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ANALYSIS OF HOUSEHOLDS' PREFERENCES FOR MPROVED SOLID WASTE MANAGEMENT IN ADAMA TOWN: APPLICATION OF CHOICE MODELING

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Analysis of Households' Preferences for Improved Solid Waste Management in Adama Town: Application of Choice Modeling

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Declaration

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

The examiners' comments have been duly incorporated

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Lists of Acronyms

CE------------------------------------ Choice Experiment

CM----------------------------------- Choice Modeling

CVM -------------------------------- Contingent Valuation Method

CV----------- -----------------------Contingent Valuation

EPA---------------------------------- Environmental Protection Agency

HP-------------------------------------- Hedonic Pricing

HPM----------------------------------- Hedonic Pricing Method

IIA--------------------------------------Independence of Irrelevant Alternatives

MNL------------------------------------ Multinomial Logit

MSW---------- -------------------------Municipal Solid Waste

OLS-------------------------------------Ordinary Least Squares

RPL----------- -----------------------Random Parameter Logit

RUT------------------------------------ Random Utility Theory

SW-------------------------------------- Solid Waste

SWM------------------------------------Solid Waste Management

TCM------------------------------------- Travel Cost Method

UNEP----------------------------------- United Nation Environmental Program

US EPA---------------------------------United States Environmental Protection Agency

WTP------------------------------------- Willingness to Pay

Abstract

In recent years, the generation of solid waste is increasing in Adama town due to rapid urbanization and population growth. Currently, out of the total waste generated in the town about 50-60 % is properly collected and disposed. The remaining amount of the waste is disposed on open spaces, streets and drainage channels along roadsides of the town. This uncollected solid waste in many places of the town may have serious adverse effect on public health and environmental quality. Moreover, the formal dumpsite, located some 8 km away from the center of the town, does not appear to have proper measures to control runoffs from rain fall. Thus, conducting a study on the demand for improved solid waste collection and disposal services is essential. The principal objective of this study is to analyze households' preferences for improved solid waste management in Adama town. Different solid waste management options are defined by the service attributes of frequency of waste collection from households, separation of waste at source, pollution control measures at the dumpsite and monthly service charge. The study employed the choice modeling technique, which is a stated preference method for the valuation of non-marketed environmental goods and services. The survey was administered on a random sample of 188 households in the town. The data was analyzed using Multinomial Logit and Random Parameter Logit models. The results of the study revealed that improvement in the levels of all the non-monetary attributes of the service increase the utility of respondents. In addition, households with higher monthly total income, larger family size, as well as respondents with higher levels of education favor the improved plans of solid waste management more frequently. Furthermore, households have a positive willingness to pay for improvement in the level of each non-monetary attribute. In conclusion, households in Adama town are willing to pay for improved solid waste collection and disposal services. The implication is that any policy directed towards the provision of effective solid waste management in the town should incorporate demand side information.

Chapter One

Introduction

1.1. Background

Effective solid waste collection and disposal is a vital component of public service provisions and should take priority particularly in emerging cities. Because, failing to have such services can result in many unfavorable outcomes in the long run; this may have serious adverse effects on public health and the environment. But, the expansion of such service provisions is often a challenging task for governments of developing nations due to heavily burdened and stretched financial and economic resources that lead to relatively high opportunity cost of funds (Murad et al., 2007).

The management of municipal solid waste resulting from rapid urbanization has become a concern for governments in most cities of developing countries. In these cities, the generation of solid waste continues to be a major challenge and an estimated 20-50% of the solid waste generated remains uncollected even though up to half of the local operational expenditures often allegedly go towards this end (Ammanuel, 2000). 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 cities of the developing world rapid urbanization and population growth has produced tremendous amounts of solid and liquid wastes that degrade the environment and destroy resources.

> *"The increasing level of solid waste is, nowadays, a serious problem in urban areas of the world. High rates of population growth and increasing per capita*

income have resulted 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 who have greater exposure to it" (Indian Statistical Institute, 2003).

In the past, most policies and frameworks governing solid waste management in developing countries have been directed at the service providers and less attention has been paid to the demand side aspects of the problem. (Sansa and Kaska, 2004). In most cities and towns of Ethiopia, the main providers of solid waste management are their municipalities. In Adama town, the standard of solid waste management has always been gauged and evaluated on the basis of the role and performance of the service provider. This leaves the service provider not fully appreciated by households and other service receivers. However, tackling the problem of solid waste requires a concerted action of both the service provider and the service receivers, especially households who are the primary producers and generators of significant proportion of solid waste (which produce around 75% of the total waste products in the town). Thus, investigating the demand side aspects of the problem may provide useful information for the municipality in designing a sound policy regarding the provision of effective solid waste collection and disposal facilities.

1.2. Statement of the problem

In Ethiopia, urbanization and urban population has been increasing in recent years. The total urban population of the country was 7.4 million in 1995 (out of a population of

55,053,000), it reached 11.9 million[1] (out of 73,918,505) in the 2007 census and is expected to reach 38 million (out of a population of 126,886,000) in 2025 (World Resource, 1996-97, UNFPA, 2008). Urbanization, at its initial stage, is bound to bring about concentration of population, which increases consumption and production activities in limited space. As a result, the generation of solid waste emanating from economic and social activities in urban areas is increasing at an alarming rate. Thus, the supply of improved solid waste management facilities that correspond with the escalating generation of solid waste is crucial. However, it has been observed that local governments have not been able to provide proper waste collection and disposal services due to insufficient financial resources and unstructured management plans.

Adama is one of the rapidly growing towns of Ethiopia and located in East Shewa Zone of Oromia Region, at 8.55^0N 39.27^0E at an elevation of 1712 meters, 99kms Southeast of Addis Ababa. It was established in 1917 (Anteneh and Associates, 2003). Adama town had a total population of 127,842 in 1994. The 2007 national population census reported that this town has a total population of 222,035. This is an increase in population of around 73.7% within 13 years. The percapita solid waste generation rate for the town was estimated as 271 gram/day (0.271kg/day) in 2005. The total amount of solid waste generated in the town was estimated at 54200kg/day and 1.98 million kg/year in 2005 (Tolina, 2006).

[1] This is an increase in urban population of about 61% in 12 years span.

In Adama town, the observed population explosion as a result of high fertility rate and rural-urban migration has resulted in open dumps of waste on streets, highways and drainage systems. Out of the total solid waste generated in the town, about 40-50% remains uncollected. Furthermore the formal dumpsite, located some 8 km away from the center of the town (towards west on the road from Adama to Addis Ababa in a place called ‘Qobbo Luxo’), does not appear to have proper measures to control runoffs from rainfall, which may result in the pollution of underground water and land surface in its neighborhoods. These problems seem to get progressively worse as the level and pace of urbanization of the town continues to grow rapidly.

Currently the municipality of Adama claims to provide solid waste collection service to 55% of its population. Such low coverage of collection coupled with the limited number of garbage collecting sites available in the town (which is 35) may aggravate the problem of open dumping around these sites. Furthermore, the shortage of garbage collecting sites in the town allows refuse from the containers filled to the brim and spillovers thereby creating health risks to the households in these neighborhoods. This improper and poor waste collection and disposal mechanism provides breeding grounds for vector-borne and infectious diseases in many places. In addition, under the present service provision arrangement mechanism, households, who are the primary producers and perhaps the biggest victims of solid waste, have not been given the chance to choose solid waste management options or be involved in the effective management of solid waste by stating their willingness to pay to backup the municipality budget that goes towards this end.

The above-mentioned problems indicate that the identification of appropriate solid waste management system is crucial for the town. Therefore, this study opts to estimate the non-market values of various solid waste management options to households. The options will be defined by their service attributes of frequency of waste collection, separation of waste at source and pollution control measures at the dumpsite. To accomplish this task, the choice-modeling (CM) technique, which is a stated preference approach for non-market valuation, will be employed.

1.3. Objectives of the study

The general objective of this study is to estimate the non-market values of various improved solid waste management options for households in Adama town using choice modeling technique.

The specific objectives are:

To estimate the implicit prices (trade-offs between money and improvements in those service attributes) of collection frequency, separation of waste at source and pollution control measures at the dumpsite.

To estimate the compensating surplus for various improved solid waste management scenarios relative to the status quo (the current solid waste management service).

To identify the attributes that affects the willingness to pay by households for improved solid waste management.

1.4. Significance of the study

With an ever-increasing generation of solid waste it is evident that the supply of improved solid waste management facilities becomes crucial. However, a mismatch between the demand and supply of this service is prevalent in Adama town. This study will, therefore, provide important demand side pieces of information for policy makers which can be used to design appropriate solid waste management services based on the defined service attributes levels and the monthly service charge that the public will be willing to pay for those improved services. The information could also be used to establish future service provision arrangements with private service providers.

1.5. Scope and limitations of the study

This study analyses households' preferences for improved solid waste management options in Adama town using one of the stated preference approach known as choice-modeling (CM) technique. The study is limited to residential solid waste and does not include commercial and industrial solid waste so as to avoid complications. In this study, the sample size is limited to 200 by the decision to use face-to-face interview method and due to time and budget constraints.

1.6. Organization of the study

The remaining part of the thesis is organized as follows. Chapter two presents theoretical background of environmental valuation and the literatures on various methods of valuation techniques, classification of solid waste and its management followed by a review of previous empirical studies particularly in relation to solid waste management and the choice modeling method. The choice modeling survey design issues, sampling method and data collection, and econometric model specification for choice modeling are described in detail in chapter three. Chapter four is devoted to discussion of the empirical results of choice modeling exercise. Finally, in chapter five, the main findings of the study are summarized and some important policy implications are discussed.

Chapter Two

Literature Review

2.1. Theoretical literature review

2.1.1. The need for environmental valuation

Most decisions regarding the allocation of environmental and natural resources between conservation and development options are likely to be informed by incorporating their estimated costs and benefits. However, the alternative uses to which environmental resources may be put generate benefits and costs that are not marketed and hence not readily valued in monetary terms. The reason behind this is that environmental goods and services often have the characteristics of public goods and are best with externalities. In these case markets (or market prices) rarely exist for such resources (Perman, 1996).

> *"Estimating environmental values in monetary terms is a challenging task because environmental benefits and costs are usually not traded in markets. Hence, the standard market based estimation technique-which rely on gaining insights in people's preferences for goods and services by reference to patterns of buying and selling-can not be applied* (Bennett and Blamey, 2001, PP. 3)

In the absence of markets or market prices, other ways of obtaining estimates of the values of such resources are required. In response to this, economists have devised a variety of empirical tools for estimating the monetary values of environmental goods and services whose market prices are not easily observed. Before proceeding to the different environmental valuation techniques it is convenient to review the concept of total economic value.

The Concept of total economic value

The environment is a very complex space. In understanding the value of the environment, it helps to use a classification scheme. One useful concept is that of total economic value, which explicitly recognizes that the economic value of a good or a service is composed of different parts - some of which are tangible and readily measured and others are less tangible and thus more difficult to quantify. Total economic value is divided between use values (including direct use values, whereby the environmental goods and services provide tangible products that the present generation uses) and non-use values, usually defined as bequest values (derived from the benefits that we obtain from knowing that a resource will be available for future generations) and existence values (the value of knowing that something exists, regardless of the fact that we have never seen or used the resource, or intend to see or use it in the future). Option value is the value derived from maintaining the option to use a good or service at some point in the future; it is sometimes treated as a special case of use value (Dixon, 2008).

> *"The purpose of dissecting value and placing it into these various categories is to understand the complexity whereby environmental goods confer values to consumers. Simply looking at the use value of an environmental asset may obscure much of the value. In fact some environmental assets have little use*

value but significant non-use value. Empirically it is often impossible to separately measure the components of value. The categorization simply provides an intellectual framework to help ensure completeness when valuing environmental goods" (Kolstad, 2000, PP. 296-297).

2.1.2. Environmental valuation methods

The main concern of environmental valuation is to attach monetary values for non-marketed environmental goods and services so as to integrate their values into economic decision making processes (Dixon, 2008). Environmental valuation is basically based on the assumption that individuals are willing to pay for environmental improvements and, conversely, are willing to accept compensation for some environmental deterioration.

In the literature, a number of market and non-market-based techniques are available to value the environment. Generally, environmental valuation methods can be divided into two main categories: revealed preference (or indirect) approaches and stated (or expressed) preference (or direct) approaches.

2.1.2.1. Revealed preference methods

Revealed preference requires exploration of people's preference as revealed by their actions in markets, which are significantly related to the non-marketed value of an environmental good under consideration. In this method, we observe a real choice in some market and cleverly infer information on the trade-off between money and the environmental good (Kolstad, 2000).

The revealed preference method includes travel cost method (TCM) for estimating the use value of recreational sites and hedonic pricing method (HPM), which has been used to estimate pollution costs. Most of the time, TCM and HPM are unlikely to estimate non-use values because of their dependence on the actual market situation (Bennett and Blamey, 2001).

Travel cost (TC) method

This is a technique, which attempts to deduce values from observed (i.e. reveled) behavior. The travel cost model, and its many variants is the most commonly used indirect approach to valuing site-specific levels of environmental resource provision. Basically, information on visitors' total expenditure to visit a site is used to derive their demand curve for the services provided by the site. Among other things, the TC assumes that changes in total travel expenditures are equivalent to changes in 'admission fee', thereby tracing out a demand curve for the site. This demand curve may then be used to measure the total benefits visitors accrue from the site.

Weaknesses of TCM

The major limitation of travel cost technique is that it is only capable of measuring that subset of values for which people are willing to pay (through the medium of incurring travel costs to visit the site with attributes for which we seek valuations). Travel cost techniques can only provide us with estimates of some values in which we might be interested (Perman, 1996).

Hedonic pricing method (HPM)

Hedonic pricing method is based on consumer theory, which postulates that every good provides a bundle of characteristics or attributes. The method identifies environmental flows as elements of a vector of characteristics describing a marketed good, typically housing. Thus HPM relies on the proposition that an individual's utility for a good or service is based on the attributes, which it possesses. If the hedonic analysis is conducted on housing data, it is referred to as the property value approach. It measures the welfare effects of changes in environmental attributes on the value (or price) of properties.

Weaknesses of HPM

The main limitation of HPM is that it is necessary to find a market good whose value is influenced by the environmental commodity under consideration. It is also important that all of the damage from the environmental commodity be reflected in the price of the market good. Another shortcoming of property value studies is that residents may spend substantial portions of their day away from their home; the damage so incurred will not be reflected in the property values.

2.1.2.2. Stated preference methods

Stated preference methods attempt to elicit environmental values directly from respondents by asking them about their preferences for a given environmental good or service. This method considers environmental gains-an improved scenic view, better levels of air quality, or water quality etc and seeks to measure the monetary value of those gains directly (Pearce and Turner, 1990).

> "*The basic idea behind any stated preference technique for estimating non-market environmental values is to quantify a person's willingness to bear a financial impost in order to achieve some potential (non-financial) environmental improvement or to avoid some potential environmental harm*" (Bennett and Blamey, 2001, PP. 38).

Interest in stated preference methods has been kindled by their capacity to yield estimates of the full array of use and non-use environmental benefits and costs. The most commonly used stated preference methods are contingent valuation method (CVM) and choice modeling (CM) or choice experiment (CE) method.

2.1.2.2.1. Contingent valuation method

The contingent valuation is a survey method used to estimate either the willingness to pay for an improvement in the quality or quantity of some environmental good, or the willingness to accept for deterioration in environmental provision. The valuation is termed contingent because the information sought from the survey respondents is conditional up on some particular hypothetical market context. This context will specify the nature of the change, how it is to be implemented, what it will cost, how payments would be made, and so on. The objective of the survey is to elicit (hypothetical) monetary bids from a representative sample of the 'population of interest'. These bids are then used to infer the shadow price of some environmental gain or loss (Perman, 1996).

The features of the hypothetical market include:

A detailed description of the good/service that is valued. The situation before and after any proposed change in environmental quality and subsequent provision of the good/service should be clearly stated

A detailed description of the "payment vehicle", i.e. the means by which the respondent would pay for the change in provision of the good/service should also be stated.

The procedure to elicit the respondent's valuation. The actual valuation can be obtained in a number of ways, for example, asking the respondent to name an amount, having them choose from a number of options. The respondent could also be asked whether he/she would pay a specific amount. In the case of the latter, follow-up questions with higher or lower amounts are often used. Statistical analysis of the responses is used to estimate the average WTP in this hypothetical market.

CVM has been the most commonly used stated preference method for non-market valuation (Jin *et al*, 2006) and provides sufficient flexibility to enable the estimation of total economic values associated with environmental impacts. However, its use has been the subject of considerable criticism. Most criticisms of CVM focus on the following biases:

Strategic bias (respondents deliberately misrepresent their preference in order to influence the decision making process);

Yea-saying (respondents agree to pay not because of the strength of their preferences for environmental impact but because of a desire to make themselves look good);

Insensitivity to scope variations (respondents values are invariant to the extent of the environmental impacts involved); and

Framing (respondents' values do not reflect the availability of substitute goods) (Bennett and Blamey, 2001).

2.1.2.2.2. Theoretical foundation of choice modeling

Choice modeling (CM) is a stated preference valuation method that has its origin in conjoint analysis. It was initially developed out of the limitations encountered in using conjoint analysis techniques to model telecommunication choices in Australia. The contingent ranking and rating are variants of techniques widely used in marketing known as conjoint analysis. A common feature of this type of approach is the requirement that survey respondents consider alternatives which are described in terms of their component characteristics or 'attributes' with different levels. The conjoint techniques have as a conceptual foundation the work of Lancaster (1966), who developed his characteristics approach to the analysis of product demand (Bennett and Blamey, 2001).

The concern of economists regarding the use of ranking and rating studies was mirrored by their marketing colleagues. A consequence of this was the evolution of a type of conjoint analysis called choice modeling in which respondents are asked to choose from a number of different alternatives. As with other conjoint variants, these alternatives are defined in terms of product ‘attributes’ and the different alternatives between which respondents are asked to choose are constructed by systematically varying the attribute ‘levels’. However, whilst other conjoint techniques required respondents to rank and rate the alternatives, under the CM technique respondents are asked to choose alternatives (Bennett and Blamey, 2001).

2.1.2.2.3. Methodology of choice modeling

Recently, choice-modeling (CM) approach has gained considerable attention among economists in the valuation of non-marketed environmental goods and services. In a CM application, respondents are presented with a series of six to eight choice sets. Each choice set contains usually a constant status quo (or baseline) option and two or three alternatives described by a number of attributes. An alternative is a combination of several attributes, with each attribute taking on a value usually called a level. A monetary value is included as one of the attributes, along with other attributes of importance, when describing the profile of the alternative. The attributes used are common across all alternatives but their levels vary from one alternative to another according to an experimental design. From each choice set, respondents are asked to choose their preferred alternative.

The most obvious features of choice set design are the number of alternatives in each choice set and the number of attributes that describe each alternative. Although increasing the number of alternatives per choice set is a way of increasing the precision of the parameter estimates, forcing the respondent to choose among too many alternatives may make the outcomes less meaningful. Depending on the choice setting, the number of alternatives per choice set is typically not much larger than a handful, but it of course depends on how familiar the respondent is with the attributes of the alternatives.

Another important issue that arises in choice experiment exercises is whether to present the choice alternatives as generic or labeled choice options. Generic choice options are unlabelled and/or the label conveys no additional information about the choice alternative per se, such as ‘Alternative A’, ‘Alternative B’ and so on. Labeled choice options have names or assigning labels that communicate information to respondents directly or indirectly about tangible or intangible qualities of each alternative. In environmental policy context, labels tend to refer sites, locations, policy names or other descriptors.

One advantage of alternative specific labels is that responses may be more reflective of the information context in which preferences are ultimately constructed and revealed. However, the potential advantage of labeled choice alternatives may be offset if generic labels and information encourage more discerning and discriminating responses. That is, the use of generic labels and attribute information discourages respondents from basing responses wholly or largely on alternatives with the most superficially attractive labels or descriptor; instead, respondents must consider differences in policy options described by the attributes. Thus more informed and deliberated preferences may be elicited from generic tasks, which may be desirable from a non-market valuation perspective (Bennett and Blamey, 2001).

Implementation of choice modeling: Choice modeling provides opportunity to assess preferences and estimate benefits and costs for environmental quality changes. However, achieving these results requires the careful implementation of a number of stages that combine to form a CM application. Applications of choice modeling generally follow the following seven steps outlined below (Adamowicz *et al*. 1998a):

Characterization of the decision problem. This involves the identification of the problem at hand (changes in environmental quality affecting recreation behavior, change in provision of public goods that requires a social choice mechanism to be specified for this issue, and so on).

Attribute and level selection. The number of attributes and value of the levels for each attribute is defined in this stage, as appropriate for the decision problem at hand.

Questionnaire development. The questionnaire can vary from chapter and pencil tasks to computer aided surveys. As in any survey-based research, pre-testing of the questionnaire is a necessary component of the research programme.

Experimental design development. Once attributes and levels have been determined, experimental design procedures are used to construct the choice tasks, alternatives or profiles that will be presented to the respondents.

Sample sizing and data collection. The usual consideration of desired accuracy levels versus data collection costs must guide definition of sample sizes.

Model estimation. The most common approach has been the use of multinomial logit (MNL) and the most common estimation method has been maximum likelihood, although the most appropriate method will depend on the issues being examined.

Policy analysis. Most CM applications are targeted to generating welfare measures, or predictions of behavior or both. Thus, the models are used to simulate outcomes that can be used in policy analysis or components of decision support tools.

2.1.3. The strengths and weaknesses of environmental choice modeling

The use of CM to estimate non-market environmental values, particularly non-use values, is at its formative stage. CM has both strengths and weaknesses relative to other stated preference technique, notably the CVM.

The strengths of CM

The output of a CM application contains a wealth of detail regarding respondents' preferences. This enables the analyst to provide an array of information to policy makers well beyond that afforded by a CVM application. Thus, a CM application provides a rich data set. In fact, it is far richer than that provided by CVM application and enables a better understanding of the process underlying the statements of preferences made by respondents and the problems that may be associated with those processes.

Moreover, it offers some advantage in the development of an appropriate frame. CM technique enables more control to be exerted over the frame that respondents use to form their preferences for the issue at hand. At last, but not least, for data generated from a stated preference CM application, the calibration and re-scaling that is afforded by integrating revealed preference data can significantly improve the fit of the resultant models and hence the accuracy of the value estimates derived (Bennett and Blamey, 2001).

The weaknesses of CM

On the other side of ledger, CM faces some specific problems: Its ability to yield a rich data set is enabled by a more complex questioning process that places greater strain on respondents' cognitive capacities. It has also been argued that CM provides some advantages over the CVM in terms of its ability to establish an appropriate frame. This does not, however, imply that the technique can automatically ensure that the issue is framed appropriately in a CM application.

Moreover**,** in a CM application, the common CM practice of including more than two alternatives in a choice set provides respondents with an additional degree of freedom in strategic behavior. If CM respondents make choices that are conditional on their expectations regarding the choices of other respondents, they may choose from those options they think have a reasonable chance of 'winning' even when this excludes their most preferred option. Furthermore, the use of CM to provide results for several fundamentally different goods, such as qualitatively different environmental goods, can involve significant additional costs.

In weighting up these strengths and weaknesses it is apparent that CM is no 'magic bullet' in the profession's attempts to deal with the estimation of non-market values. But it is also apparent that the technique has some specific characteristics that make it appealing (Bennett and Blamey, 2001).

2.1.4. Concepts of solid waste and solid waste management

2.1.4.1. Definition and classification of solid waste

According to Tchonobanglous[2] (1993), solid waste is defied as all waste emanating from human and animal activities that are normally solid and discarded as useless or unwanted. It includes municipal, industrial and commercial, agricultural and animal husbandry, construction and demolition waste as well as mining residues.

Solid waste types

Municipal solid waste (MSW): Municipal solid waste consists of every day items such as product packaging, glass clippings, furniture, closings, bottles, food scrapes, newspapers, paper and paper products etc. It does not include materials such as construction and demolition debris, municipal water sludge and non-hazardous industrial wastes (US EPA, 2001).

Industrial waste: industrial waste comprises a variety of waste streams arising from a wide range of industrial processes such as production of basic metals, food, beverage and tobacco products, wood and wood products and paper and paper products.

[2] Tchonobanglous is cited in Seleshi (2006)

Construction and demolition waste: construction and demolition wastes are generated regularly in urban areas as a result of new construction, demolition of old structures and roadways and regular maintenance of buildings. These wastes contain cement, bricks, asphalt, wood, metals and other construction materials.

Agricultural waste: agricultural waste is composed of organic wastes (animal excreta in the form of slurries and farmyard manures, spent mushroom compost, soiled water and silage effluent) and waste such as plastic, scrap machinery, fencing, pesticides and veterinary medicines (ETC/RWM, 2006).

Mining waste: mining waste arises from prospecting, extraction, treatment and storage of minerals.

Since the main area of interest in this study is MSW, we review the classifications of municipal solid waste further and its management strategies in what follows.

2.1.4.2. Classification of MSW

Municipal Solid Waste is highly non-homogeneous since it consists of residues of nearly all materials used. Therefore, detailed classification of MSW is desired in order to obtain accurate data concerning estimates of present and future production and its composition for long-term efficient and economical waste management planning (Phani et al, 2006).

The need for classification system of MSW is demonstrated through the diversity of components constituting MSW. Landva and Clark (1990) proposed a classification system that differentiates between organic and inorganic components. They subdivided these in to putrescible and non-putrescible with in the organic components and degradable (corrodible) and non-degradable with in the inorganic components.

Another classification system of MSW is proposed for energy recovery purpose by Landva and Clark (1990). This involves the separation of MSW in to combustible/organic and non-combustible/inorganic material streams. The combustible portion of MSW can be classified as putrescible and non-putrescible material. The putrescibles and a portion of non-putrescible can be classified as cellulosic (paper, wood, wet organic fractions, etc) and the rest of non-putrescibles can be classified as non-cellulosic (different plastics, rubber, leather, etc) material.

2.1.4.3. Classification of municipal solid waste management

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

To make waste management practices as environmentally sound as possible, the US Environmental Protection Agency (EPA) proposed an integrated waste management strategy. These integrated waste management strategies include source reduction (reuse of products and backyard composting of year trimming), recycling of materials (including composting) and disposal (including waste combustion, preferably with energy recovery and land filling). This integrated strategy is considered as a useful policy tool for conserving resources, dealing with landfill shortages, minimizing air and water pollution and protecting public health. According to EPA, source reduction including reuse of products is the most preferred option, followed by recycling and composting. Land filling is the last option in the ladder of waste management strategies. Some of the options are defined as follows:

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

Composting: composting is a biological process of decomposing the organic fraction of municipal solid waste. The end products of this process can be used as agricultural fertilizers or fuel for motor vehicles. However, open composting is not environmentally friendly because it produces carbon dioxide (which is a greenhouse gas) and also spreads harmful airborne spores and bacteria.

Land filling: in many respects, land filling is seen as the bottom of the hierarchy of municipal waste disposal options. It is the main option for the disposal of municipal solid waste in developing countries due to cost constraints.

Combustion (incineration): it is a process that involves the complete degradation or combustion of organic material in municipal solid waste through the application of heat in an oxygen rich –environment. This method helps to reduce the amount of waste destined for disposal (US EPA, 2001).

2.2. Empirical Literature Review

Othman (2002) conducted a study in Malaysia, where two study areas (the Kajang and Seremba municipalities) were selected. He employed two stated preference techniques: choice modeling (CM) and contingent valuation (CV) to elicit consumers' willingness to pay (WTP) for different solid waste management (SWM) options. The aim of CM was to identify the marginal values for SWM attributes and that of CV was to assess the aggregate value of solid waste management package.

The choice sets followed the standard L^{MN} experimental design (where L is the number of levels, M is the number of alternatives in each choice set and N is the number of attributes) where only the main effects were modeled. Each choice set contained three MSW management alternatives (one baseline and two improved management plans). The service attributes that were used in the study are collection frequency, free provision of multiple containers for separation of waste at source, types of waste disposal methods, mode of transportation and monthly charges. The study found that all the attributes were significant and yielded the expected signs. From the results of the two models, it was deduced that households supported improvement in solid waste management plan, in terms of collection frequency, separation of waste at source, disposal methods and mode of transportation.

Jin et al (2006) undertook a CE study to estimate the public's preferences for SWM options in Macao, China.. The service attributes included in the study were waste segregation and recycling at source, collection frequency, noise reduction and cost (monthly garbage fee). The study employed a 2x4 main effects factorial experimental design and based on minimal overlap and utility balance principle, 24 options were used. Each choice set contained one alternative and a base line (status quo) option. Two MNL models were estimated. The first model was a basic specification, which shows the importance of the attributes in explaining respondents' preferences for different management options. The second model considered both socio-economic and attitudinal variables in addition to the attributes. The estimation results of the two models have shown that the coefficients for attributes (segregation, noise reduction and cost) were significant at 1% level but the coefficient for waste collection frequency was found to be statistically insignificant. Finally, the researchers concluded that the CE technique has the capacity to provide reliable and useful information for solid waste managers.

Pek and Jamal (2009) conducted a study to estimate the non-market values of improved waste disposal facilities in Malaysia using the choice experiment method. The choice sets followed the standard L^{MN} experimental design where only the main effects were modeled. Each choice set contained three disposal facilities with one alternative being the existing facility and the other two represent improved disposal facilities. The service attributes were psychological fear, land use, air pollution, river water quality and additional monthly charge. Two MNL models were regressed. The first model was the basic specification, which used only attributes as arguments and the second model, was an extended model, which incorporated socio-economic, and environmental attitudinal variables. In the first model, all the attributes were found significant at 1% level but in the second model while all the attributes were significant only half of the socio-economic and attitudinal variables parameters were found significant. The results of this study revealed that choice experiment can successfully be applied in developing countries, like Malaysia, on solid waste related issues with careful construction of choice sets, questions and effective data collection.

In Ethiopia, most previous studies on improved solid waste management services have employed the contingent valuation method. Most of the studies have been conducted in Addis Ababa. Aklilu (2002) employed CVM, based on closed ended format with a follow-up question, to elicit information about households WTP for improved solid waste management in Addis Ababa. He selected 430 households at random and carried out a face-to-face interview. The Tobit model was used in the study and the results of the model have shown that income of households, time spent in the area, quantity of waste generated, responsibility of solid waste management, education, ownership of house and the number of children had a positive and significant influence on respondents' WTP values.

Hagos (2003) used CVM in his study to elicit individual willingness to pay for improved solid waste management in Mekele town. He employed an open-ended iterative bidding game question format and selected a total of 164 households using stratified sampling followed by systematic random sampling applied for each stratum. He employed Ordinary Least Square (OLS) to estimate the bid function where the willingness to pay (WTP) is a function of sex, age, education, family size of the household, total household income, house ownership, household awareness about SW problems, and household satisfaction with the existing level of SWM service. Out of these variables, total household income, household awareness about SW problems, age and family size of the household were found to be significant determinants of WTP. The remaining variables were found insignificant.

Tolina (2006) conducted a contingent valuation survey to estimate households' willingness to pay for improved solid waste management in Adama town. The survey was administered to a random sample of 250 households. A face-to-face interview was employed with open-ended question format to elicit the WTP of respondents. Tobit and Probit models were used for the empirical analysis. Results of the Tobit model showed that income, education level of the respondent, martial status, time spent in the area, quantity of solid waste generated and house ownership have a positive and significant effect on the WTP of respondents. The results of the Probit model indicate that income, house ownership and status of respondent in the household (all with positive signs), sex, age and waste receptacle (all with negative signs) have significant effects on the probability of having a positive WTP.

Seleshi (2007) had undertaken a CV survey to estimate WTP of residents of common building for improved solid waste management in Addis Ababa. He used single bounded dichotomous choice elicitation format followed by an open-ended question and gathered information from the randomly selected sample of 130 households. He employed Tobit and Probit models for the analysis part. The results of Tobit model revealed that income, resident of condominium, and current solid waste service had significant influence on WTP of households. From the results of the Probit model: income, type of solid waste service, life expectancy, location, current solid waste service and starting bid were found significant.

Solomon (2007) employed choice modeling (CM) to analyze household's preferences for improved solid waste management in Yeka Sub-City, Addis Ababa. He used a sample of 242 randomly selected households and carried out a face-to-face interview. The choice sets followed the standard L^{MN} experimental design where only the main effects were modeled. The choice sets generated by the experimental design were 18, which were divided in to three blocks with each block contained six-chose sets. The service attributes that were used in the study are collection frequency, separation of waste at source and monetary charge.

Two multinomial logit (MNL) models were estimated. The first model considered the baseline option and the second model considered the baseline together with socio-economic variables: sex, age, income, education level, number of working household members and family size. The results of the basic model showed that the coefficients of all attributes were significant at 1% level. In the extended MNL model, out of the six socio-economic variables, only two of them were found significant. These are age, which was negative and significant at all levels and income, which was positive in sign and significant at 10% level. All non-monetary attributes, like in the basic model, were significant and had the expected signs. Finally, the results of the study revealed that choice modeling (CM) could be applied in the context of developing countries in identifying households' preferences that fit the requirements of the model. However, the Researcher had neither undertaken tests for the violation of Independence of Irrelevant alternatives (IIA) assumption in the two MNL models nor used other models that relax this assumption. Thus, violation of the IIA assumption would lead to biased parameter estimates.

Dagnew (2009) conducted a CVM survey on improved solid waste management in Mekelle city. He employed a face-to-face interview method with a single bounded dichotomous choice questionnaire to elicit WTP of respondents using a random sample of 226 households. He used Probit model to analyze the significance of the independent variables: age, sex, perception of households about the current SWM, households waste, education, family size, marriage, income, awareness of environmental quality, house ownership and type of solid waste service. Among these, income, awareness of environmental quality and age were found to be significant determinants of households' WTP.

The above discussions reveal that most of the studies undertaken in Ethiopia in relation to SWM have employed the CVM. Although, CVM can be used for estimation of WTP for a single policy option, its use in situations in which multiple options and several attributes are being considered is problematic (Streever et al, 1998). On the other hand CM can provide estimates of the values of many different alternatives from a single application. Furthermore, it allows for the identification of the trade-offs that individuals make between attributes of a good or service. If one of the attributes is the money that a person would have to pay to secure the proposed change, it is possible to measure the marginal values of changes in each attribute. Often this might be a more useful approach from a management or policy perspective than focusing on a single change in the provision of the whole environmental good or service (Mogas et al, 2006).In addition, most of the studies are conducted in Addis Ababa. However, solid waste management problems (being consequences of rapid urbanization) are also prevalent in the rapidly growing secondary cities of the country. Therefore, conducting a study on solid waste management in Adama (which is one of the secondary cities in Ethiopia) is very important. The choice modeling

(CM) technique will be used as the proposed study will try to value multiple improved solid waste management options in which case CM can do better.

Chapter Three

Methodology

3.1. Data collection and sampling technique

The study area is Adama town. Both primary and secondary data were used in this study. Supply side information was obtained from municipality health department and interviews with department officials who are involved in the planning and provision of solid waste management services. In addition, the researcher has conducted observations of dumpsite and open dumps in a variety of places in the town. The primary data used in the study was collected from 200 randomly selected heads of households and the sampling frame was the population of Adama town.

As far as the sampling method is concerned a two-stage approach was employed. First, four Kebeles were chosen out of fourteen Kebeles in the town based on simple random sampling method. Second, fifty heads of households were selected from each Kebele using systematic random sampling method. It is worth mentioning that the sampling unit is the household not the individual, since if implemented, payments for SWM services will come from households, not individuals.

3.2. Defining attributes and levels

Improper collection and disposal of solid waste has serious adverse impacts on public health and the environment. On the other hand, improvements in the provision of solid waste management service can enhance environmental quality and the health status of residents.

Solid waste collection and disposal service can be described by a number of service attributes. The service attributes that were used in this study are frequency of waste collection, separation of waste at source, pollution control measures at the dump site and monthly service charge.

Frequency of waste collection: this attribute refers to the frequency at which the service provider collects solid waste from households. Currently, the number of garbage collecting sites available in the town is limited to 35. These leaves refuse from the containers filled to the brim and spillover. Thus, increasing the frequency of waste collection will bring about tremendous benefits to residents. This attribute has two levels: one time per week (1) and two times per week (2).

Separation of waste at source: this attribute considers whether there is a need for separation of waste in to recyclables and non-recyclables at source by households. It is assumed that introducing this attribute will reduce the quantity of waste disposed and thereby improve environmental quality. Furthermore, economic gains can be obtained from the recyclable component of the waste (like glasses, bottles, metals, used plastic bags, etc.) by processing and transforming such waste into usable or marketable products. This attribute has two levels: separation is not needed (0) and separation is needed (1).

Pollution control measures at the dumpsite: this attribute refers to whether the service provider takes some measure to reduce the polluting nature of the waste disposed at the dumpsite. Currently the waste collected by the municipality is indiscriminately disposed at a dumpsite located some 8 km away from the center of the town. This dumpsite does not appear to have proper measures to control rainfall and runoffs, which may result in pollution of underground water and land surface in the neighborhoods Thus, taking some measures at this dumpsite to reduce pollution may result in better environmental quality. This attribute has two levels: without taking any measure to reduce pollution (0) and takes some measure to reduce pollution (1).

Cost: this attribute considers a monthly service charge levied on each Adama permanent household. The improved plans for solid waste management can only be implemented if sufficient funds can be generated to finance it. Those funds must partly come from households residing in the town as a backup for the municipality budget that goes towards this end. Currently, two private institutions are providing door-to-door solid waste collection service in the town. The prices charged by these institutions are Birr 10 and Birr 15 per household per month. These service charges were used as reference point in determining the levels of the monetary attribute for this study. This attribute has five levels (Birr 5, Birr 10, Birr 15, Birr 20 and Birr 25).

3.3. Questionnaire design

The survey instrument was designed on the basis of the research objectives. Prior to conducting the survey, trainings were given to enumerators by the researcher on the choice experiment procedure, the idea of economic valuation, the ways of obtaining cooperation from the respondents and how to fill the questionnaires. A face-to-face interview was conducted using question sheets and each questionnaire has three main sections.

The first part relates to general households perception about their environment particularly in relation to solid waste management. It includes questions about households' perception of their environmental quality, concerns in improvements of solid waste management, the amount of solid waste they generate, how often waste is collected etc.

The second section of the questionnaire contains a series of five choice sets, which shows several management options, defined by different levels of similar service attributes. An orthogonal design was used to assign attribute levels into options in such a way that the attributes varied independently of one another. This is necessary for their individual effect on respondents' preference to be isolated. The four attributes and their levels included in the experiment resulted in a full factorial of 40 possible combinations. This would be more than the respondents could be expected to cope with. Therefore, to reduce the number of alternatives to a manageable level a fractional factorial design was used. The choice sets were constructed using the OPTEX procedure in SAS statistical software. Finally, ten choice sets were generated by the experimental design and these choice sets were grouped in to two blocks such that each respondent is only exposed to five choice sets in a block.

Respondents were presented with a status quo option (option-1) that is similar across the choice sets and two additional options for improved management scenarios (option-2 and option-3), which vary according to the experimental design. Respondents were then asked to choose their preferred option from each choice set. Before answering the choice sets, they were requested to keep in mind their available income and all other things on which they may need to spend money. A representative choice set is given below in Table 3.

Table 3 a representative choice set

Suppose these options were the only ones available, which one would you choose?

Attributes	Option-1 (the status quo)	Option-2	Option-3
Frequency of waste Collection		Once per week	Twice per week
Separation of waste at source		Separation not needed	Separation needed
Pollution control measures at the dumpsite		Takes some measure To reduce pollution	Takes some measure To reduce pollution
Cost		Birr 20	Birr 25

The final section of the questionnaire comprises of questions intended to gather information on the socio-economic background of the surveyed households: age of respondents, gender, education level, total household income, family size etc.

3.4. Econometric model specification for choice Modeling

The theoretical basis for choice modeling is the random utility theory (RUT). This theory poses the notion that individual consumers choose alternatives that provide them with the highest level of utility. In this setting, the probability of selecting an alternative increases as the utility associated with it increases. The utility that an individual derives from an alternative is considered to be associated with the attributes of the alternative. The respondent's utility function is composed of a deterministic component and an unobservable or stochastic component given as:

$$U_{it} = V_{it} + \varepsilon_{it} \quad ------------------------------(1)$$

where U_{it} is the total utility derived from alternative i by individual t, V_{it} is the vector of systematic, observable or 'explainable' component (indirect utility function) with the assigned attributes as arguments and ε_{it} is a vector of unobservable or stochastic component (Adamowicz and Boxall, 2001).

This stochastic specification of the total utility function means that the probability that individual t chooses alternative i can be expressed as the probability that the utility associated with alternative i is greater than the utilities associated with all other alternatives. In this setting the probability of choosing alternative i is given as:

$$P_{it} = \Pr ob\{U_{it} > U_{jt}\} \quad for\, all\; j \in C, i \neq j$$
$$= \Pr ob\; \{V_{it} + \varepsilon_{it} > V_{jt} + \varepsilon_{jt}\}\; for\;\; all\;\; j \in C,\;\; i \neq j \;\; ---------------(2)$$

where C is the set of all possible alternatives. Assuming that the stochastic component or error terms are identically and independently distributed (IID) with a type-I extreme value distribution[3], the probability that alternative i is chosen by individual t is:

$$P_{it} = \frac{e^{\omega V_{it}}}{\sum_{j \in C} e^{\omega V_{jt}}} \;----------------------------------(3)$$

This specification is known as Multinomial Logit when it uses only individual specific characteristics as arguments, or Conditional Logit, when attributes and individual specific

[3] The IID assumption entails the property of independence of irrelevant alternatives (IIA – McFadden 1984). Violations of the IIA assumption may arise when some alternatives are qualitatively similar to others or when there are heterogeneous preferences among respondents (Bateman et al. 2002). If IIA assumption is violated, alternative choice models should be used, such as the nested logit model (Louviere et al. 2002) or the multinomial probit model (Hausman and Wise 1978).

characteristics are present (McFadden, 1974)[4]. ω is a scale parameter which is inversely proportional to the standard deviation of the error distribution and is typically assumed to be one[5] (Ben-Akiva and Leman, 1985).

Assuming a linear in parameters indirect utility function, V_{it} we can characterize it as (Louviere et al, 2000):

$$V_{it} = ASC_i + \sum_K \beta_{iK} X_{iK} \text{-------------------------} (4)$$

Where ASC_i is an alternative specific constant (ASC), X_{iK} is the k attribute value of alternative i, β_{iK} is the coefficient associated with the K^{th} attribute of alternative i. The effect of attributes in the choice set will be reflected by X variables while the ASC captures any systematic variations in choice observations that are not explained by the attribute variation.

To introduce respondents' heterogeneity (that is, differences between the individual respondents) into the model, individual characteristics of respondents can be used as independent variables in the equations. This is an important part of the model estimation process as the socio-economic variables may help to overcome problems associated with violations of important assumptions that underpin the MNL model[6]. However, they cannot be introduced alone in to the modeling. Because respondent characteristics do not vary

[4] McFadden is cited in J. Mogas et al (2006)

[5] Assuming ω equal to 1 implies a constant error variance.

[6] Most importantly, the MNL model uses an assumption that the error terms are 'independently and identically distributed'.

across alternatives, 'Hessian singularities' arise in the model estimation process unless the socio-economic characteristics are introduced as interactions with either the attributes or the alternative specific constants (Bennett and Blamey, 2001).One possibility for including socio-economic variables in the indirect utility functions is to include these variables interactively with the ASC (Morrison et al, 1999, Colombo el al, 2006). In this case the model is specified as:

$$V_{it} = ASC_i + \sum_K \beta_K X_K + \sum_t \gamma_{it} \left(ASC_i * S_t \right) ------------------ (5)$$

where S_t represents the socio-economic and/or attitudinal variables for individual t, and γ_{it} is the vector of coefficients associated to the individual socio-economic characteristics interacted with the *ASC*

3.4.1. The Random Parameter Logit model

The primary drawback of the MNL model is that the Independence of Irrelevant Alternatives (IIA) assumption seems to be too restrictive in many empirical applications. This assumption requires that the ratio of probabilities for any two alternatives be independent of the attribute levels of the third alternative. Moreover, the resultant MNL parameter estimates are biased if IIA assumption is violated. Further more, MNL does not account for correlations within each respondents series of choices.

To avoid these drawbacks of the MNL model, Revert and Train (1998) have proposed the use of RPL for stated preference (SP) data. McFadden and Train (1997) have shown that any random utility model can be approximated by some RPL specification.

There are some advantages of the RPL model relative to the MNL. First, RPL is not subject to the IIA assumption. Second, it accommodates correlations among panel observations. Third, the procedure explicitly incorporates and accounts for heterogeneity in testes across respondents by allowing the model parameters to vary randomly over individuals (Adamowicz and Boxall, 2001).

In the RPL model, the attributes (characteristics) of a good or service are treated as random variables. In this case, each parameter includes a systematic and a random component and thus, the model estimates a mean and a standard deviation for each distribution. Most applications of this model utilize the normal distribution assumption for the model parameters (Bennett and Blamey, 2001).

The random utility function for the random parameter logit model takes the following form:

$$U_{it} = V_{it} + \varepsilon_{it} = X_i(\beta + \eta_t) + \varepsilon_{it} \text{ --- } 6$$

where U_{it} is the total utility for respondent t from choosing alternative i in the choice set. It is assumed that the utility function consists of both systematic component (V_{it}) and stochastic component (ε_{it}). The indirect utility is a function of the attribute vector X through β (and if included, socioeconomic and environmental attitudinal variables). In contrast to the MNL model, the stochastic component of utility now may be correlated among alternatives and across the sequence of choices via the common influence of η_{it} .

The probability that individual *t* picks alternative *i* from each choice set is then presented as:

$$P_{it} = \frac{e^{X_{it}(\beta+\eta_t)}}{\sum e^{X_{jt}(\beta+\eta_t)}} \text{ --- (7)}$$

The estimated deterministic (indirect) utility function generally will have the following form:

$$V_{it} = ASC + \sum \beta_K X_K + \sum \gamma_m S_m \text{ --- (8)}$$

ASC is an alternative specific constant that captures the effect of any attribute (not included in the choice specific attributes) on utility, *k* is the number of attributes and *m* is the number of socioeconomic variables. Note that socioeconomic variables are constant across choice occasions for any respondent and can only enter as interaction terms with the attributes.

3.4.2 Analyzing the results of choice modeling

Part worth

In a linear statistical model, the β coefficients estimated under the MNL model can be used to estimate the rate at which respondents are willing to trade-off one attribute for another. Given that the attribute being sacrificed is a monetary attribute, the trade-off estimated is known as 'part-worth' or 'implicit price'. They demonstrate the amounts of money respondents are willing to pay in order to receive more of the non-marketed environmental attribute. Defining non-monetary attribute as *nma* and monetary attribute as *ma* the part-worth P is obtained as

$$P = \left(\frac{\beta_{nma}}{\beta_{ma}} \right) \text{--- ---------} \quad (9)$$

Estimates of implicit prices (part-worth) are made on a 'ceteris paribus' basis - that is they are estimates of willingness to pay of respondents for an increase in the attribute of concern, given that everything else is held constant.

Note that the principles applying to the determination of part-worth can also be applied to derive the willingness to trade-off between any pairs of attributes. Hence, by the division of β coefficients, the marginal rate of substitution across all the attributes, monetary and non-monetary, can be estimated.

The implicit prices are useful in that they demonstrate the trade-off between individual attributes. A comparison of implicit prices affords some understanding of the relative importance that respondents hold to them. On the basis of such comparisons, policy makers are better placed to design resource use alternatives so as to favor those attributes, which have higher (relative) implicit prices. It is important to note that the comparison of implicit prices across attributes should be undertaken in full recognition of the differing units used to define the attributes (Bennett and Blamey, 2001).

Economic surplus

A particular strength of CM is its ability to generate estimates of the values of many different alternatives from a single application. Hence, from one set of choice data, the values of an array of alternative ways of re-allocating resources can be estimated. This feature of CM arises because it specifically investigates trade-offs between attributes (Bennett and Blamey, 2001).

In theory, economic welfare measures are the amount of money (given or taken away) that makes a person as well-off as they would be before a change or the amount of money (given or taken away) that make a person as well-off as they would be after a change. Algebraically, welfare measure can be expressed as:

$$V(M,0) = V(M - CS,1) \quad \text{--} \quad (10)$$

where *V* is utility, *M* is income, *CS* is compensating surplus and the second argument in the utility function is 0 for the base situation and 1 for the 'changed' situation. Suppose the change is an environmental improvement relative to the base situation. *CS* is the amount of money that is taken away from the person to make the utility with the environmental improvement equal to the utility before the change.

Assessment of economic welfare involves an investigation of the difference between the well being (utility) achieved by the individual under the status quo (or constant base) alternative and some other alternative. It is therefore a matter of considering the marginal value of a change away from the status quo.

In order to obtain the economic surplus from an environmental improvement, first, the values of the attributes that are associated with the status quo are substituted in the equation that estimates the indirect utility associated with that option. If socio-economic variables are included in this equation, the values to be substituted are the sample means (individual specific welfare measures can be calculated). Note that the monetary attribute is assigned a value of zero for this stage.

Second, the values of the attributes that are associated with an alternative allocation of resources are substituted in to the equation that relates to the relevant change alternative. The value of the relevant *ASC* is also included in this calculation. Socio-economic variables are treated the same as for the status quo option and again the monetary attribute is set at zero.

Finally, the value associated with the change alternative is then subtracted from the value associated with the status quo option. If the model is linear (in the monetary attribute) this 'indirect utility difference' is then divided by the negative of the coefficient associated with the monetary attribute. Defining economic surplus as *ES*, we obtain:

$$ES = -\left(\frac{1}{\beta_{ma}}\right)\left(V_0 - V_1\right) \text{ -- } (11)$$

where β_{ma} is the marginal utility of income (generally represented by the coefficient of the monetary attribute in an experiment), and V_0 and V_1 represent the indirect utility before and after the change under consideration. A negative value for this surplus estimate indicates that the respondents are willing to pay the amount of the surplus in order to experience an improvement in the well-being resulting from a re-allocation of the resources from the status quo to the change alternative. The complexities caused by the existence of the scale parameter within each β coefficient are avoided by dividing throughout by the β coefficient of the monetary attribute.

By setting up multiple scenarios of alternative resource allocation (by varying the values the attribute can take) and repeating this arithmetic exercise, an array of values associated with the array of scenarios can be estimated.

3.5 Specific equations for choice modeling

Particularly, for this study two models were estimated using the data from the household survey in Adama. The first model is a basic specification, which shows the importance of the service attributes in explaining the respondents' choice for different solid waste management options. The specification for this model is as follows:

$$V_i = ASC_i + \beta_1 * FREQ + \beta_2 * SEPR + \beta_3 * POCM + \beta_4 * COST \text{ ------------------- } (12)$$

Where $(\, i = 1,2,3;\ ASC_i = 0 \ \ for \ i = 1)$

Definition of variables

Dependent variable

V_i = Utility of individual for option i (1= choice option, 0= non-choice)

Independent variables

ASC: This attribute stands for Alternative –Specific Constant and takes values 1 for option 2 and 3 in the choice sets and 0 for the base (status quo) option.

Frequency of waste collection (FREQ): This attributes takes the value 1 or 2 indicating that the number of times waste is collected per week. The attribute refers to the frequency at which the service provider collects waste. Increased frequency of waste collection can improve environmental quality and public health. Therefore an improvement in this attribute is assumed to increase the utility of the respondent and the expected sign of its coefficient is positive.

Separation of waste at source by households (SEPR): This attribute takes the value 1 for indicating the need for separation of waste at source by households, and 0 otherwise. This attribute refers as to whether there is a need for separation of waste into recyclables and non-recyclables at source by households. Introducing this attribute will reduce the quantity of waste to be disposed thereby reducing environmental pollution. Thus, it is expected to have a positive influence on the respondents' welfare.

Pollution control measures at the dumpsite (POCM): This attribute takes the value 1 for taking some pollution abating measures at the dumpsite and 0 otherwise. It considers whether the service provider takes some measure to reduce the polluting natures or not. The coefficient of this attribute will have a positive sign since pollution reduction is expected to enhance the well being of respondents.

COST: is the monthly service charge levied on the household. Its coefficient is expected to take on a positive sign because an increase in cost will decrease the utility of respondents.

The second model is extended to include the socio-economic variables of respondents in addition to the service attributes in the choice sets. It is specified based on the assumption that socio-economic variables influence respondents' preferences and behavior. However, as stated earlier, they cannot be introduced separately in the model. Because respondent characteristics do not vary across alternatives, 'Hessian singularities' arise in the estimation unless the socio-economic characteristics are introduced as interactions with either the attributes or the alternative specific constants (Bennett and Blamey, 2001). Six variables are included in this extended model as interactions with the alternative specific constant for option 2 and 3 (age, family size, gender, monthly total household income, respondent's level of education and number of 50 kg of waste generated per week by the household). These interactions show the effect of various attitudes and socio-economic characteristics on the probability that a respondent will choose either option 2 or 3. The specification of this model is given as follows:

$$\begin{aligned} V_i = \; & ASC_i + \gamma_1 * ASC_i * AGE + \gamma_2 * ASC_i * FAMS + \gamma_3 * ASC_i * SEX + \\ & \gamma_4 * ASC_i * THIN + \gamma_5 * ASC_i * EDU + \gamma_6 * ASC * NOHSW + \beta_1 * FREQ + \\ & \beta_2 * SEPR + \beta_3 * POCM + \beta_4 * COST \end{aligned} \quad \text{------------ (13)}$$

Definition of Variables

The attributes used in this extended model have the same definitions and their coefficients are expected to take on the same signs as in the basic model. The definition of the remaining variables and the expected sign of their coefficients are:

Age of respondent in years (**AGE**): A negative sign is expected for its coefficient because in most cases older people are adapted to traditional way of living and they will be less willing to pay for environmental improvements.

Gender of the respondent (**SEX**): A dummy variable equating to 1 if the respondent is male and 0 otherwise. Women are around the house and will have more responsibility to collect and dispose the waste generated by the household. Therefore, it is expected that women will have more preference than men for improved solid waste management.

Family size of the respondent (FAMS): Households with larger family size will tend to generate greater amount of solid waste. Hence, respondents with larger family size will choose improved SWM systems more frequently than those with smaller family size.

Monthly total household income in thousands of birr (THIN): Assuming that improved SWM is a normal good, respondents with higher income will have greater capacity to pay for the improved management options. Therefore, income will have a positive sign.

Education level of the respondent in years (**EDU**): Respondents with higher education level are expected to have more knowledge about social, economic and environmental factors. Higher education level also leads to greater awareness about existing SWM problems. Therefore, respondents with higher education level will have more preference to improved SWM systems and a positive sign is expected for its coefficient.

Household weekly generation of solid waste in 50 kg sacks (NOHSW): Households who generate larger amount of solid waste per week are expected to support the improved solid waste management options.

Assuming that choices are consistent with the Independence of Irrelevant Alternatives (**IIA**) restriction, the parameters in the above two Multinomial Logit models can be estimated using the maximum likelihood method[7].

The estimated parameters in the above models can be used to calculate the marginal value of a change within a single attribute using a linear-in-parameters utility function as follows:

$$MWTP = -\frac{1}{\beta_{ma}}\left(\beta_{nma}\right) \tag{14}$$

Where *MWTP* is marginal willingness to pay, β_{nma} is the coefficient of the non-monetary attribute and β_{ma} is the coefficient of the monetary attribute (defined as the marginal utility of income). This part worth provides the marginal rate of substitution between the attribute of interest and the monetary attribute.

In addition, the compensating surplus (*CS*) measure for various improved solid waste management scenarios relative to the status quo can be obtained using the following equation:

$$CS = -\frac{1}{\beta_{ma}}\left(V_0 - V_1\right) \tag{15}$$

where V_0 and V_1 represent the level of indirect utility before and after the change under consideration.

[7] analysis was done using Limdep Nlogit 3.0.

CHAPTER FOUR

Empirical results

4.1 Descriptive analysis of the survey data

Out of the total 200 households in the survey 12 were incomplete or unusable and therefore are excluded. The 188 questionnaires provided a total of 940 completed choice sets.

Simple descriptive statistics for some selected socio-economic variables are shown in Table 4.1. Out of the total 188 respondents, about 62.23% were males. The mean age of respondents for the sample was around 40 years with a minimum of 22 and a maximum of 68 years. The average years of schooling were 9.33 years and about 17.34% of the respondents did not attend any formal education. The average monthly total household income for the sample was Birr 1353.72 with minimum of Birr 250 and maximum of Birr 6500. The average family size of the survey households was 4.91 with minimum of 1 and maximum of 11.

Table 4.1. Descriptive statistics for some selected socio-economic variables

Variables	Description	Mean	Min	Max
SEX	Gender of the respondent, 1 if the respondent is male and 0 otherwise	0.622	0	1
AGE	Age of respondent in years	40.16	22	68
EDU	Education level of the respondent in years of schooling	9.33	0	18
FAMS	Family size of the household	4.91	1	11
NOHSW	Household weekly generation of waste in 50 kg sacks	0.973	0.25	2
THIN	Monthly total household income in thousands of Birr	1.35372	0.25	6.5
HOWN	House ownership of the respondent, 1 for own house and 0 otherwise	0.553	0	1

Around 55.3 % of the respondents are living in their own house and the remaining rented either from public or private owners. The average household solid waste produced per week was about 0.97 sacks with minimum of 0.25 and maximum of 2 sacks.

Respondents were asked to rank eight socio-economic sectors for government funding on the basis of their importance to them. The results showed that the environmental protection sector was ranked fourth on average. This is an indication of the fact that improving SWM, which is one component of protecting environmental pollution, can enhance households' welfare.

When asked about their overall perception of the quality of their environment, only 28.72% regard it as good, 36.17% deem it average and 34.04% find it poor. When asked whether household waste collection is a problem to them, 59.57% of the respondents answered yes. They were also asked to rate the current solid waste management system in the town; about 38.83% of the respondents considered it to be fair and 27.65% of them rated it as poor. The above results reveal that solid waste collection and disposal is a problem for most of the respondents in Adama town.

Each respondent, up on completing the five choice sets, was asked follow-up questions about the criteria they employed in answering the choice sets. About 23.47% of the respondents said that they have chosen the current solid waste management option because of an objection to the way the cost is imposed.

4.2 The choice model results

Two multinomial logit models were estimated. The first is a basic model, which shows the importance of the four services' attributes in explaining respondents' choice across different solid waste management options. The second model includes some socio-economic variables in addition to the attributes in the choice sets.

In this first model, utility is determined by the levels of four attributes in the choice sets (FREQ, SEPR, POCM, and COST). Thus, the model provides an estimate of the effect of a change in any of these attributes on the probability of choice.

Table 4.2 Results of the basic Multinomial Logit (MNL) model

Variable	Coefficient	Standard Error	P [|Z|>z]
ASC	0.3863*	0.2061	0.0609
FREQ	0.7041***	0.0877	0.0000
SEPR	0.7616***	0.1275	0.0000
POCM	0.3436***	0.1102	0.0018
COST	-0.0986***	0.0088	0.0000
Summary statistics			
Log-likelihood	-881.8415		
R-squared	0.1010		
Iterations completed	5		
Observations	940		

* Significant at 10% level
** Significant at 5% level
*** Significant at 1% level

The results for this model are shown in Table 4.2. The coefficients for all the attributes in the choice sets are significant at the 1% level and all have the a priori expected signs. The positive signs of the coefficients for the attributes of frequency of waste collection, separation of waste at source by households and pollution control measures at the dumpsite suggest that an improvement in the levels of these attributes increase the utility of respondents. The coefficient for the monetary attribute (cost) is negative, which indicates that an increase in monthly service charge will decrease the utility of respondents.

The inclusion of the socioeconomic variables (AGE, FAMS, SEX, THIN, EDU and NOHSW) in to the model was done by interacting them with the ASC to account for heterogeneity in preferences. The results of this model are displayed in Table 4.3.

Table 4.3 Results of the extended MNL model

Variable	Coefficient	Standard Error	P [|Z|>z]
ASC*NOHSW	0.2510	0.3078	0.4150
ASC*SEX	-0.1051	0.2246	0.6398
ASC*AGE	-0.0006	0.0130	0.9613
ASC*THIN	1.9437***	0.3351	0.0000
ASC*EDU	0.0359**	0.0145	0.0130
ASC*FAMS	0.1884**	0.0768	0.0141
ASC	-2.7402***	0.4701	0.0000
FREQ	0.7172***	0.0908	0.0000
SEPR	0.9522***	0.1376	0.0000
POCM	0.4379***	0.1152	0.0001
COST	-0.1145***	0.0097	0.0000
Summary statistics			
Log-likelihood	-863.8315		
R-squared	0.1193		
Iterations completed	7		
Observations	940		

* Significant at 10% level
** Significant at 5% level
*** Significant at 1% level

As shown in Table 4.3, out of the six socioeconomic variables, only three of them are statistically significant at the 10% level. Total monthly household income is significant at the 1% level. The positive sign of its coefficient signifies that respondents with higher income have greater capacity to pay and would choose the improved solid waste management option more frequently. The coefficient for years of education is positive and significant at 5% level. This fact suggests that respondents with higher education level would have greater awareness about the existing SWM problems and the consequences thereafter and would therefore favor the improved plans of SWM. Family size of the respondent is also positive and significant at 5% level. The reason may be households with larger family size would generate more solid waste and support the new improved SWM plans more frequently then households with small family size. As in the basic model, the coefficients for all the attributes are significant at the 1% level and their signs are as expected.

Compared to the basic MNL model, the extended MNL model has a higher level of parametric fit. The larger the value of R-squared static, the batter is the fit of the model to the observed data (Christie *et la*, 2004). As it can be seen from the results, the extended MNL model has a larger R-squared which is11.93%.

The MNL model imposes a strong assumption of the independence of irrelevant alternatives (IIA) property. This property requires that the ratio of probabilities of choosing any two alternatives must be independent of the attribute or the availability of third alternative. However, the MNL parameter estimates are biased if IIA is violated. A standard Hausman test for the violation of IIA assumption could not be completed as the difference matrix was not positive definite. Thus, the random parameter logit model which relaxes the IIA assumption was used. Table 4.4 presents the results for the random parameter logit model.

Table 4.4 Results of the random parameter logit (RPL) model

Variable	Coefficient	Standard Error	P [|Z|>z]
ASC	0.3914*	0.2109	0.0635
FREQ	0.7197***	0.0923	0.0000
SEPR	0.7857***	0.1345	0.0000
POCM	0.3671***	0.1153	0.0015
COST	-0.1014***	0.0094	0.0000
Summary statistics			
Log-likelihood	-880.5034		
R-squared	0.1474		
Iterations completed	5		
Observations	940		

* Significant at 10% level
** Significant at 5% level
*** Significant at 1% level

As in the basic MNL model, all the attributes are statistically significant at the 1% level and the signs of the coefficients are consistent with a priori expectations. These two models are also fairly similar in terms of the magnitude of the coefficients.

Comparing the fit of this RPL model to the basic MNL model shows that the RPL model appears to do a much better job of capturing preferences by several measures. The R-squared, which was 10.097% in the basic MNL model, has now increased to 14.74% when the parameters are assumed to be random variables. Thus, the RPL model results will be used in subsequent analysis as a more accurate and unbiased measures of households' preferences for improved SWM options in Adama town.

4.3 Estimation of implicit prices (marginal WTP)

The estimated coefficients from the above models can be used to calculate implicit prices for the non-monetary attributes. Implicit prices show the marginal rates of substitution (MRS) between the monetary attribute and the attributes under consideration. Estimation of implicit prices are made on a "ceteris paribus" basis that is, they are estimates of respondents' WTP for additional unit of the attribute of concern, given that every thing is held constant. Given the assumption of a linear-in-parameter utility function, the marginal WTP for a certain attribute is the ratio of the attribute coefficient and the coefficient of the monetary attribute. The implicit prices for the three non-monetary attributes can be estimated using equation 14.

Table 4.5 Estimates of Implicit prices using the results of RPL model

Attributes	WTP in Birr
FREQ	7.096
SEPR	7.746
POCM	3.62

The results from Table 4.5 reveal that the implicit prices for all the attributes are positive. This is an indication of the fact that respondents have a positive WTP for an increase in the quantity and/or quality of each attribute. The implicit price imply that the respondents are willing to pay Birr 7.096 per household per month for an improvement in the attribute FREQ Birr 7.746 per household per month for an improvement in the attribute SEPR and Birr 3.62 per household per month for an improvement in the attribute POCM.

4.4 Estimating compensating surplus

One of the strength of CM is that the estimated coefficients of the attributes may be used to estimate the economic value of a wide range of policy scenarios in which the attributes can be combined (Bergman *et al*. 2006). The results of the CM exercise can further be used to estimate the compensating surplus for a change from the initial situation (status quo) to different improved SWM scenarios. It measures the change in income that would leave an individual indifferent between the initial (status quo) and subsequent situation (improved SWM) assuming that the individual has a right to the initial (status quo) level of utility.

Current situation: Frequency of waste collection per week is assumed to be zero, separation of waste at source is not needed, and the service provider takes no measure at the dumpsite to reduce pollution.

Scenario 1: Frequency of waste collection per week is one, separation of waste at source is not needed, and the service provider takes no measure at the dumpsite to reduce pollution

Scenario 2: Frequency of waste collection per week is one, separation of waste at source is needed, and the service provider takes no measure at the dumpsite to reduce pollution

Scenario 3: Frequency of waste collection per week is one, separation of waste at source is needed, and the service provider takes some measure at the dumpsite to reduce pollution

Scenario 4: Frequency of waste collection per week is two, separation of waste at source is not needed, and the service provider takes no measure at the dumpsite to reduce pollution

Scenario 5: Frequency of waste collection per week is two, separation of waste at source is needed, and the service provider takes no measure at the dumpsite to reduce pollution

Scenario 6: Frequency of waste collection per week is two, separation of waste at source is needed, and the service provider takes some measure at the dumpsite to reduce pollution

To estimate compensating surplus, it is necessary to calculate the utility associated with the current solid waste management system and the option being considered. Using the RPL model, this is achieved by substituting the model coefficients and the attribute levels for the current SWM option. The value of utility of the alternative SWM option is calculated in a similar fashion, except that the coefficient for the alternative specific constant for options 2 and 3 is included and the attribute levels associated with the changed scenario are used. Calculating the difference between these two values and multiplying this by the negative inverse of the coefficient of the monetary attribute gives an estimate of the compensating surplus for the change from the status quo to the new scenario.

Estimates of WTP for the six scenarios are presented in Table 4.6. These values can be interpreted as the price that respondents are willing to pay for the change from the status quo (the current condition) to the scenarios (improved SWM options) For instance the average WTP of households for the change from the status quo to scenario-3 (where collection frequency is once per week, separation of waste is needed and the service provider takes some measure at the dumpsite to reduce pollution) is Birr 22.32. The WTP values for the shift from the status quo to scenario 4, scenario 5 and scenario 6 are Birr 18.05, Birr 25.79 and Birr 29.42, respectively.

Table 4.6 Estimates of compensating surplus using the results of RPL model

Scenario	**Attribute levels**			**Compensating surplus (in Birr)**
	FREQ	**SEPR**	**POCM**	
Status quo	0	0	0	__
Scenario 1	1	0	0	10.95
Scenario 2	1	1	0	18.70
Scenario 3	1	1	1	22.32
Scenario 4	2	0	0	18.05
Scenario 5	2	1	0	25.79
Scenario 6	2	1	1	29.42

The WTP results indicate that households have preferences towards improved solid waste management service. Furthermore, policy makers can use these results to value a range of other SWM scenarios resulting from different combination of the attributes levels used in this study.

CHAPTER FIVE

Conclusion and policy recommendations

5.1 Conclusion

Effective solid waste collection and disposal is a vital component of public service provisions and should take priority in emerging cities. The failure of this service can result in many kinds of unfavorable outcomes in the long run, which may have serious adverse effects on public health and the environment. However, the governments of developing nations usually suffer from heavily burdened and stretched financial and economic resources and high opportunity cost of funds to expand such service provisions (Murad et al., 2007).

In Adama town, the municipality mainly provides solid waste management service and the standard of solid waste management has always been gauged and evaluated on the basis of the role and performance of the service provider, without taking in to account the attitudes and opinions of the service receivers. However, tackling the problem of solid waste requires a concerted action of both the service provider and the service receivers, especially households who are the primary producers and generators of significant proportion of solid waste (which produce around 75% of the total waste products in the town).

Population explosion in the town, as a result of high fertility rate and rural-urban, migration resulted in open dumps of waste on streets, highways and drainage systems. Out of the total solid waste generated in the town, about 40-50 % remains uncollected The coverage of solid waste collection service by the municipality is very low (55%) and the number of garbage collecting sites in the town is limited to only 35, which resulted in the problem of open dumping in many places of the town. Given the above-mentioned problems, it is evident that the identification of appropriate solid waste management system is crucial for Adama town.

The main objective of this study was to analyze households' preferences for improved solid waste management options in Adama town using one of the stated preference techniques called choice modeling.

Using the data from 188 randomly selected households, two multinomial logit models and one random parameter logit model were estimated. The results from these models were then used to estimate implicit prices for the attributes and the over-all WTP of households for the change from the status quo (current solid waste management system) to different scenarios (which shows improved SWM options).

The results of the study show that improvement in the levels of all the non-monetary attributes can increase the utility of respondents. In addition, households with higher monthly total income, larger family size, as well as respondents with higher levels of education would favor the improved plans of solid waste management more frequently.

The implicit price estimation results of the study have also clearly indicated that respondents have a positive WTP for an improvement in level of each non-monetary attribute. The marginal WTP for frequency of waste collection, separation of waste at source and pollution control measures at the dumpsite are Birr 7.096, Birr7.746 and Birr 3.62, respectively. The over-all WTP of respondents was Birr 29.42 when frequency of waste collection is twice per week, separation of waste at source is needed and the service provider takes some measure at the dumpsite to reduce pollution. From the above facts it can be concluded that households in Adama town have preferences for improvements in the provision of solid waste collection and disposal service.

The choice modeling (CE) method has only been used in a small number of cases to estimate the benefits of solid waste management facilities in developing countries, particularly in Ethiopia. However, the results of this study have revealed that CM has the capacity for evaluating alternative solid waste management systems characterized by a number of attributes.

5.2 Policy recommendations

1. Policy makers should take into account information about the preferences of service receivers to design appropriate solid waste management in Adama town.

2. Policy makers can use the implicit prices (or marginal prices) results to identify the relative importance of the attributes to the households and allocate resources in favor of the attributes that have higher implicit prices.

3. Policy designers can use the compensating surplus (welfare measure) results for the change from the status quo (current SWM service) to different improved SWM scenarios to minimize the mismatch between the demand for and supply of SWM service in the town and to determine the appropriate price for the service.

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APPNDAX

ADDIS ABABA UNIVERSITY

DEPARTMENT OF ECONOMICS

A CHOICE EXPERIMENT SURVEY QUESTIONNAIRE FOR VALUING IMPROVED SOLID WASTE MANAGEMENT SERVICE

Date of interview ________________________________

Interviewer's Name _______________________________

Interview started _________________________________

Interview ended __________________________________

Hello! How are you? Thank you for giving me your precious time.

My name is ______________. I am a student at _______________ University. Mr Yonas Berihun is undertaking a research titled "Analysis of Households' Preferences for Improved Solid Waste Management Options in Adama town" as a partial fulfillment for the award of MSc in Economics and this interview is part of his research. You are selected randomly from the population living in the city. The information obtained from this interview will be used to help policy makers make informed decisions. The interview may take a few minutes. This interview is completely confidential; your name will never be associated with your answers. Most of the questions have to do with your attitudes and opinions, and there are no right or wrong answers.

Section one

1.1. Ranking of social and environmental problems for government funding.

Would you please rank the following sectors according to their importance to you (your household) for government funding from the most preferred to the least preferred?

Sectors	Rank
Public health services	
Public education	
Protecting the natural environment	
Crime prevention	
Poverty or unemployment reduction	
Housing	
National defense	
Expanding road infrastructure	

1.2. Questions about households' perception of their environment and the existing solid waste management system

1. Are you concerned about environmental issues in your area?

1) yes 2) no

1.1. Why____

2. Over all, how would you rate the quality of your environment?

1) Very good 3) average

2) Good 4) poor

3. Are you concerned about solid waste management issues in your area?

1) yes 2) no

4. Do you think that solid waste collection and disposal is a big problem for you and your neighbors?

1) yes 2) no

5. Can you tell us the impacts of poor solid waste management in your area?

____

____

____.

6. How do you evaluate the current solid waste management system in Adama city?

1) Very good 3) average

2) Good 4) poor

7. Who is responsible in managing solid waste in your household?

---

8. How does your household dispose solid waste?

a) Dispose on the solid waste (garbage) container around our home

b) Dispose on open space around

c) Dispose on mobile waste collector (truck)

d) Collected by private solid waste service provider from our home

8.1. If your answer for Q.No-8 is **d:**

8.1.1. Which institution provides you the service?______________________

8.1.2. How often do you get the service per month? ____________________

8.1.3. How much do you pay for the service per month? _________________

9. How do you dispose waste like glasses, use plastic bags, paper, etc?

a) by separating from other waste types

b) Simply dispose together with other waste types

c) Others, specify

10. How much solid waste does your household produce per week? ___________ (in 50 kg sack)

Section Two

2.1. Statement of the issue

This study tries to identify the desirable future solid waste management system in Adama town based on the values that households attach for different service attributes, which are at various levels. The research mainly attempts to estimate households' willingness to pay for various improved solid waste management options. In recent years, the generation of solid waste is increasing in Adama town due to rapid urbanization and population growth. Currently, out of the total waste generated in the town about 50-60% is properly disposed. The remaining 40-50% of the waste is disposed on open spaces, streets and drainage channels along roadsides of the town. This uncollected solid waste in many places of the town may have serious adverse effect on public health and environmental quality. Further more, the dumpsite located 8 kms away from the center of the town does not appear to have proper measures to control rainfall and runoffs, which may result in pollution of underground water and land surfaces in the neighborhoods. There are possible solutions to the existing problem which can improve the quality of the environment. We are undertaking this research to obtain opinions about the desirable features of solid waste management services as an attempt to find out solutions to the existing solid waste management problems in the town. We would also like to investigate if there are possible benefits associated with the waste generated in terms of material reuse and recovery. The solutions must be available if funds can be generated to pay for it and those funds must partly come from households residing in the town. Therefore, it is important to note that if the program is implemented, all permanent residents in Adama town would pay for the service. The payment vehicle is such that service receivers pay a monthly service charge to the service provider. The information provided is confidential (i.e., it will never be associated with your name) and it may be used to design future waste management policy. You are invited to participate in this survey by providing answers to the best of your knowledge.

2.2. Introducing the choice sets

You are randomly selected from the residents living in Adama town. We are assessing households' preferences for various improved solid waste management options. These options are defined by the service attributes of collection frequency, separation of waste at source by households and pollution control measures at the dumpsite. Improvements in these service attributes would cost your household. It is important to note that the options provided in this questionnaire are not exhaustive solutions to the problem at hand and there are many variants to the solutions outlined in this questionnaire. There are no right or wrong answers to the questions. It is just to have your say in what future policy regarding solid waste management should look like. Your attitudes and opinions as to which variant (option) is best is a useful input to policy determination. Please consider carefully the service attributes: collection frequency, separation of waste at source by households, pollution control measures at the dumpsite and the associated costs to carry out the different management options in the choice set questions that follow. The levels of these attributes are independent of each other. Before answering the choice sets, we do request you to keep in mind your available income and other things on which you may need to spend money.

2.3. An example of a choice set and a sample answer

Suppose that there are only three possible options. Option-1 (the status quo) refers to the current solid waste management service and in this case, the quality of the environment continues the way it is at the present. Option-2 and option-3 represent two different proposed situations that would involve households paying an extra amount of money to achieve an environmental outcome better than under the current solid waste management program. Would you choose option-1 (the current solid waste management program) or option-2 (i.e. collection frequency is twice per week, separation of waste at source is needed, the service provider takes some measure to reduce pollution at the dumpsite and monthly service charge is birr 10) or option-3 (i.e. collection frequency is once per week, separation of waste at source is needed, the service provider takes some measure to reduce pollution at the dumpsite and monthly service charge is birr 5). Note that option-2 and option-3 entail costs to your household.

Consider carefully each of the following three options. Suppose these options were the only ones available, which one would you choose? (Please tick in the box given below your preferred option).

Attributes	Option-1 (the current solid waste management system)	Option-2	Option-3
Frequency of waste collection		Twice per week	Once per week
Separation of waste at source		Separation needed	Separation needed
Pollution control measures at the dumpsite		Takes some measure to reduce pollution	Takes some measure to reduce pollution
Cost		Birr 10	Birr 5
	☐	☐	☐

If a respondent chooses option-1, then he/she needs to check the box below option-1 column as indicated above.

Block-1

Choice set-1

Consider carefully each of the following three options. Suppose these options were the only ones available, which one would you choose? (Please tick in the box given below your preferred option).

Attributes	Option-1 (the current solid waste management system)	Option-2	Option-3
Frequency of waste collection		Twice per week	Once per week
Separation of waste at source		Separation needed	Separation needed
Pollution control measures at the dumpsite		Takes some measure to reduce pollution	Takes some measure to reduce pollution
Cost		Birr 10	Birr 5
	☐	☐	☐

Choice set-2

Consider carefully each of the following three options. Suppose these options were the only ones available, which one would you choose? (Please tick in the box given below your preferred option).

Attributes	Option-1 (the current solid management syst	Option-2	Option-3
Frequency of waste collection		Once per week	Twice per week
Separation of waste at source		Separation not needed	Separation needed
Pollution control measures at the dumpsite		Takes some measure to reduce pollution	Without taking any measure to reduce pollutic
Cost		Birr 20	Birr 25
		☐	☐

Choice set-3

Consider carefully each of the following three options. Suppose these options were the only ones available, which one would you choose? (Please tick in the box given below your preferred option).

Attributes	Option-1 (the current solid v management syst	Option-2	Option-3
Frequency of waste collection		Twice per week	Once per week
Separation of waste at source		Separation needed	Separation not needed
Pollution control measures at the dumpsite		Without taking any measure to reduce pollution	Without taking any measure to reduce pollution
Cost		Birr 15	Birr 5
	☐	☐	☐

Choice set-4

Consider carefully each of the following three options. Suppose these options were the only ones available, which one would you choose? (Please tick in the box given below your preferred option).

Attributes	Option-1 (the current solid waste management system)	Option-2	Option-3
Frequency of waste collection		Twice per week	Twice per week
Separation of waste at source		Separation not needed	Separation not ne
Pollution control measures at the dumpsite		Takes some measure to reduce pollution	Without taking any measure to reduce pollution
Cost		Birr 25	Birr 20
	☐	☐	☐

Choice set-5

Consider carefully each of the following three options. Suppose these options were the only ones available, which one would you choose? (Please tick in the box given below your preferred option).

Attributes	Option-1 (the current solid waste management system)	Option-2	Option-3
Frequency of waste collection		Once per week	Once per week
Separation of waste at source		Separation not needed	Separation not needed
Pollution control measures at the dumpsite		Takes some measure to reduce pollution	Without taking any measure to reduce pollution
Cost		Birr 10	Birr 15

☐ ☐ ☐

Block-2

Choice set-1

Consider carefully each of the following three options. Suppose these options were the only ones available, which one would you choose? (Please tick in the box given below your preferred option).

Attributes	Option-1 (the current solid waste management system)	Option-2	Option-3
Frequency of waste collection		Twice per week	Once per week
Separation of waste at source		Separation needed	Separation needed
Pollution control measures at the dumpsite		Takes some measure to reduce pollution	Takes some measure to reduce pollution
Cost		Birr 20	Birr 25
		☐	☐

Choice set-2

Consider carefully each of the following three options. Suppose these options were the only ones available, which one would you choose? (Please tick in the box given below your preferred option).

Attributes	Option-1 (the current solid waste management system)	Option-2	Option-3
Frequency of waste collection		Twice per week	Once per week
Separation of waste at source		Separation not needed	Separation needed
Pollution control measures at the dumpsite		Takes some measure to reduce pollution	Without taking any measure to reduce pollution
Cost		Birr 15	Birr 10
	☐	☐	☐

Choice set-3

Consider carefully each of the following three options. Suppose these options were the only ones available, which one would you choose? (Please tick in the box given below your preferred option).

Attributes	Option-1 (the current solid waste management system)	Option-2	Option-3
Frequency of waste collection		Once per week	Twice per week
Separation of waste at source		Separation needed	Separation needed
Pollution control measures at the dumpsite		Takes some measure to reduce pollution	Without taking any measure to reduce pollution
Cost		Birr 15	Birr 5
	☐	☐	☐

Choice set-4

Consider carefully each of the following three options. Suppose these options were the only ones available, which one would you choose? (Please tick in the box given below your preferred option).

Attributes	Option-1 (the current solid waste management system)	Option-2	Option-3
Frequency of waste collection		Once per week	Twice per week
Separation of waste at source		Separation needed	Separation not needed
Pollution control measures at the dumpsite		Without taking any measure to reduce pollution	Takes some measure to reduce pollution
Cost		Birr 20	Birr 5
	☐	☐	☐

Choice set-5

Consider carefully each of the following three options. Suppose these options were the only ones available, which one would you choose? (Please tick in the box given below your preferred option).

Attributes	Option-1 (the current solid waste management system)	Option-2	Option-3
Frequency of waste collection		Twice per week	Once per week
Separation of waste at source		Separation not needed	Separation not needed
Pollution control measures at the dumpsite		Without taking any measure to reduce pollution	Without taking any measure to reduce pollution
Cost		Birr 10	Birr 25
	☐	☐	☐

2.4. Follow-up (debriefing) questions

A) Which of the following statements best describe the reason why you made your choices in answering the choice set questions above?

1. I choose the status quo option because of an objection to the way the cost is to be imposed.
2. I choose the alternative with the highest level of one attribute or the lowest cost on the basis of a single characteristic of the service.
3. I agree to pay in order to experience the 'warm-glow' of supporting a good cause.
4. I agree to pay because the payment is a reflection of the value of environmental quality.

B) Which of the following challenges (if any) did you face while answering the choice set questions? (Please circle one or more of the statements that best describe the challenges you encountered).

1. Ability to understand the choice set questions
2. Inability to manage the information since its content is a lot.
3. I do not accept the proposed scenarios.
4. Other (specify) ____

Section three

Information on socio-economic characteristics of the household

1. Gender ________. 1) male 2) female

2. Are you head of the household?

1) yes 2) no

3. How old are you? _______ (years).

4Years of formal education? _________ (years)

5. Occupation

1) salaried employee 3) trader

2) self employed 4) retired

6. What is an estimate of monthly total income of your household? Birr______________.

7. Martial status

1) married 3) divorced

2) single 4) other (please specify)

8. Family size of the household___________.

9. Number of household members less than 18 years of age_____________.

10. The house you are living is__________

1) your own 2) rented

11. How many years have you lived in this town? ___________ number of years.

End. Thank you very much for your cooperation

Date ____________________________________

Interviewer name __________________________

Signature_________________________________

Address___________________________________

Interviewer's observation

(To interviewer) did the respondent consider the survey and answer the questionnaire carefully?

a) Yes he/she considered the survey process carefully

b) Yes he/she considered the survey process carefully but did not visualize it.

c) He/she seems visualizing

d) He/she did not think about it.

Comment about the respondent

____

____.

Comment about specific questions (attributes, attribute levels)

____

____

____