responsible for disposal and collection of solid waste in household level, 5.6 %(13 respondents) said children are responsible and the rest 4% (9 respondents) responds that both are responsible.

Respondents were also interviewed about responsibility of SWM on city level. To this question, around 44% (99 respondents) respond that it is the responsibility of municipality or city government; about 28.3% (64 respondents) community and 27.8% (63 respondents) said all government, community and polluters are responsible.

About the choice of the improved solid waste service, 34% of the respondents choose the service to provide by the government, 24% from private and 42% by organized community.

5.2 Regression Results of WTP

So far, we have discussed the characteristics of the sample and simple relationship between the sample characteristics and WTP using descriptive data analysis. We now turn to the multivariate econometric analysis that can give us a broader framework as to which factors are responsible for Willingness to Pay (WTP) for improved solid waste management service.

First, it is necessary to distinguish between responses that can be considered as valid and those that appear 'invalid'[7]. Out of the 226 completed interviews, 24 respondents (10.6%) were considered to have invalid responses to the valuation question. The main reasons for such invalid responses include actual zeros (6) or protest zeros (12) and outliers (4). Identification of actual or protest zeros was based on a follow-up question to the valuation question in which the respondent was asked to give reasons for not wanting to pay for the scheme. Six said they have insufficient income to pay, two said that they have no faith on the scheme, whereas ten said they would prefer to wait for the city government. Outliers are those whose maximum willingness-to-pay bids are more than 5% of their estimated income no in this case, and also those who accepted the improvement but reported a significantly lower amount than the initial start price (bid) in the follow-up question in this case (four).

In addition, it was also necessary to determine whether excluding invalid responses from the econometric analysis would lead to a sample selection bias. Simple comparisons of means of household covariates between the two groups (i.e., valid and invalid responses) were performed. For some of the variables such as the gender of the respondent, income, perception of existing SWM system, educational level and household generation of wastes, the differences between the two groups (i.e., valid and invalid responses) are quite significant(see annex 3). If these variables influence the respondent's WTP value for the scheme, then the final estimates obtained from the sub-sample of valid responses may be affected by selectivity bias and therefore we include all the respondents in the analysis.

[7] By 'invalid', we mean WTP responses that were actually excluded from the censored regression (i.e., actual or protest zeros, as well as outliers).

Second, conducting different testing is very important. For testing whether multi-co linearity is present or not a simple correlation coefficient matrix has been computed. Gujarati (1995) sets a rule of thumb, which indicates that multi co-linearity is a serious problem when correlation coefficient is 0.8 and above. The expenditure of the respondent is omitted due to high correlation with income. Generally, multi co-linearity is not serious problem in this data (see annex 2).

In addition we are likely to encounter hetroskedasticity frequently in econometric data, particularly with the cross-section data. The reason is that the variation in the dependent variable seldom remains constant when the levels of one (or more) explanatory variable(s) increase or decrease (Mukherjee, White and Wuyts, 1998). Therefore there is a need to test on the possible existence of this problem and the test conducted is shown on annex 3.

5.2.1 The Probit Model Results and Discussion

Starting first with the Probit results, there are some significant coefficients of variables in this model. In this model, these identified variables characteristic aspects of the sample that influence the likelihood that the respondent will provide a positive WTP value, but do not influence the magnitude of the resulting WTP values. Such variables are particularly important for understanding the possibility of some inherent self-selection bias induced by the respondent choice to respond adequately to the WTP questions (McClelland et al., 1993).

Table 5 Results of Probit Model

WTP	Coef.	Std. Err.	z	P>|z|
ASWG	.0392442	1.554377	0.03	0.480
TSWSD	.0247149	.6764658	0.04	0.571
SER	.428413	.445316	0.96	0.336
AGR	-.0639994	.0268229	-2.39	0.017
EDLR	.1080922	.3687739	0.29	0.469
EAR	1.580988	.6229722	2.54	0.011
Fam_Sz	-.0265765	.1262397	-0.21	0.833
income	.003767	.0005392	6.98	0.015
Marriage	.5565871	.5196829	1.07	0.284
PERCEPT	.4573019	.5553125	0.82	0.410
House	.6178679	.5504317	1.12	0.262
Start_price	-1.972244	1.517966	-1.30	0.194

As presented in table 5 many variables in this Probit Model are not influence significantly the likelihood that the respondent will provide a positive WTP value. The variables which have positive relationship with WTP value but statistically insignificant includes: amount of solid waste generation of households (ASWG), type of solid waste service demanded by households (TSWSD), sex of respondent (SER), educational level of respondents (EDLR), marriage of respondent (marriage), and house ownership of the respondent (house). On the other hand family size of the respondent (fam_Sz) shows a negative but insignificant impact on the probability of yes response for the WTP in SWM improvement and this sign have no intuitive sense.

The variables that are significantly related to providing positive WTP values are: household income and respondents' awareness of environmental quality while respondents' age has negative significant relation with WTP. All of the signs of these three variable coefficients make intuitive sense. A higher-income consumer apparently has a greater demand for the waste-management amenity and is, therefore, more willing to pay for it. Households those with higher awareness of environmental quality tend to provide positive WTP values. On the other hand age of households has negative relation with the WTP. The negative relationship indicates that the old people who freely dispose their solid waste for many years are less willing to pay for improved solid waste management.

Goodness of fit: - A goodness of fit measure is a summary statistic including the accuracy with which the model approximates the observed data, like the R^2 measure in the linear regression model. In the case in which the dependent variable is qualitative, accuracy can be judged either in terms of the fit between the calculated probabilities and observing response frequencies or in terms of the model's ability to forecast observed responses. Contrary to the linear regression model, there is no single measure for the goodness of fit in binary models and a variety of measures exist (Verbeek, 2000).

Some of the measures of goodness of fit are PseudoR^2 and McFadden. The results of test for goodness of fit are: PseudoR^2 = 0.6398 and McFadden= 0.608461 (see anex3). As the value of the calculated result closes to 1, the explanatory power of the model will increase.

5.2.2 The Tobit Model Results and Discussion

As indicated in table 7, from the 12 independent variables (determinants) eight of them are statistically significant. Amount of solid waste generated by the household (ASWG) per week: this variable has a positive impact on the amount of WTP as expected and it is statistically significant even at 1% i.e. households who generate more solid waste will have more demand for improved SWM system.

Type of solid waste service demanded by the households (TSWSD): As explained earlier this is a dummy variable and takes 1 if respondents choose collection, recycling and separation of waste and zero otherwise. This dummy shows a positive relation with the amount of WTP and is significant at 5% significant level. This can be related with the awareness of respondents and as respondents are more aware about the environment, they prefer for best method of solid waste management i.e. separation and recycling in addition to collection and disposal, and households who prefer for separation and recycling may have greater amount of WTP for improved SWM than the others.

Table 6 Results of Tobit Model

MWTP	Coef.	Std. Err.	t	P>|t|
ASWG	4.795559	.9262455	5.18	0.000
TSWSD	1.217005	.5120089	2.38	0.018
SER	-.1682642	.437997	-0.38	0.701
AGR	-.0347685	.0263077	-1.32	0.188
EDLR	1.119762	.2828829	3.96	0.000
EAR	2.287087	.4557459	5.02	0.000
Fam_Sz	-.1060251	.1283966	-0.83	0.410
income	.0006381	.000199	3.21	0.002
PERCEPT	-1.239538	.5017137	-2.47	0.014
Marriage	.9047512	.5207924	1.74	0.084
House	1.310588	.464285	2.82	0.005
Start_price	-.751212	1.573669	-0.48	0.634

Educational level of respondents (EDLR): educational level of respondents has strong positive relationship with amount of WTP and it is significant at 1%. It is logical that as respondent's educational level increases, their income increases this leads to increase environmental demand.

Environmental awareness of respondents (EAR): this variable has a positive relationship and is significant at 1 percent. More awareness about the environment means respondents know the benefit of the environment and it is likely to have more environmental demand.

Income of respondents (income): another determinant that has positive impact on the amount of WTP is income. It is significant at 95% confident level. This is consistent with economic theory that explains income is positively related with demand in general and the same with environmental demand. This also indicates that environmental good is a normal good since its demand increases with income.

Perception of respondents for the current solid waste management (PERCEPT): This dummy variable has a negative impact on WTP for improved solid waste management and is significant at 5%. This negative relationship indicates that households who perceive the current SWM system as good will be less willing to pay than households who perceive the current solid waste management system as bad.

Marriage of respondents (marriage): this dummy variable has a positive and significant at 10% significant level with amount of WTP. Married respondents have higher WTP than others.

House ownership (house): this dummy has a significant impact at 1% and positive relation with WTP which means households with their own house have more WTP for improved SWM system than those living in rented houses. This may be because of those people living in a rented house considers their residential area as temporary or may be due to the current condition in the city that only hues owners are paying for sanitation.

The other four variables such as starting bid, sex of respondents, family size of the household, and age of the respondent have no significant impact on the amount of WTP for improved solid waste management.

Starting bid (start_price): the coefficient of the starting price (Start_price), or the initial offered amount to the CVM participant, is insignificant, though it is negative. This result suggests that respondents do not tend to give invalid responses for higher starting prices than lower ones. Such a result provides some comfort in the belief that our findings would not be biased by the level of starting prices offered to participants.

Sex of respondent (SER): This female dummy has negative sign even though insignificant. In the descriptive analysis we have seen that female respondents have greater percentage of positive response than their male counterparts. In the probit model of probability of yes response this female dummy has positive though insignificant. This implies that female

dummy affects only the probability of saying yes but not affects the amount of willingness to pay.

Family size of the household (Fam_Sz): This variable has negative relation with amount of WTP though insignificant. This negative relation is not as hypothesized. The reason may be in large family size there is high dependency rate and share of income will small consequently less environmental demand.

Age of the respondent (AGR): Age has negative relationship as expected but not significant. The negative relationship indicates that the old people who freely dispose their solid waste for many years are reluctant to pay for improved solid waste management.

In the probit model, the variables which have individual insignificant influence to WTP may have significant impact together in addition to the three variables. Unlike the probit model many variables in the Tobit model have intuitive sign and significant relation with the amount of WTP for improved solid waste management service.

5.3 Estimation of Benefits for Improved Solid Waste Management

So far we have seen the factors that are influential for WTP when there is improvement in solid waste management service. Now we look to the aggregation and estimation of benefits due to improved SWM system which is the last part of CVM survey.

One of the main objectives of estimating empirical WTP model based on the CV survey response is to draw central measure or mean and median of the WTP distribution (Hanemann, 1994). The mean WTP is –intercept divided by the bid coefficient.

The mean WTP (μ) using Probit model for the single bounded dichotomous format is calculated as:

$\mu = -\alpha/\beta$ where α is the intercept and β is coefficient of the bid

Therefore the monthly mean WTP of the respondents (sample household heads) can be computed by using the above formula and from the results from the single bounded model. Using Limdep version 7, the mean WTP for improved solid waste management per month per household is found Ethiopian Birr 8.68

In addition we can also compute the mean WTP using the open-ended elicitation format i.e. the maximum WTP of the respondents as follows.

Variable	Mean	Standard deviation	Min	Max
MWTP	7.878319	5.21255	0	30

We have seen that the mean WTP from the open-ended format is Birr 7.88 per month per household and is less than but closer to the closed format. Therefore, households' mean WTP for improved solid waste management is in the range of Birr 7.80 – 8.60 per month per household.

We can calculate the monthly WTP of the city by multiplying this mean by the total number of households and it is about Birr **426,138.28** per month.

In addition we can also estimate by using one of the aggregation methods of WTP. As explained in earlier, the current population of Mekelle is 257, 290 and based on the sample the average family size is 4.76 and the number of households is about 54090.

Table 7 Total monthly WTP estimates for improved SWM in residential houses of Mekelle city

WTP interval (Birr per month)	Frequency of sample distribution		Mid WTP	Total Number of households	Total WTP
	Number	Percent			
0 - 3	36	0.159292	2	8616.106195	17232.21
4 -6	83	0.367257	5	19864.9115	99324.56
7 -9	19	0.084071	8	4547.389381	36379.12
10 – 12	59	0.261062	11	14120.84071	155329.2
13 – 15	12	0.053097	14	2872.035398	40208.5
16 – 18	2	0.00885	17	478.6725664	8137.434
19 - 21	14	0.061947	20	3350.707965	67014.16
22 – 24	0	0	23	0	0
25 -27	0	0	26	0	0
28 -30	1	0.004425	29	239.3362832	6940.752
Total	226	1		54090	430566

Source: result of this study

Prior to the aggregation of benefits class boundaries for the results of the open-ended questions are set. The mid WTP or class mark is the average of the WTP interval or class boundaries. The total monthly WTP of the city using this method is estimated to be Birr ***430566.00.*** Using the dichotomous single bounded question the monthly WTP is estimated to be Birr ***469501.20*** and therefore the actual WTP of the households in Mekelle city may fall between these two figures.

CHAPTER SIX

CONCLUSION AND POLICY IMPLICATIONS

6.1 Conclusion

In several rapidly growing cities in developing countries solid waste is a major source of concern due to lack of appropriate planning, inadequate governance, resource constraint and ineffective solid waste management. According to UNEP (2004), the generation of solid waste has become an increasing environmental and public health problem everywhere in the world, particularly in developing countries.

In Mekelle city, solid waste management is mainly provided by the municipality and it has been measured and evaluated always based on the role and performance of the service provider (supplier of the service) and demand side i.e. WTP of the residents is ignored.

The participation of the service receivers especially households who are the primary producers and generators of significant proportion of solid waste and may be main victim of the effect of solid waste, should allow to determine their providers and participate in making of sound policy decisions including designing of effective joint solutions of solid management. This would help the providers to understand households' willingness to participate and pay.

In Mekelle city annual solid waste generation is 28098577 kilogram. Collection coverage of solid waste based on the study by promise consultant (2005) was only 34.2%. Solid waste collection coverage is very low this implies solid waste is thrown everywhere in the city such as open space, green areas, rivers, canal ditches etc due to this waste is spread to all residential houses in the form of dust by the high wind in the city and causes disease. Canal ditches and sewerage system filled by waste and causes flood overtop on the streets.

In Mekelle municipality none of the modern solid waste management is implementing and still there are no recycling activities by the municipality in organized manner. Solid waste is not separated or sorted at source and after collection simply it is dumped together.

The revenue covers only 9.5 percent and the rest 90.5 percent is covered from other sources. Since the waste management has no enough source of revenue it can't be sustainable even with the present condition.

This study aims to analyze households' valuation of improved solid waste management service in Mekelle city by using the data obtained from the sample of 226 household heads. The study used primary data form the sample and secondary data from respective institutes, authorities and reference materials.

The method of survey we employed was contingent valuation method with single bounded elicitation format followed by open-ended follow-up questions, and we administered the survey using face to face interview (in person interview). The study used both descriptive and econometric techniques of analysis and twelve explanatory variables were used in the regression models based on the degree of theoretical importance and their impact on WTP. Probit and Tobit models were used to identify the determinants of households' WTP for improved solid waste management system and to analyze the mean WTP of households.

In the descriptive analysis, 92 percent of the respondents had positive WTP values for the SWM improvement. From the sample it is reported that 116 respondents (53.33%) considers the current SWM as not good and 110 respondents (48.67%) perceived the current SWM system as fair. 99 percent of the respondents reported that they dispose their solid waste together whether it is organic, plastic or glass (there is no waste separation)

In the results of the Probit model, the variables that are significantly related to providing positive WTP values are: household income and respondents' awareness of environmental quality while respondents' age has negative significant relation with the likelihood that the respondent will provide a positive WTP value. All of the signs of these three variable

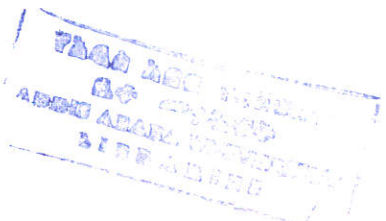
coefficients (coefficients of income, awareness of environmental quality and age) make intuitive sense and significant at 1%, 5% and 5% respectively. The other variables have no significant impact on the likelihood that the respondent will provide a positive WTP value.
In the Tobit model, eight variables from 12 have statistically significant impact on the amount of WTP for improved solid waste management system. Amount of solid waste generated by the household (ASWG) per week, Educational level of respondents (EDLR), Environmental awareness of respondents (EAR) and House ownership of household heads (house): have a positive relationship with the amount of WTP and significant even at 1 percent.

Type of solid waste service demanded by the households (TSWSD) and Income of respondents (income) have positive relationship and significant at 5% and marriage of respondents (marriage) has positive and significant at 10 % significant level while Perception of respondents for the current solid waste management (PERCEPT) has negative relation and significant at 5% with the amount of WTP for improved solid waste management system.

The rest four variables such as Starting bid (start_price),Sex of respondent (SER), Family size of the household (Fam_Sz), and Age of the respondent (AGR) have negative but insignificant relation with the amount of WTP for improved solid waste management.

By using Single bounded the mean WTP for improved solid waste management per month per household is found Ethiopian Birr 8.68 and using the open-ended (maximum WTP) is found Birr 7.88 per month per household.

The total monthly WTP of the city using aggregation method is estimated to be Birr ***430566.00.*** Using the dichotomous single bounded question the monthly WTP is estimated to be Birr ***469501.20*** and therefore the actual WTP of the households in Mekelle city may fall between these two figures. Comparing with the revenue collected based on the service fee regulation and current expenditure for the existing solid waste management, this WTP is much bigger and SWM of the city can be improved by residents' participation.



6.2 Policy Implications

- By the current sanitation fee and the existing system, the solid waste management can not be improved and can't cover its cost even with the existing level and therefore participation of residents is important to improve and make sustainable for improved solid waste management of city.
- Assuming that what respondents' say to day remained the same for the future, an important policy implication of greater WTP obtained in this study is that the current payment for sanitation in the city is much below WTP of the people.

- The strong positive relationship between income, environmental awareness of respondents and educational level reveals that efforts towards improving residents' income, environmental awareness, and education will increase WTP for improved environmental quality in general and improved solid waste management in particular.

- If people know or are informed about the nature of improvement in environmental quality, that is, improved solid waste management, the envisaged welfare improvement elicits people's WTP (Hartwick et al 1998). Therefore WTP can be used to predict the level of welfare gained from improved SWM system.

- Comparing this mean WTP with what Gojo, which is private solid waste collector institution practically charged for households for the service (i.e. 10 Birr) this study can be used as initial for a fee to be charged to the various waste-generating agents such as households for public decision making.

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Annexes

Annex 1 CVM survey questionnaire for the value of improved solid waste management

This survey is being conducted only for academic purpose and will be kept confidential. Hence, we request you to participate in the discussion truly and voluntarily. The questionnaire is designed to obtain information on your willingness to pay (WTP) towards the improved solid waste management in Mekelle city.

Interview started time _____

I. Questions about Current situation of solid waste management and awareness of respondents

1. How does your household dispose solid waste?
    1) Dispose on the solid waste (garbage) container around our house
    2) Dispose on open space around
    3) Dispose on mobile waste collector (tractor)
    4) Dispose in river around
    5) Collected by private solid service providers form our home
    6) Others specify_____
2. If your answer for question number 1 is 5:
    2.1. 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 services in your household?
    [1] Females [2] Males [3] Children 4[ ] if other specify _____
4. How do you dispose used plastic bags glasses and other plastics?

[1] By separating from other type of waste [2.] Simply dispose all waste together

5. How much solid waste you produce per week? _____sack
6. How do evaluate the current situation of SWM in the city.

[1] Very bad [2] bad [3] good [4] very good [5] I can't judge [6] I don't know

7. What environmental and health problem (impact) will create the current unsound solid waste disposal (disposal on open space) do you think?

_____

_____

8. Who is responsible for provision of solid waste management service in your view?

   1) Municipality 2). The community 3) Polluters 4) All

   5) Specify if others _____

9. Which body do you prefer for the provision of the improved solid waste management?

   1) Government
   2) Private sector
   3) Organized community members
   4) Others specify _____

10. Which type of solid waste services do you want to get from the service providers?

   1) Collection from house and Proper disposal of solid waste
   2) 1 plus Separation and Recycling of solid waste

11. What do you suggest for the current solid waste to improve? _____

_____

II. The environmental problem and description of scenario

In Mekelle city, there is an increasing in population growth and economic activities. But there is failure to pay adequate attention to solid waste management and due to this the sanitation of the city becomes worsen and worsen from time to time. Such a failure in solid waste management incurs a severe consequence at present and particularly at a later time in the form of resources needlessly lost and a staggering adverse impact on the environment and on public health and safety.

Therefore, the aim of this survey is to improve environmental conditions of residents of the city and to recommend to fined solution for the existing problem based on your

information. The proposed idea is that to collect solid waste products twice weekly from each household resident's solid waste receptacles and to separate solid waste on recyclable and non-recyclable; to process the recyclable and dispose the non recyclable to the new landfill site i.e. currently on construction located at West side of the city. The operators of these activities are the organized Micro and Small Enterprises (MSEs) or any private sector.

The benefits to be derived from the clean environment (improved solid waste management) would include: cleaner environment as a result of regular disposal of waste, safe drinking water, control of rodents and mosquitoes, reduction in bad odour predominant in most parts of Mekelle city and waste recycling for biomass energy production for household consumption and other uses.

However, for the scheme to be sustainable, each household would have to pay some money for the operators of the activity on monthly basis.

Please we would like you to think carefully of your monthly expenditure on other goods and services before deciding on what amount your household can vote into the payment for support of the new SWM service for the city. No answer given is right or wrong; but we would like just to know how your household would support of this environmental improvement

III. WTP questions

Now, considering all these benefits that might accrue to your household and the city:

2.1. Would your household be willing to pay in support of the scheme?

Yes (go to2.2) _____

No (got to 2.4) _____

2.2 Would you willing to pay _____ Birr per month for the improvement in SWM?

Yes_____ No _____

2.3 What is the maximum amount your household would be WTP in support of the new SWM scheme? ____ Birr monthly.

2.4 If your answer for 2.1 is No why is your household not WTP in support of the scheme?

1) We cannot pay due to lack of income.
2) We don't have faith in the proposed service.
3) The improvement in SWM is not important and priority to the city

4) Wait for the city government since I am paying sanitation fee for it

5) I do not know about its importance.

2.5 Your payment preference for solid waste is:

1) Monthly

2) Annually

3) On the service provision

4) If other specify _____

IV. Questions related to socioeconomic conditions of the households.

3.1 Sex 1) Male _____ 2) Female _____

3.2 Age ___ years

3.3 Level of education [0] for illiterate [1] for elementary [2] for secondary [3] for tertiary (college)

3.4 Occupation [1] Civil servant [2] Trader [3] Self employment [4] Daily labourer

[5] unemployed [6] others specify_____

3.5 Religion _____

1) Orthodox 2) Muslim 3) Protestant 4) Catholic

5) Other, specify _____

3.6 Marital status

[1] Married [2] Single [3] Divorced [4] Widow/ Widower

3.7 Household size [1] below 18 years _____ [2] 18 years and above_____

3. 8 The house you are living is [1] your own [2] rented

3.9 Number of household members with job _____

3.10 Monthly of the household head in Birr _____ Total household total income _____

3.11 Total household expenditure_____

3.12 Name and address of the respondent

Name _____ Woreda _____ Kebele _____ house number_____

For the enumerator

Interview completed Time _____

1. How the respondent was understands to the questions of the survey?

[a] very good [b] good [c] moderate [d] Little [e] was not understand

2. General observation of the enumerator

_____

_____

Annex 2 Test for multi co-linearity (simple correlation coefficient matrix)

	ASWG5	TSWSD10	SER	AGR	EDLR	EXPH	EAR	Fam_Sz	income	Marriage	PERCEPT	House	Start_prce
ASWG5	1.0000												
TSWSD10	0.3099	1.0000											
SER	-0.0876	-0.0224	1.0000										
AGR	0.1454	-0.2221	-0.2572	1.0000									
EDLR	0.1837	0.3912	-0.0303	-0.3816	1.0000								
EXPH	0.4892	0.3911	-0.0385	0.0316	0.4846	1.0000							
EAR	0.2847	0.5596	-0.0095	-0.3321	0.6328	0.5064	1.0000						
Fam_Sz	0.3885	-0.0037	-0.1741	0.3846	-0.2046	0.2692	-0.0623	1.0000					
income	0.3867	0.5051	0.0305	- 0.0847	0.5463	0.8751	0.5537	0.1905	1.0000				
Marriage	0.2829	0.0441	-0.1118	0.1187	0.0683	0.4293	0.0952	0.4100	0.4231	1.0000			
PERCEPT	-0.2736	-0.4625	0.0981	0.2017	-0.4096	-0.3216	-0.5334	0.0566	-0.4170	-0.1054	1.0000		
House	0.2407	0.0841	-0.0729	0.4008	-0.0539	0.2373	0.0737	0.2371	0.1491	0.1134	-0.1224	1.000	
Start_Price	0.4162	0.5666	-0.0357	-0.2489	0.6364	0.5818	0.7342	-0.0020	0.6833	0.2466	-0.5677	0.1547	1.0000

Annex 3 Test statistic

1. Test for comparison of means for 'valid/ invalid' WTP response

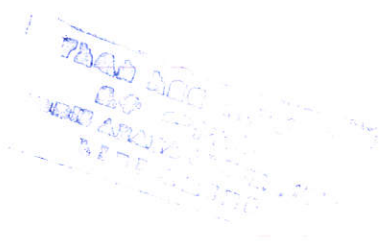
Variable	Mean		T _ stat
	Valid responses	Invalid responses	
Start price	7.47549020	2.50	2.340
Income	1594.76961	578.636364	3.297
EDLR	1.89215686	.363636364	3.826
AGR	36.9607843	55.3636364	-1.922
ASWG	.446078431	.352272727	0.547
SER	.578431373	.318181818	-.339
EAR	1.40686275	.181818182	3.333
TSWSD	1.45588235	1.04545455	2.574
FAM_SZ	4.71078431	5.59090909	-1.021
Marriage	.745098039	.5000	.710
PERCEPT	.450980392	.818181818	-3.349
House	.524509804	.636363636	2.283

2 Test for hetroskedasticity

A test of the hypothesis that $\alpha = 0$ (except for the constant term) can be based on the likelihood ratio statistic (Greene, 1994). LR statistics of testing the null hypothesis of homoscedasticity assumption is obtained by the following formula.

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

Where Log Lu is log likelihood function of the unrestricted and Log Lr represents the value of the restricted log likelihood function.



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

λ_{LR} = 2[Log Lu-Log Lr]

= 2[-24.59111-(-62.80630)]

= 2[-24.59111+62.80630]

= 2(38.21519)

λ_{LR} = 76.43038

The critical value of the chi-square at 11 degree of freedom is 19.68 at 95% confident level. The sample value exceeds the critical table value; therefore the null hypothesis can be rejected.

3 Test for goodness of fit

$\text{PseudoR}^2 = 1 - \frac{1}{1 + 2(\log L1 - \log Lo)/N}$ and in this case $\text{PseudoR}^2 = 0.6398$

Where Log L1 is log likelihood function of the unrestricted and Log L0 represents the value of the restricted log likelihood function and N denotes the number of observations

An alternative measure is suggested by McFadden, 1974

McFadden = 1-logL1/logLo or LRI = 1-lnL1/lnLo and this is some times referred to as the likelihood ratio index.

Where lnL1 is the value of the unrestricted log-likelihood function and lnLo is the value of log likelihood function with intercept only. Its value lies between zero and one. According to Greene (1993) values between 0 and 1 have no natural interpretation but as LRI closes to 1 it shows improvement in goodness of fit.

The computed value of LRI for this probit model is:

LRI = 1-(-24.59111/- 62.80630)

= 0.608461

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.

The examiners' comments have been dully incorporated.

Declared by:

Name: Dagnew Hagos

Signature: Hagos

Date: 27/01/2009

Confirmed by Advisor

Name: Ayele Mekonnen

Signature:

Date: 27/1/09

Place and date of submission: _____