ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

HOUSEHOLD'S WILLINGNESS TO PAY FOR SOLID WASTE MANAGEMENT OPTIONS: THE CASE OF YEKKA SUB CITY, ADDIS ABABA, ETHIOPIA

BY

SOLOMON TARFASA

JULY, 2007
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A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF ADDIS ABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN ECONOMICS

(RESOURCE AND ENVIRONMENTAL ECONOMICS)

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By

Solomon Tarfasa Faro

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Declaration

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

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ACKNOWLEDGEMENTS

I would like to express my gratitude to my advisor Dr. Alemu Mekonnen for his intellectual guidance and comments from the inception right through to the completion of this study. I am lucky having been advised and guided by someone so resourceful, constructive and friendly.

I am also very grateful to all who have been with me in the completion of this study. I especially want to express my gratitude to Abbi M. Kedir (Asst. Professor) in Economics, University of Leicester, UK who assisted me in providing baseline information on the application of Microeconomerics in the research area. Big thanks to my friend and classmate Sinafik Asrat for his assistance in handling the software for this study without whom it would have been difficult for this study to be realized.

I am greatly indebted to the staff members of the German Church School. Specifically they have been very supportive morally and materially. Besides, their affection is never forgettable.

Finally, it gives me pleasure to take this opportunity to express my warm thanks to my brothers Guta Tarfasa, Major Ayinalem, Fra'ol Taasisaa and to those who helped me in the successful completion of this paper from inception right through the end.

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Lists of Acronyms

AACASWAP	Addis Ababa City Administration Solid Waste management Policy
BMW	Biodegradable municipal Waste
CA	Conjoint Analysis
CE	Choice Experiment
CM	Choice Modeling
CS	Compensating Surplus
CVM	Contingent Valuation Method
CV	Compensating Variation
ENDA	Environmental Development Action
EV	Equivalent Variation
HP	Hedonic Pricing
IIA	Independence of Irrelevant Alternatives
MNL	Multinomial Logit Model
MRS	Marginal Rate of Substitution
MSW	Municipal Solid Waste
RUT	Random Utility Theory
SW	Solid Waste
TCM	Travel Cost Method
UN	United Nations
WTP	Willingness to Pay
WTA	Willingness to Accept
WEEE	Waste Electrical and Electronic Equipment

Abstracts

A major implication of the pattern of urbanization and rapid population growth in developing countries, like Ethiopia, is expanding adequate infrastructures, waste management service being one of them. However, it seems that this has not been the case in developing countries in general and in Ethiopia in particular. There is a range of solid waste problems, including inadequate waste collection systems, open dumping and other forms of improper final disposal resulting in environmental pollution. The primary objective of this study is to conduct an economic study on demand for municipal solid waste management (SWM) improvements in Yekka-sub city, Addis Ababa, so that the adverse effects of the solid waste in terms of economic, health and environmental impacts may be minimized. In this study an environmental valuation technique – Choice modeling (CM) was employed on 242 randomly selected urban households in Yekka-sub city to estimate the economic values of household's preferences for improved solid waste management service. This study has obtained estimates of marginal values of improved SWM service attributes and households' WTP for improved MSW management services. Households on average are willing to pay an additional charge of Birr 12.95 per month for a change in collection frequency form once per week to twice per week or from twice per week to thrice, *ceteris paribus,* and that households' net benefit per unit of waste is higher when there is sorting compared with the situation when there is no sorting since they pay less per unit of total waste ((i.e. both the recyclable and the non-recyclable solid waste) when there is sorting relative to what they pay for total waste when there is no sorting, *ceteris paribus.* In conclusion, households are willing to pay a positive amount of money for solid waste management service, which implies that any policy to bring about efficient solid waste management service in an area needs to include the

demand side information should it yield the needed environmental impacts while yielding the needed environmental impacts.

Chapter One

Introduction

1.1 Background

One of the channels through which environmental change affects human beings is through human health and economic productivity. Production is always accompanied by waste according to the Material Balance principle. To meet the need of rapidly growing population, it is obvious that production has to be increased by at least the population growth rate which leads to waste creation that is beyond the absorptive capacity of the environment.

The management of solid waste is one of the challenges facing urban areas in the world. An aggregation of human settlement has the potential to produce a large amount of solid waste. Municipal governments in the developed world have generally assumed the collection, transfer and disposal of waste. Municipal solid waste (MSW) management has been a major issue of concern for many under-developed nations, however, as population increases (Zerbock, 2003).

The problem of municipal solid waste management is compounded as many nations continue to urbanize rapidly; 30-50% of the population in many developing countries is urban (Thomas-hope, 1998) and in many African countries the growth rate of urban areas exceeds 4% per annum (Senkoro, 2003).

Although developing nations do spend between 20 and 40% of municipal revenues on waste management this is often unable to keep pace with the scope of the problem. In fact, when African countries were asked by the World Health Organization (WHO) to prioritize their environmental health concerns, the results revealed that while solid waste was identified

as the second most important problem (after water quality), less than 30% of the urban population have access to proper and regular garbage removals (Zerbock, 2003).

Most attempts to improve solid waste management in cities in developing countries, like Ethiopia, have focused on the technical aspects of different means of collection and disposal. Recently much attention has been given to investigating the demand side aspects related to solid waste management (Hartwick, 1998). In Ethiopia also the provision of solid waste management services had for long been from municipality which had focused on the technical aspects of collecting and disposal of solid waste. This arrangement to solve the problem of solid waste in urban areas of the country, in general and in Addis Ababa in particular have not been achieving the desired goal. This resulted in searching for another alternative that better minimizes the problem of urban solid waste. It was this trend that pushed / forced the Ethiopian government to form an agency that assumed the full responsibility of administering the management of municipal solid waste since 2003. Since then there is an inclination towards the inclusion of the demand side aspects of solid waste management in addressing the problem of municipal solid waste management (AACASWMP, 2002). Thus it is important to find efficient ways to treat solid waste. The improvement in environmental quality these treatments produce may lead to increase in individual and social welfare for which, in principle, there should be a positive willingness to pay (WTP).

1.2 Statement of the Research Problem

Developing countries have a range of solid waste problems, including: inadequate waste collection systems, open dumping and other forms of improper final disposal and the resulting environmental pollution, scavenging at landfill sites by waste pickers, and illegal dumping. These problems are being aggravated by growing waste generation rates associated with economic growth, increases in consumption levels, and the transition to mass consumption lifestyles in developing countries. There is concern that these problems, if left unaddressed, will become a serious challenge for generations to come. This concern has been shared by the international community since the 1990s. Agenda 21, a global action plan for sustainable development adopted at the UN Conference on Environment Development in Rio de Janeiro (the Earth Summit) in 1992, called for the environmentally sound management of solid wastes, among other priority issues(Toru, 2004).

A major implication of the pattern of urbanization and rapid population growth in developing countries, like Ethiopia, is expanding adequate infrastructures, waste management service being one of them. However, it seems that this has not been the case in developing countries in general and in Ethiopia in particular. For instance, waste generation every day in Addis Ababa was estimated to be 1386m^3 out of which 750m^3 was left uncollected. That means out of the total amount of waste generated about 46% remained uncollected and the rest 54% was collected (ENDA, 1996/7).

In another study, the amount of waste generated in Addis Ababa in 2003 was estimated to be 1841.8m^3 every day (0.22kg per household per day on average). Out of this, about 50 - 60 % is collected and the rest is unattended (Walelegne, 2003). The above examples may imply that ongoing SWM has become a major problem both for the concerned authority and

the population in Addis Ababa in terms of the environment, economy and health. It is common observing the sanitation workers busy removing garbage from roads, drainage systems, and streets in Addis Ababa, the implication of which is extra cost is being incurred. Thus it is reasonable to say that the amount of solid waste left uncollected in the city of Addis Ababa is significant implying that the service is not being given satisfactorily for the population living (residing) in it. If the accumulation and diffusion of solid wastes in this city continues the way it is now, property values, scenery and aesthetic values, environmental and health problems will get worse and in general quality of life deteriorates. To reduce the adverse effects of the solid waste in terms of economic, health and environmental impacts and provide efficient service for the population of concern there has to be a way out of it, and this is partly addressed in this study.

1.3 Objectives of the study

The primary objective of this study is to conduct an economic study on demand for municipal solid waste management improvements in Addis Ababa.

Specifically, the objectives of this study are: -

I. to estimate the implicit price for each service attribute i.e. collection frequency per week and sorting of waste.

II. to estimate compensating surplus for the improvement in environmental quality,

III. to assess what determines household's choices with respect to different solid waste management options.

1.4 Justification and significance of the study

Currently one of the major problems facing urban cities of developing countries, like Ethiopia, is lack of efficient infrastructure such as solid waste management service for urban households which was assumed by the municipality and efforts made to improve it emphasized to a large extent on the service providers only, ignoring or giving less emphasis to the demand side. Therefore, this study, as it focuses on the demand side of the SW management service, is expected to provide the following valuable information both for the public and private policy makers concerning solid waste management services in designing of municipal SW management service and service charge rates, and in understanding the role that households can play in solid waste management.

Another important contribution of this study is that it can be used as the starting point in applying Choice Modeling (CM) which to our knowledge has not been applied in any of the environmental valuation studies conducted so far on SW management service either in Addis Ababa or in other towns in the country. In general, knowledge obtained from this study may help to reduce the gap between the service that will be provided and the public demand for SW services.

1.5 Limitations of the Study

It is obvious that any study has limitations and thus this study is not an exception. Not using models like random-effects and not estimating standard errors for the estimates of implicit price and WTP are the main limitations of this study. Independence of Irrelevant Alternatives (IIA) will not be a problem in this study because the two alternatives proposed were collapsed into one. Thorough evaluation of the status of SWM is not done mainly because of limited time and lack of adequate information. The other limitations of this method are the cognitive burden it imposes

on the respondents as an individual is required to answer at least six choice sets. Instrument biases are also there because of the face to face interview nature of the study. Though the study tries to minimize the biases of this methodology, its problem is acknowledged. In addition, the time constraint limited a more detailed approach for data collection. Thus, the sample survey carried out for this study is limited in both size and scope. The sample size was limited to 240 households.

1.6 Organization of the study

The paper is organized as follows. Various concepts that are used in the analysis of SWM and the methods for valuing environmental goods such as SWM are discussed in chapter two. Chapter three discusses the nature of the data and the sampling method used to carry out the survey. It also describes the structure of the questionnaire, field procedure, specification of the model and the variables included in the analysis. Chapter four presents the application and the results of the evaluation of the status of SWM in Yekka sub- city, where marginal willingness to pay for each SWM attribute and the compensating surplus are discussed. Chapter five presents conclusion and recommendations.

Chapter two

Literature Review

2.1 Review of theoretical literature

2.1.1. Environmental Valuation Techniques

The word "environment" literally means 'the entire range of external influences acting on an organ' (Encyclopedia Britannica).The concern here is with a sub-group of consequences pertaining to the physical environment land, air, water and vegetation. The functions of the environment that we are concerned with can be specified as (1) source of natural resources (raw material, energy) (2) a source of environmental services and (3) an assimilator of residuals. Environmental changes affect human beings through (1) living systems which include human health, economic productivity (i.e. Agriculture, Forestry, Fisheries and Recreation (production)) and other ecosystem impacts such as recreation (amenities),ecological diversity, and stability.(2) non-living systems such as material damage, weather & climate and others like odor, visibility, visual aesthetics (Bateman et al., 1992).

A large environmental economics literature has grown since the late 1960s, encompassing a range of monetary valuation methods and techniques designed to 'price' the spectrum of environmental goods and services provided by the biosphere. Because of the fact that many environmental goods and services are non-marketed commodities; the valuation methods utilized involved market-adjusted, surrogate and simulated-market approaches (ibid).

2.1.2. Measures of welfare change and total economic value

Measures of welfare change

The Marshallian demand curve tracks the 'full price effect' which occurs when the provision of a good changes. Typically it has been used to show how much the quantity consumed of normal good increases when its price falls. A practical problem therefore arises in estimating the Marshallian demand curve for an unpriced environmental public good. Without private property characteristics, such as rival consumption and excludability, a good cannot be traded in a market and the price/consumption information required for estimating the Marshallian demand curve will not be directly observable. One solution is to estimate the Marshallian demand curve via a surrogate market, for example, using incurred travel costs as a proxy for the recreational value of an open-access leisure site. However, a more fundamental theoretical problem remains in that the presence of income effects means that consumer surplus itself can give an inaccurate measure of the welfare change resulting from a change in good provision.

In the case of environmental public goods the individual is usually faced with a quantity rather than a price constraint, the good often being unpriced. Furthermore, these goods often have much higher income elasticities than those associated with many market goods (Bateman et al., 1992). The consequently large income effect arising from a change in quantity may undermine the consumer surplus measure of welfare change. In order to move from the ambiguity of consumer surplus to a theoretically more accurate measure of welfare change we therefore need to compensate for the income effect by holding real income

constant, i.e. moving from using the ordinary Marshallian demand curve to the compensated (Hicksian) demand curve(ibid).

The Hicksian approach evaluates welfare change as the money income adjustment necessary to maintain a constant level of utility before and after the change of provision. Two such welfare change measures are feasible for such an approach. The 'Compensating Variation' (CV) is the money income adjustment (welfare change) necessary to keep an individual at his initial level of utility (U_0) throughout the change of provision, while the 'Equivalent Variation' (EV) is the money income adjustment (welfare change) necessary to maintain an individual at his final level of utility (U_1) throughout the provision change. We therefore have two approaches to measuring welfare changes. Furthermore these changes can be either positive (a welfare gain) or negative (a welfare loss) giving us four possible scenarios. For a proposed welfare gain (i.e. a change in provision which increases utility, e.g. more recreation; less pollution; etc.) the CV measure tells us how much money income the individual should be willing to give up (WTP) to ensure that the change occurs[9] while the EV measure tells us how much extra money income would have to be given to an individual (WTA) for them to attain the final improved utility level in the absence of the provision change occurring. For a proposed welfare loss (i.e. a change in provision which decreases utility, e.g. less recreation; more pollution; etc.) the EV measure will now show how much an individual is WTP to prevent the welfare loss occurring while the CV measure now shows individuals WTA compensation for allowing the welfare loss to occur(ibid).

These variation measures (CV and EV) only strictly apply where the consumer is free to vary continuously (i.e. non-discretely) the quantity of the good consumed. Where the consumer is constrained to consume only discrete or fixed quantities (as for most

constant, i.e. moving from using the ordinary Marshallian demand curve to the compensated (Hicksian) demand curve(ibid).

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These variation measures (CV and EV) only strictly apply where the consumer is free to vary continuously (i.e. non-discretely) the quantity of the good consumed. Where the consumer is constrained to consume only discrete or fixed quantities (as for most

environmental public goods) then we should consider compensating surplus (CS) and equivalent surplus (ES) measures in place of CV and EV respectively(ibid).

Total economic value

As far as conventional economic theory is concerned, the value of all environmental assets can be measured by the preferences of individuals for the conservation/utilization of these commodities. Given their existing preferences/tastes individuals will possess a number of held values which, in turn, result in objects being given various assigned values. In order, in principle, to arrive at an aggregate measure of value (total economic value) economists begin by distinguishing use values from non-use values (Pearce, D. W et al, 1990).

Use values- by definition, use values derive from the actual use of the environment. Those values which are expressed through options to use the environment in the future are called option values. They are essentially expressions of preference (willingness to pay) for the conservation of environmental systems or components of systems against some probability that the individual will make use of it at a later date. Provided the uncertainty concerning future use is an uncertainty relating to the "supply" of the environment, economic theory indicates that this option value is likely to be positive (Weisbrod, 1964;1971; Krutilla and Fisher, 1975; Kriström,1990). A related form of value is bequest value, a willingness to pay to preserve the environment for the benefit of one's descendants. It is not a use value for the current individual valuer, but a potential future use value or non-use for his/her descendants (ibid).

Non-use values- suggest non-instrumental values which are in the real nature of the thing but unassociated with actual use, or even the option to use the thing. Instead such values are taken to be entities that reflect people's preferences, but include concern for, sympathy

with, and respect for the rights or welfare of nonhuman beings. These values are still anthropocentric but may include recognition of the value of the very existence of certain species or whole ecosystems (ibid).

Total economic value is then made up of actual use value plus option value plus existence value. During the 1980s more extensive use of monetary valuation methods was combined with technical improvements in techniques. The result is a large literature consisting of a wide diversity of valuation case studies (both in terms of environmental assets and valuation methods).

The demand for monetary estimates of non-market values especially associated with environmental impacts has grown steadily over the last two decades. In the public sector, decision makers assessing capital works proposals and alternative natural resource management policies have sought quantitative assessments of environmental costs and benefits. In the private sector, an increasing number of firms find it useful to incorporate environmental value estimates in their project appraisals and environmental reporting processes to meet this demand, economists have developed an array of techniques that go beyond traditional market based means of estimating benefits and costs. The techniques can be classified as either 'revealed preference' or 'stated preference' methods (ibid).

2.1.3 Valuation methods

Valuation methods could be broadly classified into revealed preference and stated preference methods.

2.1.3.1. Revealed preference

The revealed preference pathway involves the use of information from markets that are specifically related to the non- marketed value under consideration to infer value estimates.

Examples of such methods include the travel cost method for estimating use values of recreation areas and the hedonic pricing technique which has been used extensively to estimate pollution costs. In addition to the above most popular methods, there are other methods like averting cost (or defensive expenditure).

Travel Cost (TCM) - assumes that the cost that an individual incurs in visiting a recreational site can be used to estimate his or her valuation of that site. The approach involves asking visitors question about where they have traveled from and the cost they have incurred. This information is related to the number of visits to generate a demand curve for the recreational site under question. Since we expect people living near the site to make more visits compared to those living far away, the demand curve will be downward slopping. That is travel cost will be inversely related to number of visits. The information requested in a travel cost survey includes the following: travel cost (petrol, food and other travel related expenses), income, alternative site and personal motivations. Entrance fees to recreation sites are often non-existent or nominal. The demand curve drawn from the relationship between travel costs (a proxy for the price of recreation) and number of visits can be used to estimate the total recreation value of the given site (Freeman, 1986).

Weaknesses of the TCM

The major assumption of the TCM is that the value of a recreational site can be proxied by the costs that the receptionist incurs in undertaking the recreational experience. The strength of the approach is that it is based on real rather than hypothetical data and as such can provide true values. However the assumption that the recreational value of a place is directly related to travel costs incurred in getting there could be an oversimplification of reality. For

example people who live near the site may incur zero or minimal travel cost but may nevertheless have high values for the site.

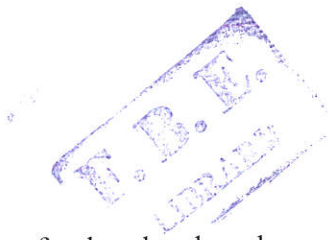
Other limitations include the following:

(1) The TCM is suited to estimating the value of particular sites or location and is unsuited for measuring other kinds of goods or services.

(2)Multiple destinations: a problem arises about the appropriate allocation of costs among multipurpose journey. The allocation of such costs could be arbitrary. The issue of how to treat visitors from overseas is also problematic.

(3)Visits to certain sites could be seasonal and therefore the survey results could be biased unless it is conducted over a long period.

(4)TCM cannot be used to estimate non-use (passive) values.



Hedonic Pricing Method (HP)

Hedonic pricing method (HP) derives from the characteristics theory of value developed by Lancaster (1966). The method identifies environmental service flows as elements of a vector of characteristics describing a marketed good, typically housing. According to HP consumers consider the level of environmental quality (such as air quality) in addition to other characteristics of a house when deciding about their location for living and that house prices are expected to differ depending on the environmental quality(Bennett,J. and Blamey,R.2001).

Weaknesses of the HPM

The main limitation of the HPM is that it is only applicable in areas where the property market is well developed and the property owners are aware of the environmental attributes or impacts and take them into consideration in their assessment of property values. Other limitations of the HPM include statistical skill, other factors such as taxes and interest rates

which are not accounted for in the hedonic pricing equation and the fact that this method cannot be used to estimate non-use values (ibid).

2.1.3.2 Stated Preference

The stated preference pathway uses people's responses to questions regarding their willingness to pay for hypothetical situation. Interest in stated preference methods has been kindled by their capacity to yield estimate of the full array of use and non-use environmental benefit and costs.

The most commonly applied methods are, the Contingent Valuation Method (CVM), Choice Modeling (CM) or Choice Experiment (CE) and Conjoint Analysis. Because CM has only recently emerged as a non-market environmental valuation technique; there are few resources available for greater understanding of its operation (ibid).

2.1.3.2.1. The Contingent Valuation Method (CVM)

In most applications, CVM has been the most commonly used approach. In particular, closed-ended CVM surveys have been used, in which respondents are asked whether or not they would be willing to pay a certain amount of money for realizing the level of the non-market good described or, more precisely, the change in the level of the good. The idea of CVM was first suggested by Ciriacy- Wantrup (1947). Since then, CVM surveys have become one of the most commonly used methods for valuation of non-market goods, although its use has been questioned. Hanley (1990) identifies six distinct phases involved in the practical application of CVM which has been briefly summarized below (table 2.1).

Table 2.1 Phases involved in the application of CVM.

stages	main features
1.preparations	set up a hypothetical market, define the elicitation methods provide information regarding the quality and/or quality change in the provision of the good define the payment vehicle
2.survey	obtaining responses to the questionnaire
3.calculation	calculate the mean WTP(or WTA)from the responses.
4.estimation	a bid curve can be estimated to investigate the determinants of WTP bids.
5. aggregation	this is required in order to move up from mean WTP to total value
6. appraisal	-checking whether the CVM exercise is successful

The limitations of Contingent Valuation

The use of stated preference techniques provides sufficient flexibility to enable the estimation of total economic values associated with environmental impacts. However, their use has been the subject of considerable criticism. That criticism has been centered on the technique's reliance on people's statements of preference (their intentions). This is in contrast to the revealed preference techniques where values are estimated on the basis of people's actions. Hence, numerous biases have been hypothesized to inflict stated preference techniques such as the Contingent Valuation Method (CVM). These are:

* Strategic bias (respondents deliberately misrepresent their preferences in order to influence the decision making process),
* Yea-saying (respondents agree to pay not because of the strength of their preferences for the 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, J. and Blamey, R.2001).

2.1.3.2.2. Theoretical basis of choice modeling

Choice modeling (CM) has its origin in conjoint analysis, information integration theory in psychology and discrete choice theory in economics and econometrics (Louviere, 1988). The contingent ranking and rating methods 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 'alternatives'. The alternatives are constructed by combining attributes at different 'levels'. The conjoint techniques have as a conceptual foundation in the work of Lancaster (1966), who developed his characteristics approach to the analysis of product demand (Bennett,J. and Blamey,R.2001).

Conjoint analysis has been widely used in market research, and involves the use of individual evaluations of a designed set of multi-attribute alternatives to obtain a decomposition of the total utility of any one or more alternatives into the utility associated with the individual attributes of those alternatives As such, these approaches have foundations in Lancaster's (1966, 1991) modern consumer theory (ibid).

2.1.3.2.3 Methodology of Choice Modeling.

Recent years have seen increasing interest in the use of conjoint-based stated preference methods for the assessment of environmental values. The most commonly applied stated preference technique in this area, choice modeling (CM) also referred to as choice experiment, and is increasingly being favored. Respondents to CM exercises are typically presented with six to ten choice sets, each containing a base option and two or three alternatives. They are required to indicate which option they prefer in each choice set. The levels of the attributes characterizing the different choice set options are varied according to an experimental design, permitting estimates of the relative importance of the attributes describing the options to be obtained. Rather 'than being questioned about a single event in detail, as in CVM analysis, subjects are questioned about a sample of events drawn from the universe of possible events of that type (Boxal et al, 1996).

A fundamental question that arises in the application of CM is whether to present the choice sets in a generic or labeled form. The generic form involves assigning generic labels to

each alternative in the choice set, such as 'alternative A', 'alternative B' etc. The labeled form involves assigning labels that communicate, directly or indirectly, information regarding the tangible and/or intangible qualities of the alternatives. In the context of environmental policy, labels tend to refer to sites, locations, policy names or other descriptors. An advantage of assigning issue-relevant and alternative-specific labels is that responses will better reflect the emotional context in which preferences are ultimately revealed. For example, a respondent may have a predisposition toward visiting a particular recreation site because he or she has fond memories from a past visit. This factor may not be reflected in the results of a CM exercise that describes sites purely in terms of tangible attributes involving recreation opportunities, camping facilities, proximity and cost. Often, the most plausible way of including such information is in the form of a label. This information not only increases predictive validity, but may also make the exercise less cognitively demanding.

Offsetting this potential advantage of labeled choice set configurations is the likelihood that generic configurations may encourage more discerning and discriminating responses. Instead of respondents being able to base their responses wholly or largely on the alternative with the most superficially attractive label or descriptor, respondents are required to consider differences in policy options as described by the attributes listed in the choice sets. The result is that more informed and deliberated preferences may be desirable from a non-market valuation perspective (Mitchell and Carson, 1983).

Choice Model (CM) has its theoretical bases in random utility theory (RUT). According to RUT, the i^{th} respondent is assumed to obtain utility U_{ij} from the j^{th} alternative in choice set C. U_{ij} is held to be a function of both the attributes of the alternatives (X_{jk} representing

the k^{th} attribute value of the j^{th} alternative) and characteristics of the individual, S_i. U_{ij} is assumed to comprise a systematic component indirect utility function in which the attributes are arguments, V_{ij} and a random component ε_{ij} . Whilst V_{ij} relates to the measurable component of utility, ε_{ij} captures the effect of omitted or unobserved variables.

We thus have

$$U_{ij} = V_{ij}(X_{ij}, S_i) + \varepsilon_{IJ} \quad \text{---------- (1)}$$

Respondent i will choose alternative h in preference to j if $U_{ih} > U_{ij}$. Hence, the probability of i choosing h is:

$$P_{ih} = prob(U_{ih} > U_{ij}) \text{ for all j in C, } j \neq h .$$

$$= prob(V_{ih} - V_{ij} > \varepsilon_{ih} - \varepsilon_{ij}) \text{ for all j in C, j} \neq \text{h---------- (2)}$$

The ε_{ij} for all j in C are typically assumed to be independently and identically distributed (IID) and in accordance with the extreme value (Gumbell) distribution. This gives rise to the multinomial logit model, commonly employed in discrete choice modeling, of which the binary logit used in CVM studies is a special case:

$$p_{ih} = \frac{\exp^{(\lambda v_{ih})}}{\sum_{j \in C} \exp(v_{ij})} \quad \text{---------- (3)}$$

where λ is a scale parameter, which is inversely proportional to the variance of the error term, and commonly normalized to 1 for any one data set (Ben-Arkiva and Lerman, 1985). An estimated linear-in-parameters utility function for the jth alternative often takes the following form:

$$V_J = ASC_J + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + --- + \beta_N X_N + \gamma_1 (S_1 * ASC_J) + \\ --- + \gamma_m (S_M * ASC_J) ----------(4)$$

where there are n attributes with generic coefficients across alternatives, and m individual-specific variables multiplied by an alternative specific-constant (ASC). The ASCs capture the mean effect of the unobserved factors in the error terms for each alternative. This provides a zero mean for the error terms and causes the average probability of selecting each alternative over the sample to equal the proportion of respondents actually choosing the alternative. Socioeconomic and attitudinal variables can be included in the model interacting them with the alternative-specific constants (as shown in Eq (4)) and/or the attributes (not shown). ASCs should be included regardless of whether generic or alternative-specific labels are employed. The inclusion of alternative-specific labels simply alters the interpretation of the estimated ASCs (Bennett, J. and Blamey, R.2001).

The inclusion of ASCs helps mitigate inaccuracies due to violations in the assumption of independence of irrelevant alternatives (IIA). This assumption, which arises from the above-mentioned IID assumption, implies that the ratio of the choice probabilities for any two alternatives be unaffected by the addition or removal of alternatives. This is equivalent to assuming that the random error components of utility are uncorrelated between choices and have the same variance (Carson et al., 1994). Violations of the IIA assumption render the MNL model inappropriate (ibid).

In order to calculate the choice probabilities, the researcher must make some assumptions about the distribution of the random component. Typical assumptions are that the E is (1) independently and identically distributed-Gumbel random variables, which assumption leads to the familiar binary or multinomial logit (MNL) models or (2) neither

independently nor identically distributed random variables, which assumption leads to complex binary or multinomial probit (MNP) models. In practice, it is difficult to distinguish normal and Gumbel models that otherwise are derived from the same assumptions about dependence, variance and covariance of random components because of observations in the far tails.

Part-worth

In a linear statistical model the b coefficients estimated under the MNL model can be used to estimate the rate at which respondents are willing to trade-off one attribute with another. When the attribute being sacrificed is the money attribute, the trade –off estimated is known as a "part worth" or "implicit price ".They demonstrate the amount of money respondents are willing to pay in order to receive more of the non-marketed environmental attribute.

Part-worth (implicit price) $=\beta$non-monetary attribute/βmonetary attribute---------- (5)

Estimates of implicit prices are made on a "ceteris paribus" basis, that is, they are estimates of the WTP of respondents for an increase in the attribute of concern, given that every thing is held constant.

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

The implicit prices allow an analysis of the composition of potential alternative allocation of resources. A comparison of the implicit prices of attributes affords some understanding of the relative importance that respondents hold for them. On the basis of such

comparison, policy makers are better placed to design resource use alternatives so as to favor those attributes which have higher (relative) implicit prices.

It can be tempting for analysts to observe the indirect utility functions estimated using CM and conclude that the coefficients represent the contributions to utility of each of the attribute. This is an incorrect approach because the coefficient by themselves are confounded by what is known as a scale parameter that is dependent on the variance of the error involved in the estimation process. In other words, the extent of the variance of the statistical error involved in the estimation process has an impact on the absolute magnitude of the b coefficients. It is only through the division of the b coefficients that is integral to the process of part- worth calculation that the scale parameter is cancelled out and the confounding effects of the error variance is eliminated.

Finally, it is important to note that part-worth is generally not a welfare measure that can be used in benefit-cost analysis. Part-worth expresses the marginal rate of substitution within an alternative (or conditional indirect utility function).In Random Utility models each alternative has some probability of being realized thus welfare measures must take into consideration the probability of being realized plus the change in all the attributes being examined, not just a single attribute(Bennett,J. and Blamey,R.2001).

Stated preference and opt-out preference

Opt out options are alternatives that don't vary from one choice to another. These non varying options are useful for several reasons. First, and most importantly, including an opt out option prevents a forced choice in the experiment. Second, surveys which include an opt out option may reveal information about total demand or market participation information as well as share information. They may also facilitate aggregating different data set that use the same

non-varying alternatives. Lastly, incorporating opt-out option into each choice set makes generating an efficient experimental choice design easier (Bennett,J. and Blamey,R.2001).

Economic surplus

A particular strength of CM is its ability to generate estimates of the values of many different alternatives from the one application. Hence, from one set of choice data, the values of an array of alternative ways of reallocating resources can be estimated .This feature of a CM arises because it specifically investigates the trade-offs between attributes. Thus, different combination of the attributes that are used to describe alternatives can be evaluated.

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

First, the values of the attributes that are associated with the status quo are substituted into the equation that estimates the indirect utility associated with that option. If socio-economic variables are included in that equation, the values to be substituted are the sample mean (or the individual specific welfare measures can be computed).Note that the monetary attribute is assigned a value of zero for this stage.

Next, the values of the attributes that are associated with an alternative allocation of resources are substituted into the equation that relates to the relevant change attribute. The value of the relevant ASC should be 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. 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:

$$\text{Economic Surplus} = \frac{-(1)(V_1 - V_2)}{\beta_{monetary}} \quad \text{---------- (6)}$$

where V_1 and V_2 are the indirect utilities associated with before and after the proposed change respectively.

A negative value for this surplus estimate would indicate that the respondents are willing to pay the amount of the surplus in order to experience an improvement in their well-being caused by the reallocation of resources from the status quo to the change alternative. By setting up multiple scenarios of alternative resource allocation (by varying the values the attributes can take) and repeating this arithmetic exercise, an array of values associated with the array of scenarios can be estimated. Note that these results apply only when all attributes enter in a linear fashion (ibid).

2.1.3.2.4 Strengths and Weaknesses of Choice Modeling

Choice Modeling, as applied to the estimation of non-market environmental values particularly non-use values- is at a formative stage internationally. Choice Modeling (CM) has both strengths and weaknesses relative to other stated preference techniques notably the CVM. As far as strengths are concerned, the most significant is the techniques' ability to produce a rich database on people's preferences and to generate statistically robust models of choice. With that level of information, policy markers are able to make decisions about both the provision and management of natural resources that are far better informed and, hence, more likely to generate net benefits for the community at large. Some of the problems that have beset applications of the CVM are better tackled using the CM approach. The technique enables control to be exerted over the frame that respondents use to form their preferences for

the issue at hand. CM will often provide more discerning and scope sensitive response than the CVM. The problems that CM analysts do confront are likely to be more readily understood because of the wealth of data that the technique yields.

On the other side of the 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. The heuristics respondents develop to cope with these complexities may not be appropriate to the decision making context. The complexities also mean that there are more contingencies or simplifying assumptions upon which a CM estimated value is based. The more contingencies, the more prospects there are of inappropriate contingencies being integrated into the value estimates derived. Complexities also occur in the design and analysis of CM applications. This will necessarily limit its application as will any cost burdens associated with the complexities (ibid).

2.1.4. Welfare measures for improved environmental quality

A particular strength of CM is its ability to generate estimates of the values of many different alternatives from the one application. Hence, from one set of choice data, the values of an array of alternative ways of reallocating resources can be estimated .This feature of a CM arises because it specifically investigates the trade-offs between attributes. Thus, different combination of the attributes that are used to describe alternatives can be evaluated.

In theory economic welfare measures are:

a) The amount of money (given or taken away) that makes a person as well-off as they would be before a change (WTP) or b) the amount of money (given or taken away) that makes a person as well-off as they would be after the change (WTA). Algebraically, welfare measure-compensating surplus (CS) can be expressed as:

$$V(M, 0) = V(M\text{-}CS, 1) \quad \text{---------- (7)}$$

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

There are two main categories of welfare measures that arise from the two approaches to using CM in applied studies .The first is the so-called state of the world approach in which one compares the utility in the base case with the utility in a "changed" case. In these state of the world models there is only one alternative in each case. In contrast, in behavioral studies, the improvement may be a quality change at one recreation site –but there are still multiple sites to choose from. The base case contains multiple alternatives and so also does the improved case, thus the welfare measure must examine the utilities with and without the improvements, as well as the probabilities of choosing each alternative (ibid).

2.1.5 Solid waste and solid waste management

2.1.5.1 Solid waste, definition, types and sources

Waste includes all items that people no longer have any use for, which they either intend to get rid of or have already discarded. Additionally, wastes are such items which people are required to discard, for example by lay because of their hazardous properties. Many items can be considered as waste e.g., household rubbish, sewage sludge, wastes from manufacturing activities, packaging items, discarded cars, old televisions, garden waste, old paint containers etc. Thus all our daily activities can give rise to a large variety of different wastes arising from different sources.

2.1.5.1a Waste types

Municipal Waste: - Municipal waste is generated by households, commercial activities and other sources whose activities are similar to those of households and commercial enterprises.

It does not include other waste arising e.g., from mining, industrial or construction and demolition processes.

Industrial waste- Manufacturing: - industry waste comprises many different waste streams arising from a wide range of industrial processes such as the production of basic metals, food, beverage and tobacco products, wood and wood products and paper and paper products.

Hazardous waste: - Hazardous waste arises from a wide range of different sources including households, commercial activities and industry.

Construction and demolition waste: - Construction and demolition waste is made up of two individual components: *construction* waste and *demolition* waste. It arises from activities such as the construction of buildings and civil infrastructure, total or partial demolition of buildings and civil infrastructure, road planning and maintenance. In some countries even materials from land leveling are regarded as construction and demolition waste.

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

Waste electrical and electronic equipment (commonly referred to as WEEE): - consists of end of life products and comprises of a range of electrical and electronic items such as Refrigerators, IT and telecommunication equipment, Freezers, Electrical and electronic tools, washing machines, medical equipment toasters, monitoring and control instruments, hairdryers, automatic dispensers, televisions, etc.

Biodegradable municipal Waste: - Biodegradable Municipal Waste (BMW) is waste from households and commercial activities that is capable of undergoing biological decomposition. Food waste and garden waste, paper and cardboard are all classified as biodegradable municipal waste.

Packaging waste: - Packaging is defined as any material which is used to contain, protect, handle, deliver and present goods. Items like glass bottles, plastic containers, aluminum cans, food wrappers, timber pallets and drums are all classified as packaging. Packaging waste can arise from a wide range of sources including supermarkets, retail outlets, manufacturing industries, households, hotels, hospitals, restaurants and transport com.

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, waste oils and veterinary medicines(ETC/RWM,2006).

2.1.5.1b Definition of Municipal Solid Waste

Municipal solid waste (MSW) refers to the materials discarded in the urban areas for which municipalities are usually held responsible for collection, transport and final disposal. MSW encompasses household refuse, institutional wastes, street sweepings, commercial wastes, as well as construction and demolition debris. In developing countries, MSW also contains varying amount of industrial wastes from small industries, as well as dead animals, and fecal matter (Medina, 2002).

Solid waste management (SWM) is defined as, according to Jamal Othman (2002), the control, generation, storage, collection, transfer and transport processing and disposal of solid waste consistent with the best practices of public health, economics, financial, engineering, administrative, legal and environmental consideration. According to Zerbock (2003), solid waste can broadly be defined as including non-hazardous industrial, commercial and domestic refuse including household organic trash, street sweepings, hospital and institutional garbage

and construction garbage; generally, slug and human wastes are regarded as a liquid waste, a problem which is outside the scope this study.

2.1.5.1c Types of Solid Waste Management

The four most common methods of municipal solid waste management are land- filling, incineration, composting and anaerobic digestion. Incineration, composting and anaerobic digestion are volume reducing technologies; ultimately, residues from these methods must be land filled. Land- filling is the only true "disposal" method of managing MSW. It is also the most economical, especially in developing countries where it typically involves pitching refuse into a depression or closed mining site. Landfills produce landfill gases and leachate which can harm human and natural systems.

Incineration is the high-temperature combustion of wastes .noncombustible must be sorted out before incineration. Benefits of incineration include reduction of volume of waste and production of energy in the form of electricity and heat However, construction and start-up costs of incineration facilities can be prohibitively expensive for developing nations. Composting and anaerobic digestion use natural microbial organisms to decompose the organic fraction of MSW The non-organic fraction must be land filled or incinerated. These methods reduce the volume of waste that must be landfilled, and end products can potentially be used as agricultural fertilizers, or processed into fuels for motor vehicles However, like incineration, project implementation can be too expensive for poor communities (Medina, 2002).

2.1.5.1d Countries' Experience

Table2.2 Municipal Solid Wastes Generation in Different Countries

Country	Population	MSWgeneration (kg/person/day)
Sri Lanka (Colombo)	17.19 (1991)	0.42
Thailand (Bangkok)	56.68	0.45
The Philippines (Manila)	62.69	0.50
Indonesia (Jakarta)	181.39	0.60
Malaysia	18.29 (1995)	0.76
Singapore	3.10	0.87
Japan	123.97 (1990)	1.12
Denmark	5.10 (1990)	1.30
USA	252.04 (1990)	1.97
United Kingdom	57.54 (1990)	0.95
Sweden	8.60	1.02

**Source: Beede, and Bloom. 1995.

It can be observed from the table above that the per capita waste generation between the developed and underdeveloped countries are very much different in terms of magnitude. The per capita waste generation of the developed countries more that doubles those of under

developed ones. For instance, per household waste generation for Ethiopia is about 0.22kg per day which is far below the above figures.

2.2. Empirical Literature

Othman (2002) conducted a study in Malaysia, where two study areas were selected for the study, the Kajang and the Seremban municipalities in Malaysia. He employed non-marketed goods valuation techniques Choice Modeling (CM) and Contingent Valuation (CV) to elicit consumers' willingness to pay (WTP) for different service options. The aim of CM was to identify marginal values for SWM attributes.

The CV was to assess the value of a total solid waste management (SWM) package. For the CM, 600 heads of households (or alternatively a working family member), stratified based on house types, were sampled randomly. For the CV, about 600 households were also sampled. Three focus groups and a pre-test were employed to identify the non-market SW management attributes and the levels these attributes could take.

The choice sets followed the standard L^{MN} experimental design where only the main effects are modeled. In the focus groups, three MSW management alternatives (one baseline and the other 2 represent an improvement of MSW management plan) and 6 service attributes were constructed. The service attributes and levels that it took for the 2 improved alternatives were as follows: Collection frequency, free provision of multiple containers for separation of wastes at source, time of collection, types of waste disposal methods, mode of transportation, and monthly charges.

The Statistical Packages for Social Sciences software,, SPSS, (orthogonal design routine) was used to determine the mix of attribute levels for the choice sets. The payment vehicle was direct monthly payment to the service providers.

The Wald test showed that all coefficients were significant at the 1% level. Results showed that 9 out of 18 socio-economic and attitudinal variables were significant at least at the 10% level. These were age, sex, incomes, environmental concern, number of large waste bags, working members of the households, awareness for importance of environment, knowledge of recycling program in the area and separation of waste by households. The study found that all monetary and non-monetary attributes, were significant and yielded the expected signs. From the results of the two models, it was deduced conclusively that households supported improvement in solid waste management plan, in terms of collection frequency, waste separation at source, disposal methods and mode of transportation. Households on average are willing to pay an additional charge of YR2.57(USD 0.68) per month for a change in collection frequency from 3 times irregular to either 3 times every alternate day or 4 times per week, *ceteris paribus,* the implicit price for SEPWASTE was MY 5.15 (USD 1.37).Households, on average were to pay an additional charge of MYR 3.90 (USD 1.03) per month if waste disposal method was improved from control tipping to sanitary landfill, *ceteris paribus*, households are willing to pay an additional charge of MYR 3.19 (USD 0.84) per month if transportation mode was improved from a mix of compactor and open trucks to either compactor or a mix of compactor and covered trucks, ceteris paribus.

The analysis of marginal willingness to pay indicated that at the outset of the CM survey, households' WTP for the current waste management services (equivalent to surplus measure) was estimated (Othman 2002). In Ethiopia, most of the valuation studies that were

made in the context of the environment employed the Contingent Valuation method (CVM) to elicit consumers' willingness to pay for environmental goods and services. Very few of the studies applied the Choice Modeling (CM) technique in Ethiopia. The following is a brief literature survey of the studies that employed both the CM and CVM in environmental valuation in general and in valuing Solid Waste Management (SWM) services in Addis Ababa and regional towns and cities, in particular.

A study was made by Carlsson et al (2005) to investigate the dichotomy between extension driven adoption of modern inputs, on the one hand, and community driven local public goods, on the other hand, in the highlands of Ethiopia, where the farmers were given a choice between an agricultural extension package and a local public good - health care or protected spring, using choice experiment.

The survey covered a total of 1520 households from two zones in the Amhara region of Ethiopia-East Gojjam and South Wollo. Twelve research sites were purposely selected, six from each zone while households within each site were selected at random. Respondents were asked to make hypothetical trade-offs between various extension packages and local public goods.

The head of the household (who is typically the husband) and another member of the household (typically the spouse) were asked the choice experiment questions. The extension package was described as improved seed ('Teff or Maize) and modern agricultural inputs. The extension package was described by two additional attributes: (i) the amount of money they had to pay back at harvest time, and (ii) an insurance scheme. Each respondent made eight pair-wise choices. The empirical analysis included three sets of variables. The first describes the attributes of the experiment, i.e. whether the household has chosen the maize or

the 'teff' package, whether the public good is a health station or an improved spring, the amount that the household needed to pay back after harvest, having received the extension package, and whether this repayment needed to be done if there were a crop failure (insurance). The second set included the standard socio-economic variables. The third set of explanatory variables was chosen to control for the availability of the proposed goods.

Their final data set included 12591 choices made by 1591 individuals in 1012 households in East Gojjam and South Wollo. The share of choices made in favor of the extension package was as low as 20 percent. The proportion of households that chose the health station and protected spring were 84 percent and 76 percent respectively. However, the share choosing the extension package more than doubled had the cost of inputs not been paid in case of crop loss. This gave a clear indication of the importance of risk aversion in reducing the adoption rate of modern inputs in Ethiopian agriculture.

Finally, there were also some differences with respect to which public good that they were asked to make a trade-off with health station had been preferred to protected spring.The overall result was that households in these regions in general preferred such local public goods as compared to the proposed extension package.

From the socio-economic characteristics they also got some interesting insights. The probability of choosing the extension package decreased with age in Gojjam while age was not a significant factor for Wollo. There was also a significant difference across gender. Female respondents were less likely to opt for extension packages than their male counterparts both in the Wollo and Gojjam sub-samples. Literacy was surprisingly insignificant for each of the two sub samples, maybe because increased literacy had a similar impact on both the preference for extension packages and health-improving local public goods. Family size has a negative and significant effect on choice of extension package in Gojjam suggesting that larger families in

Gojjam preferred health facilities and protected springs to extension package. They also found that while whether or not the household had some land was not significant in Gojjam, the size of land owned had a positive and significant impact both in Wollo and Gojjam.

Gebresilasie (2006) conducted a study to elicit individual's preferences for different aspects of lake Awasa and its surroundings using choice experiment. 200 fishermen were randomly collected from two fishing cooperatives working on Lake Awasa for the study. The survey was administered using face to face interview. Three attributes-*tilapia fish, lake surrounding forest cover* and *the monetary attribute (fishing permit)* were employed for the study without which the relevance of the attributes is questionable.. In his study, Gebresilasie pointed out that the combination of choice sets which were about 18 were more than the respondents could be expected to cope with. The choices sets for the study were constructed using the OPTEX procedure in SAS. After dropping identical and unrealistic combinations, 12 choice sets were left and randomly assigned to two blocks such that a single respondent would be confronted with six choice sets. Two different multinomial Logit Models were used for estimation. The first model was the basic specification which shows the importance of the choice set attributes in explaining respondent's preferences for the three lake environmental rehabilitation options: continue with the current plan (status quo option) and improving the environmental quality of the lake in terms of its three attributes. The second model incorporates the socio-economic and environmental attitudinal variables in addition to the attributes in the choice set. The estimate from the basic multinomial Logit showed that the two environmental attributes -tilapia fish and the forest cover have the expected positive signs and all the coefficients of the attributes were statistically significant. The positive sign of the coefficient of the tilapia fish and the forest cover attributes indicated that an increase in their levels are considered as an improvement of the environment. Likewise, the monetary attribute

–fishing permit-had the expected negative sign which was in agreement with the hypothesis that cheaper alternative or plan is preferred to more expensive ones, ceteris paribus.

In the extended model, where the socio-economic characteristics are interacted with the attributes and the alternative specific constant, all the attribute coefficients with the exception of the forest attribute were statistically significant at 1 percent level.

The parameter estimates associated with each of the attributes were very similar across the two specifications. The overall model was significant at 1 percent level and the explanatory power was also relatively high. In estimating implicit prices using the MNL model, the result indicated that the local fishermen were, on average, willing to pay Birr 8.83 per month for an improvement in the tilapia fish stock while the willingness to pay for the forest attribute was not significant. The compensating surplus (CS) for the change from the status quo to the new scenario was estimated. Mean willingness to pay for scenario 3 (that is low impact improvement scenario) was Birr 28.58 per month for the medium impact improvement scenario and a mean willingness to pay of Birr 31.42 per month for the high impact improvement.

In Ethiopia, particularly in Addis Ababa, a lot of contingent valuation method (CVM) based studies have been made on improvement of solid waste management services in the last decade. To begin with, Yitbarek[1] (1998) undertook a CV survey on solid waste collection in A.A by selecting 210 households in which a face to face interview was conducted and open-ended question method was applied to elicit respondent's willingness to pay (WTP). In his research, linear and log-linear models (OLS) were used to study the significance of the independent variables- respondent's interest in environmental problems, awareness of solid

[1] Yitbarek is cited in Tolina(2006)

waste problems, perceived level of the existing solid waste collection system, responsibility for various solid waste problem, age, sex, family size, level of education and house hold income. Of all these variables, awareness of solid waste problem, household income and interest in environmental problems were important factors determining respondents' WTP values (Yitbarek 2003).

Aklilu[2] (2002) used CVM, based on closed ended with a follow-up format, to elicit willingness to pay for an improved solid waste management of households' of Addis Ababa, drawing 430 households at random. The model used in the study, the Tobit model, showed that the income of households, time spent in the area, quantity of waste generated, responsibility of solid waste management, education dummies, ownership of the house and the number of children had a positive and significant effect on WTP.

Hagos (2003) also used CVM in his study to elicit individual willingness to pay for improved solid waste collection and disposal services for Mekele town. He employed an open ended with the iterative bidding game format and selected a total of 164 households using stratified sampling based on the smallest administrative unit 'Kebele' thereby applying systematic random sampling for selecting households from each stratum. He employed Ordinary Least Square (OLS) in estimating the bid function where the Willingness To Pay (WTP), is function of sex, age, education, household size, household income, house ownership, household awareness about SW problem, household satisfaction with the existing level of SW service. Of these variables, household's income, awareness about SW problem, age, size of the household, were found to significantly influence the dependent variable (WTP).The remaining explanatory variables were found insignificant.

[2] Aklilu is cited in Tolina(2006)

Walelegne (2003) conducted a CVM survey on valuation of improved solid waste management in Addis Ababa. He selected a sample of 500 households using two stage stratified sampling followed by a random sampling applied on each stratum to ensure representativeness. The information on different characteristics of households obtained from the survey was used to test the model that explains WTP for improved solid waste services as a function of income age, sex, education, and number of children, wealth, interest in environmental issues, service provider dummies and starting bids. The results using Ordinary Least Square (OLS) and the result showed that income, education, wealth, and types of service (private versus public) were significant while the remaining repressors were found insignificant in influencing households' WTP for improved solid waste management service. The literature review shows that almost all the studies made to evaluate the non-market environmental goods in Addis Ababa and other towns in the country, particularly on solid waste management services, employed the contingent valuation technique (CVM) to elicit consumer's willingness to pay for an improvement in the non marketed environmental goods. The potential socio-economic, demographic and other factors that influence household's willingness to pay for improved solid waste management options attribute can be identified from the literature review. It also shows that majority of the studies used the Ordinary Least Square (OLS) for their estimation. It is clear from the literature review that the WTP was used to estimate only the total economic value to a society of a marginal increase in the non-marketed environmental good as a whole as CVM cannot value the environmental improvement brought about by an increase in a solid waste management attribute. CVM as a technique to reveal individual's preference for non marketed environmental commodities also suffers from several potential biases such as strategic bias, information bias, hypothetical bias, constant budget bias and interviewer or non-respondent bias.

Given the above background and the flaws with respect to CVM as a technique of revealing individual preference for non-marketed environmental commodities and others, it is reasonable to find a technique that takes into account the pitfalls in CVM as a technique in revealing individual preferences for valuing the marginal as well as the aggregate benefits brought about by a change in an attribute in solid waste management option. The technique thought appropriate for the proposed study, is the Choice Modeling (CM) .CM has never been used, as to the best of our knowledge, in valuing the benefits to a society of improvement in environmental quality as a result of a marginal change in an attribute of a SW management option in Addis Ababa in particular, in Ethiopia.

Chapter three

Methodology of the Study

3.1 Data Collection and Sampling Design

Both primary and secondary data were collected to analyze SWM system in one of the ten sub-cities of Addis Ababa 'Yekka' sub city. Supply side information was obtained from documents of Addis Ababa Health Bureau, other relevant secondary sources, and interviews with officials involved in the provision and planning of solid waste services. Field observation was also carried out in order to supplement the available statistics.

The sample for the study was drawn from Yekka sub city which was purposively selected based on information on Urban Economic Establishment Census (CSA, 2004) (see annex1), covering a total of 4 "kebeles" randomly selected. Given the method used to collect the data i.e. face to face interview and the time limit within which the data is collected, a random sample of 254 households were selected for the survey. Households were selected from each Kebeles by randomly picking the house number. According to the CSA, the income distribution of the households in this administrative unit (Yekka sub city) is 7%, 35% and 58% for high, middle and low standard respectively. It is by this proportion that the households in the study area were drawn i.e. about 18 households from high standard, 88 households from middle standard and 148 households were drawn from low standards.

The households from each smaller administrative unit ('Kebele') were selected based on the proportion given in the Urban Economic Establishment Census standard (see annex1) that categorized all the households in the city in to three standards: high, medium and lower, in

order to ensure homogeneity in the grouping of households, based on house types and the facilities and infrastructure in the neighborhood.

3.2. Defining the attributes and levels

It is assumed that the environmental quality can be improved through improving the solid waste management service provision. This service can be decomposed into its attributes.The attributes of the service that were used in this study are collection frequency, separation of waste at source by households, and monthly charges. These attributes were set after consulting people involved in the provision of solid waste service in the area under consideration. It is also assumed that by increasing the collection frequency of solid waste per week and sorting waste at source, solid waste in the area can be reduced leading to the improvement of environmental quality. The collection frequency has three levels(1,2,3),waste sorting attribute has two levels sorting is needed(1) and sorting is not needed(0) and the monthly charge has six levels(1,5,10,15,20 and 25).The levels of these attributes are intransitive, that is, they are independent of each other.

3.3 Questionnaire Design

Prior to conducting the survey, enumerators were trained on how to obtain a good cooperation from the respondents and hints on handling questions. The questionnaire was presented to a small group of sample units to get an opportunity to correct for any shortcomings in the design of the questionnaire. The questionnaire has three sections. The first section introduces the purpose of the study and why it is important. It also introduces the choice set to the respondents and the choice questions also starts in this section. The second section is related with the socio-economic characteristics of the respondents. Finally, the third section deals with health and sanitation issues.

Respondents were presented with six choice sets where each choice set contained three management options. In the study three solid waste management alternatives (one baseline and the other two represent an improvement of solid waste management plan) and three service attributes mentioned earlier were constructed. A mix of the levels of the attributes was used in the alternatives. Respondents were asked to choose their preferred option from each choice set. The choice sets follow the standard L^{MN} experimental design where only the main effects are modeled. The choice sets generated by the experimental design were 18 which were divided into three blocks comprising of six choice sets presented to each respondent. The SAS software was used to determine the mix of attribute levels for the choice sets.

3.4 Field Procedure

Two surveys were carried out in Yekka-sub city, the first was a pilot survey with a sample size of 20 households, and the second was the main survey with a sample size of 254 households. Three college students and three persons who have been collecting data on solid waste management for other purposes and already had some background on the issue conducted the interviews. They were trained before commence of the survey. The pretest result revealed that the respondents had little problem in understanding the attributes and their level The pretest result also revealed that the questionnaire was very long and not written in simple word so that in the main survey these issues were taken into consideration.

After some adjustment, the questionnaire was made ready for the main survey. Households interviewed during the pilot survey were not included in the main survey.

3.5. Econometric Model specification

In the Choice model (CM) analysis, 2 models were estimated. The first model considered the base line model option while the second model considered the baseline together with the

selected socio-economic variables (Adamowicz, W., & Bennett, J.,1994). It is the role of the alternative specific constant (ASC) to take up any variation in choices that cannot be explained by either the attributes or the socio-economic variables.

The baseline model

$$V_i = ASC + \beta 1\ COLLFREQ + \beta 2\ WASTSORT + \beta_3\ CHARGE \text{ ---------- (8)}$$

Where (i = 0, 1, 2; ASC = 0 for i =0)

Definition of variables

Dependent variable

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

Independent variables

ASC = Alternative Specific Constant (for options1 and 2)

COLLFREQ = frequency of weekly waste collection (once, twice and thrice per week).

WASTSORT = separation of waste by households (1= sorting is needed, 0=sorting not needed)

CHARGE = monthly charges.

CM with socio-economic factors

$$V_i = ASC + \alpha_1 ASC*AGE + \alpha_2 ASC*SEX + \alpha_3 ASC*EDUCATE + \alpha_4 ASC*INCOME + \alpha_5 ASC*FAMSIZE + HOWORK + \beta 1 COLLFREQ + \beta_2 WASTSORT + \beta_3 CHARGE \text{ ----- (9)}$$

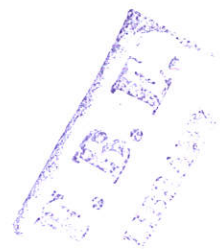
(i = 0, 1, 2; ASC = 0 for i =0)

Definition of variables

Independent variable

AGE = age of respondent in years

SEX = gender (1=female, 0= male)



EDUCATE = dummy variable for level of highest education level attained (EDUCATE=1 if school year is greater than or equal to 1, EDUCATE=0 otherwise).

INCOME = gross monthly family income in Birr.

FAMSIZE = number of household members living together.

HOWORK = number of working household members.

Definition for the attributes is the same as in the baseline equation.It is expected that all the coefficients for the non-monetary variables, except AGE in the extended model to be correlated positively with utility. The expected sign for AGE coefficient is ambiguous as it may strongly be related to disposable income. The higher the AGE, the lower is the disposable income.

As the dependent variable is of three outcome, the multinomial logit regression model , which assumes the choices to be consistent with the Independence of Irrelevant Alternatives (IIA) was used for the estimation of β coefficients.

CHAPTER FOUR

DATA, RESULTS AND DISCUSSION

4.1. Descriptive analysis of the survey data

Out of a total of 242 respondents for which responses were valid, about 61.52% (149) were males and 39.12 %(93) were females. Mean age was 47 years. About 10% of the respondents had diploma level education, 4% had a first degree and above, 31% were high school educated(grade 9 to 12), 23% had completed their secondary level of education(grade5 to grade8), while 6% had completed primary level schooling and about 26% had no formal education or had never gone to school.

Around 27.33% of the respondents earned a monthly income between Birr 200 and 1000, 10.46%earned a monthly income between Birr 1000 and 2000, and, 6.72% earned Birr between 2000 and 5300 and finally about 4.18% earned nothing(i.e these households were not generating their own income and they were dependent on their relatives, remittance etc). There were also some respondent earning different amounts not mentioned. Monthly mean income was Birr 713.

About 19% of the respondents came from households of 4 people. The mean household size was5.The mean number of household members who were working was 1.57 with most of the respondents having one working member (60.33%).

The data revealed that while 38.54% of the respondents were concerned with the importance of waste sorting to minimize solid waste, 61.46% were unconcerned. The study has also obtained some insights on the pattern of household waste flows in the context of material balance analysis. Yard wastage (vegetable peelings, onion seed coats, soil, dust,

grasses, etc) formed the most dominant waste type produced, followed by papers and cardboards, festal.

Respondents were also asked to rank the importance of the various socio-economic sectors in terms of government funding. According to the finding, the environment sector was ranked third on average. This reflects that SWM, which adversely affects the environment if not handled properly, is an important aspect of human welfare.

The result of the debriefings showed that as many as 33% of the respondents chose the current solid waste management system because it is the cheapest option compared to the suggested options of the study. Besides, they said they would choose the suggested plans if there was a system that takes care of the sorted solid waste and at the same time all the residents were willing to pay the service charge based on their standard. They strongly complained about the scarcity of skip. Had the municipality provided enough skips the problem of solid waste would have been minimized. Because the skips are scarce, they said, even the house to house collectors themselves dump the solid waste on open spaces and nearby rivers. The result of the debriefings also showed that about 66% percent of the respondents supported the improvement plan just because the improvement in terms of collection frequency and sorting waste can minimize waste problem in the area under consideration. It can be seen from the analysis of the debriefings that respondents have a lexicographic answering pattern. This means that a respondent of this behavior always picks up the alternative that is better just in one of the attributes and its levels. Attributes of highest level and lowest price is the preferred option for such a respondent.

4.2. The Choice Model

Two models were employed in the Choice Model (CM) analysis in this study. The first model only considered the basic solid waste management (SWM) attributes while the second model considered the basic attributes together with the selected socio-economic variables.

Majority of the respondents (i.e. 66.7%) favored the improved plan (alternatives 1 and 2) over the baseline i.e. the current solid waste management system.

4.3. Results of the Basic Model

The format of the choice sets requires, employing standard multinomial logit regression on the CM specification. Of course, employing another regression such as nested logit will produce similar result. The results of the basic model are given below (see table 4.1).

Table 4. 1 Results of multinomial logit model for the basic model.

VARIABLE	COEFFICIENT	STANDARD ERROR	SIGNIFICANCE
INTERCEPT	-1.494841	0.0971737	0.000
COLLFREQ	0.3729408	0.047014	0.000
WASTSORT	0.5105123	0.0392185	0.000
COST	-0.0288512	0.004699	0.000

Significant at 1% level

Summary statistics	
Log-likelihood	-3179.8302
Pseudo R2	0.1426
Number of observation	4355

As can be seen from table 4.1, the result of the multinomial logit regression of the basic model showed that all coefficients are significant at the 1%, 5% and 10% level. The positive sign of the coefficients for all non-monetary attributes suggests that improvements in all the non-monetary attributes more likely bring about positive utility among individuals. The result also showed that the coefficient for the monetary attribute was negative implying that the utility of the households are negatively affected as monthly charge increases.

4.4. Socio-economic Characteristics included Choice Model (CM)

Table 4.2 Results of extended multinomial Logit model with Socio-economic Variables

VARIABLES	COEFFICIENT	STANDARD ERROR	SIGNIFICANCE
ASC	-1.083235	.2511692	0.000
ASC*SEX	.0015361	.012774	0.904
ASC*AGE	-.0018528	.0005098	0.000

ASC*INCOME	.0000155	8.85E-06	0.079***
ASC*EDUCLEVEL	-.0076166	.0053932	0.158
ASC*HOWORK	.0023901	.0077887	0.759
ASC*FAMSIZE	.0050639	.0031249	0.105
COST	-.0286208	.0047146	0.000
COLLFREQ	.3876725	.047337	0.000
WASTSORT	.5082892	.0393093	0.000

***-significant at 10% level.

Summary statistics

Logistic regression Number of obs = 4355

Log likelihood = -3143.7045 Pseudo R^2 = 0.1523

LR $chi^2(18)$ = 1129.78

Prob > chi^2 = 0.0000

Results show that out of the six socio-economic variables, two of them were significant. These are age, which is negative in sign and significant at all levels and income, which is positive in sign and significant at 10% level. The negative sign of age may imply that older people favor the cheapest option or the current waste management option. The positive sign of income indicates the fact that the higher the income the more willingness to pay for the proposed change. All non-monetary attributes, like in the basic model are significant and yield

the expected signs. The inclusion of socio-economic characteristics interactively into the model is just to introduce heterogeneity into the model and also to improve the explanatory power of the model. The explanatory power of the model is increased by10% as a result of including the socio-economic characteristics. From the results of the two models, it can be concluded that households support improvement in solid waste management service in terms of collection frequency and waste separation at source. In other words, increasing collection frequency of solid waste from households in the area minimizes the solid waste in the area thereby reducing pollution which in turn increases environmental quality. Sorting waste also minimizes solid waste in the area thereby reducing pollution and consequently increasing environmental quality. It is this benefit that households derive from improvement in solid waste management system in the area under consideration.

4.5. Estimation of Implicit Prices

In this sub-section, the estimation of implicit prices for each attribute is undertaken. Implicit prices reflect the marginal rate of substitution (MRS) between each non-monetary attribute and the monetary attribute. It is estimated using equation (5).

Thus, implicit price reflects individual's WTP for the presence of an additional unit of non-monetary attribute, *ceteris paribus*. The estimation of implicit prices for each non-monetary attribute is shown below (Table 4.3).

Table 4.3 Estimation of Implicit Prices

Non-monetary attribute	BasicModel (Birr)	Model with socio-economic factors (Birr)
COLLFREQ	12.95	18.48
WASTSORT	17.69	20.71

5.1. Interpretation of Implicit Price

Estimates of implicit prices are made on a "ceteris paribus" basis, that is, they are estimates of the WTP of respondents for an increase in the attribute of concern, given that every thing is held constant (Bennett, J and Blamey, R., 2001).

In the case of the basic model:

1.The implicit price for collection frequency is Birr 12.95.This means households on average are willing to pay an additional charge of Birr 12.95 per month for a change in collection frequency form once per week to twice per week or from twice per week to thrice and, *ceteris paribus*.

2. The implicit price for sorting waste is Birr 17.69.This means that households on average are willing to pay an additional charge of Birr 17.69 per month for a change from not sorting to sorting and the sorted waste is put into use. In other words, the net increase in the utility of households is Birr 17.69, ceteris paribus, since they pay less per unit of total waste (i.e., both the recyclable and non-recyclable waste) when there is sorting relative to what they pay for total waste when there is no sorting.

4.6. Estimating compensating surplus

As mentioned earlier, in this study, the compensating surplus (CS) welfare measure was used. It measures the change in income that would make an individual indifferent between the initial (status quo) and subsequent situation (higher environmental quality) assuming the individual has the right to the status quo. This change in income reflects the individual's willingness to pay (WTP) to obtain an improvement in environmental quality.

Using the results from the multinomial regression CS can be obtained by employing equation (6). Assuming that the status quo(the current solid waste management system) is with no collection service (i.e., frequency of collection is zero) and no sorting of waste, several solid waste management systems were considered and compared with the status quo (baseline option). There were six solid waste management improvements were considered as given below.

Base line scenario

Frequency of collection per week is zero.

No sorting of waste

Scenario 1

Frequency of collection per week is 1.

There is sorting of waste

Scenario 2

Frequency of collection per week is 2.

There is sorting of waste.

Scenario 3

Frequency of collection per week is 3.

There is sorting of waste.

Scenario 4

Frequency of collection per week is 1.

No sorting of waste

Scenario 5

Frequency of collection per week is 2.

No sorting of waste

Scenario 6

Frequency of collection per week is 3.

No sorting of waste

Using equation (8) the utility of the current waste management system (the baseline) can be calculated. To use the equation to estimate compensating surplus it is necessary to calculate the utility associated with the current option and the option being considered. This is achieved by substituting the model coefficients and the attribute levels for the current option (that is V_0)

The value of the utility of the alternative option is estimated in a similar way, except that the coefficient for the alternative specific constant for suggested option is included and the attribute levels associated with the changed scenario is used (Bennett,J. and Blamey,R., 2001). Here the several scenarios considered were compared with the baseline. The compensating surplus for the change from the current(the status quo) to the new scenario is then estimated by

calculating the difference between these two values and multiplying by the negative inverse of the coefficient for monetary attribute (that is the service charge).

The results are presented in table 4.4

Table 4.4.Estimation of Compensating Surplus or WTP per month (in Birr).

	with sorting			with no sorting		
	collection frequency(1)	collection frequency(2)	collection frequency=3	collection frequency=1	collection frequency=2	collection frequency=3
WTP	30.62	43.55	56.47	12.93	25.85	38.78

Assuming that the status quo is with no collection service (i.e., frequency of collection is zero) and no sorting of waste, the WTP for six scenarios are indicated (see table 4.4). As you can see from the table, these six scenarios are 1. Collection frequency is once per week and no sorting, 2. Collection frequency is twice per week and no sorting; 3. Collection frequency is thrice per week and no sorting; 4.collection frequency is once per week and there is sorting; 5.collection frequency is twice per week and there is sorting; 6. Collection frequency is thrice per week and there is sorting. One can see from the results that as collection frequency increases, WTP increases holding sorting constant. When all the attributes are improved (scenario3), on average, WTP would be Birr 56.47.

In, general, the above results imply that households have preference towards solid waste management improvement. Thus, there is a room for a policy to be implemented by policy

maker in such a way that the households' demand and the supply of the solid waste management service by concerned bodies can be matched. For instance, should the service provider wish to collect twice per week and wish to sort (scenario 2), then the cost of service ought to be at a level below the estimated household's WTP of Birr 43.55.

CHAPTER FIVE

CONCLUSIONS AND POLICY IMPLICATIONS

5.1. CONCLUSIONS

As mentioned earlier, a particular strength of CM is its ability to generate estimates of the values of many different alternatives from the one application. Hence, from one set of choice data, the values of an array of alternative ways of reallocating resources can be estimated. This feature of a Choice modeling (CM) arises because it specifically investigates the trade-offs between attributes. Thus, different combination of the attributes that are used to describe alternatives can be evaluated.

The main aim of this study was to estimate the economic values of household preferences for improved solid waste management service attributes in Yekka sub city. It is assumed that the environmental quality can be improved through improving the solid waste management service by decomposing the service into its attributes i.e. collection frequency per week, and separation of waste at source by households. An environmental valuation technique –Choice Modeling (CM) was employed on 242 randomly selected urban households in Yekka sub city.

Estimates of marginal values of improved solid waste management (SWM) service attributes and households' willingness to pay (WTP) for improved MSW management services had been obtained in this study. The result of the study also indicated that households on average are willing to pay an additional charge of BIRR 12.95 per month for a change in collection frequency - from once per week to 2 times per week, ceteris paribus. If waste sorting is done by households, the net increase in the utility of households is Birr 17.69, ceteris

paribus. It was also found that households' net benefit per unit of waste is higher when there is sorting compared with the situation when there is no sorting since they pay less per unit of total waste (i.e. both the recyclable and the non-recyclable solid waste) when there is sorting relative to what they pay for total waste when there is no sorting. In general, households value improvements in SW management plan. Specifically, it has been determined that households are willing to pay a charge for improvements in collection frequency and waste sorting attributes. More specifically, by employing the Choice Modeling (CM) it was found that households on average are willing to pay a charge of Birr 43.55 per month if collection frequency is twice per week and they are required to sort waste at source, ceteris paribus. It was also found that households' net benefit per unit of waste is higher when there is sorting compared with the situation when there is no sorting since they pay less per unit of total waste (i.e. both the recyclable and the non-recyclable solid waste) when there is sorting relative to what they pay for total waste when there is no sorting.

From the study it was also found that household waste flows show some pattern in the context of material balance analysis. Yard wastage (vegetable peelings, onion seed coats, soil, dust, grasses, etc) formed the most dominant waste type produced, followed by papers and cardboards, plastic bags.

Most of the wastes produced were disposed off in skips provided by the municipality. Insignificant amount of solid waste generated such as onion peelings, dust and soil were reused for composting. Any type of paper was used either for cooking or sold to nearby shops. A significant portion of plastics, bottles and /or glasses were being reused by households.

According to this study, the attributes collection frequency and waste sorting are some of the determinant factors of solid waste management service. Generally, by employment Choice modeling (CM) it is possible to reveal the demand side of municipal solid waste management

(MSW) improvements and any service provider can make balance between the demand of the households for the solid waste management service and their ability to pay for the service and at the same time the feasibility of providing this service by the service provider. Given this potential of Choice Modeling (CM) in revealing the demand side of the solid waste management service, it is possible to identify a scenario at which efficient allocation of resources, in this case, an efficient solid waste management (SWM) service. Besides, the whole practices made in this study clearly shows that Choice Modeling (CM)can be applied in the context of developing countries in identifying households' preferences for some policy options that fit the requirements of this model.

5.2. POLICY IMPLICATIONS

1. Policy makers can make balance between household's demand for and the supply of improved solid waste management services by estimating implicit prices of the attributes of SWM services.

2. Any policy to bring about efficient solid waste management service needs to include the demand side information should it yield the needed environmental impacts.

3. Enough skips needs to be provided and placed in appropriate places if SWM service is to be improved.

4. Policy makers can consider the Choice Modeling as having a potential in providing important information in the context of developing countries as the case may be.

REFERENCES

AACASWAP, (2002); "Addis Ababa City Administration Solid Waste Management Policy",Addis Ababa,Ethiopia.

Adamowicz, W., & Bennett, J.(1994), "Combining revealed and stated preference for valuing Environmental amenities', Journal of Environmental Economics and Management 26, 271-292.

Baraki, H., (2003), "Contingent valuation survey on household's Willingness to pay (WTP)for improved solid waste collection and disposal: the case of Mekele town"; The working paper series of faculty of business and economics- Civil Service College, Addis Ababa.

Bateman, I.J., Willis, K.G., Garrod, G., Doktor, P. & Turner, R.K. (1992) "A Contingent Valuation Study of the Norfolk Broads", report to the National Rivers Authority,UK pp.403.

Bayrau, A., & Walelegne, D. (2004), "Integrated Solid Waste Management in Addis Ababa" paper presented on 'Local Economic Development and Globalization' conference organized by Addis Ababa University and Institute of Social Study (ISS) at Ghion Hotel, Addis Ababa (Ethiopia).

Beede, D.N., & Bloom, D.E, (1995) "The Economics of Municipal Solid Waste", World Bank Research Observer. 10(2), 113-150.

Ben-Arkiva, M., & Lerman S.R (1985) "Discrete choice analysis theory and application to travel demand", Cambridge, MA: MIT press.

Bennett, J. & Blamy, R. (2001),"The Choice Modeling Approach to Environmental Valuation", Edward Elgar publishing, Inc, UK.

Blamey, R., Bennett, J., Louviere, C., Morrison, M.D. & Rolfe, J. (2000) "A test of policy labels in environmental choice modeling studies" Ecological Economics 32,269–286, www.sciencedirect.com.

Boxal, P., Adamowicz, W., Williams, M., Swait, J., & Louviere, J. (1996), "A comparison of stated preference methods for environmental valuation". Ecological Economics, 243-253.

Carson, Richard T., Nicholas E. Flores, Kerry Martin and Jennifer Wright(1994), "Contingent Valuation and Revealed Preference Methodologies: Comparing the Estimates for Quasi-Public Goods," Discussion Paper 94-07,University of California, San Diego.

Cicchetti, C.J. & Freeman, A.M. (1971) "Optional Demand and Consumer's Surplus: Further Comment". Quarterly Journal of Economics 85, no.3, 528-539.

Ciriacy-Wantrup, S. V., "Capital Returns from Soil-Conservation Practices," Journal of Farm Economics, November 1947, *29*, 1188-90.

ENDA- Ethiopia, (1996), "Environmental Development Action" in the third world, Addis Ababa,Ethiopia.

ETC/RWM (2006) "The European Topic Centre on Resource and Waste Management" working paper under European Environment , Copenhagen , Denmark(http://waste.eionet.europa.eu/waste).

Freeman, A.M. (1986) "On Assessing the State of the Arts of the Contingent Valuation Method of Valuing Environmental Changes", in Cummings, R.G., Brookshire, D.S. and Schulze, W.D. eds., Valuing Environmental Goods. Rowman and Allanfield, Totowa, N.J.

Gebresilassie,G (2006).Valuing the benefits of improvement in lake quality: An application of Choice Experiment, the case of Lake Hawasa.

Haeneret, M.K. (2001), "Modeling recreational site choice": Do hypothetical choices reflect actual behavior? Journal of Agricultural Economics, Vol.83, N0.3, pp.629-642.

Hanemann, W.M., Loomis, J., & Kanninen, B., (1991). "Statistical efficiency of double bounded dichotomous choice contingent valuation". American Journal of Agricultural Economics, Vol. 73, No. 4, pp.1255-1263.

Hanley, N.D. (1990). "Valuation of Environmental Effects: Final Report – Stage one"; Industry Department of Scotland and the Scottish Development Agency, Edinburgh.

Hanley, N.D., & Munro, A. (1991); "Design Bias in Contingent Valuation Studies: The Impact of Information", Discussion Paper in Economics No. 13, Department of Economics, University of Stirling.

Hartwick, D.(1998); "The economics of natural resource use". Edit. Addison Wesley, USA.

Ian J. B., & Kerry Turner, R. (1991), "Evaluation of the environment: the contingent valuation method" Working Paper GEC 92-18 ,University of East Anglia.

Jamal, O. (2002), "Household preferences for solid waste management", the Economy and Environment Program for South East Asia (EEPSEA) publication, Malaysia.

Kriström, B. (1990a). "Valuing environmental benefits using the contingent valuation method an econometric analysis"; Umeå Economic Studies No. 219, University of Umeå, Sweden.

Krutilla, J.V., and Fisher, A.C.(1975). "The Economics of Natural Environment Studies in the Valuation of Commodity and Amenity Resources" (Baltimore, the Johns Hopkins University Press for Resources for the Future).

Lancaster, K.,(1966) "A new approach to consumer theory", Journal of [Political Economy, 132-157.

Louviere, J.J.,(1988); "Conjoint Analysis modeling of stated preferences" Journal of Transport Economics and Policy; 93-119.

Martin,M.,(2001),"Globalization, Development, and Municipal Solid Waste Management in Third World Cities"; El Colegio de la Frontera Norte, Tijuana, Mexico.

Mitchell, R.C and Carson, R.T.(1983) "A Re-estimation of Bishop and Heberlein's Simulated Market - Hypothetical Markets - Travel Cost results Under Alternative Assumptions", Discussion Paper D-107,Resources for the Future,Washington, D.C.

Pearce, D. W., Turner, R. K., Bateman, I.J. (1992). "Valuing the Environment: The European Experience". Scandinavian University Press, Oslo.

Senkoro, T. (2003); "Solid waste in Africa: WHO/Afro perspective". Paper presented in Dar es Salaam at the CWG Workshop.

Smith, V. K., Desvousges, W.H., & Fisher, A. (1986), "A comparison of direct and indirect methods for estimating environmental benefits", American Journal of Agricultural Economics, Vol. 68, pp. 280-289.

Thomas, H. (1998), "Solid Waste Management: critical issues for developing countries": Kingston: Canoe Press.

Tiruneh, T. (2006), 'Household's Willingness to pay for improved solid waste: the case of Adama Town, Ethiopia.

Toru, T. (2002); "Supporting Capacity Development for Solid Waste Sector in Developing Countries" (Institute for International Cooperation Japan International Cooperation Agency).

Walelegne, D. (2003), "Public Valuation for Improved Solid Waste management in Addis Ababa: Affordability and Willingness to Pay Analysis, Addis Ababa, Ethiopia.

Weisbrod, B.A. (1964). "Collective-consumption services of individual- consumption goods". Quarterly Journal of Economics 78, 471-477.

Zerbock, A. (2003), "Urban solid waste management: waste reduction in developing countries", M.Sc candidate School of forest Resource &Environmental Science Master's International Program Michigan Technological University, USA..

APPENDIX

ADDIS ABABA UNIVERSITY

DEPARTMENT OF ECONOMICS

A CHOICE EXPERIMENT SURVEY QUESTIONNAIRE FOR VALUING IMPROVEMENT IN SOLID WASTE MANAGEMENT SERVICE

Date _____

Interviewer's Name_____

Interview started_____

Interview ended_____

Interview Number/Code_____

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

My name is _____. I am a student at Addis Ababa University. This interview is part of the research Mr. Solomon Tarfasa is undertaking as a partial fulfillment of the award of MSc in Economics. You are selected randomly from population living in the city. This interview takes a few minutes.

SECTION ONE

1.1 Importance of sector for government funding and ranking of environmental problems.

Rank the following sectors according to their importance for government funding from the most preferred to the least preferred. (e.g. 1 for most preferred, and so on)

Sectors	Ranks
Public education	
The natural environment	
Crime prevention	
Housing	
Poverty or unemployment	
Public health services	
Defense	

The research attempts to identify desirable future waste management program in this area in terms of priorities over different service attributes varied across levels. The study aims at estimating consumer willingness to pay for improved solid waste management system for the households in Yekka Kifle sub city in Addis Ababa. Waste generation in Addis Ababa is currently about 1841.8m^3 per day. Of this total, the municipality, households & businesses properly dispose only 50-60%. The remaining 40-50 % is disposed indiscriminately in tree belts, along road sides (verges) and storm water drains. This trend cannot continue if there is better services are than the present. We would like to find out the opinions about the service level and the waste generation rates at household level with a view to seeking solutions to waste problems in the city. We would also like to find out if there are possible benefits associated with the waste generated, in terms of material recovery. To do this, fund must be available and it must come from households residing in this city. It needs to be clear that all households in Addis Ababa would pay for the program if implemented. The payment vehicle is such that service recipients make direct payment

to the service providers the same way it has been paid for other utilities like electricity, water etc. While the information provided would be kept confidential and anonymous, it may be used to direct future waste management policy. You are therefore invited to participate in this survey by providing as accurate information as is to the best of your knowledge.

1.2 Introducing the choice set

You are randomly selected from the residents of the city of Addis Ababa, particularly from Yekka sub city. We are assessing households' preferences for different solid waste management options that lend itself to improving environmental quality in terms of collection frequency, and sorting waste at source by households. And these would cost households. We do request you to consider these factors and the costs to carry out the different measures in the choice set questions that follow. It is important to note that the options listed in this questionnaire are not exhaustive solutions to the issue at hand, that is, there are hopefully many variants to the solutions just mentioned in this questionnaire. There is no " correct" or "wrong "answer. This is just to have your say in what future policy regarding municipal solid waste service should look like. Your opinions, as to which variant (option) is best, is useful input to policy determination so you need to be careful in making choice between the alternatives. Please consider the attributes: collection frequency, separation of waste at source by households, and monthly charges. The levels of these attributes are intransitive, that is, they are independent of each other.

1.3 An example of choice set and a sample answer.

Suppose options 1 and 2 are the only possible alternative (i.e. a proposed situation that involves the respondents paying an extra amount of money to achieve an

environmental outcome that is superior to that which current policy would provide) to the current waste management plan i.e. the'status quo' situation that prevails under current policy. Do you prefer to choose option1 (i.e. collection frequency twice per week, waste separation at source is not needed, and monthly charge is Birr10) or option2 (i.e. collection frequency 3 times weekly, waste separation at source is needed, and monthly charge is Birr 15)?Options 1 and 2 entail cost to your household. The current waste management plan i.e. the status quo refers to what is already being provided by the solid waste service providers and the quality of environment, in general, continues the way it is at the present.

If options 1 and 2 were the only solid waste management options possible, which one would you prefer? (Tick in the box given below your preferred option)

Implication/attribute	**The status quo(the current waste management service)**	**Option1**	**Option2**
collection frequency		**2 times per week**	**3 times per week**
separation of waste at source		**separation not needed**	**separation needed**
monthly charges		**birr 10**	**birr 15**
	√		

If a respondent chooses the status quo, then he/she needs to check in the box below the statuesque column as shown above.

1.4 Follow -up questions

A) Which of the following reasons best explains why you made your choices in answering the choice set questions above?

1. I chose the status quo option because of an objection to the way the cost is to be imposed.

2. I chose the alternative with the highest level of one attribute or the lowest cost or on the basis of a single characteristic of the task.

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 the environmental benefit.

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

1. Ability to understand the questions

2. Inability to manage the information because it is a lot.

3. I don't believe in the setting of the questionnaire.

4. Bias is present in the questionnaire.

5. Other (specify).

SECTION TWO

2 Socio-economic characteristics of the respondents

2.1 Household composition

Serial NO	Name	Sex	Age	Education Highest Attained	Income	Relation to Household's Head	other(specify)
1							
2							
3							
4							
5							
6							
7							
8							
9							

2.2. Other sources of income_____

2.3. Ownership status of dwelling unit ----------

1=owner occupied, 2=rented from government, 3=rented from private, 4=company or government's house without paying rent, 5=relative's house (not paying rent)

2.4 Income

What is an estimate of gross monthly income of this family? _____

2.5 Expenditure

1 How much money does your household spend per month on the following?

Item	**Amount per month(in birr)**
Water	
Electricity	
Property tax(per year)	
House rent	
Food	
Clothing	
Medical cost	
Waste disposing	
Drinks	

Transport	
School fees	
Domestic workers(or maid)	
Other household items e. g detergents, cosmetics, etc.	
Others(specify)	
Total	

3. Do you pay for the collection of waste in the neighborhood per month?1=If yes,2= if no. How much?____(birr).And what is the frequency of collection per week? days?

_____

2.6. Health and sanitation

1. The table below shows a list of diseases related to waste .Which of these health problems is faced by your household, multiple answers are possible)? State estimated expenditure on medicine and prevention for these diseases.

Problems	**1=if yes,2= if no**	**Estimated expenditure(in birr)**
diarrhea/bacillary		
sore eyes		

amoeba sis		
stomach worms, typhoid		
coughs		
others(specify)		

1. Has any member of your household suffered from diarrhea during the last month? 1= Yes, 2=No

If yes, how many members were they?, for how long on, average, how serious was it?_____

_____

_____

2: Does your household have the following facilities?

Facility	1=yes,2=no
Rubbish pit for off-site disposal	
Water borne sanitation system	
Pit latrine	
Skip(container placed by municipality)	

2.7. Waste generation data

1 Which method (s) do you use in disposing waste (multiple answers possible)? _____

1=backyard landfill

2=skip collected by the municipality

3= house –to- house collecting.

4=recycling (i.e. sorting materials) such as plastic bottles

5=disposing in an open space and/or a river around the neighborhood and

6=others (specify)

2. If disposing in skip or container collected by the municipality, how far is it from your house? _____ (in meters)

3 If dumping in open spaces how far is the place from the house? _____ (meters)

4 Considering the quantity of your household's waste generation per week, what is the quantity of the waste _____? (in 'madaberia' (50 Kg sack) e.g. half or full etc)

5 What type of waste does your household generate and how much is recovered (reused)?

See the table below.

2.8 Waste generated and/or recovered per week.

Waste item	Waste generated per week			Waste recovered per week		
	No	volume	weight	No	volume	weight
Plastic bottles e.g. detergents, cooking oil bottles, beverages etc						
Glass e.g. jar bottles, soft drinks and beer bottles						
Aluminum tins						
Newspapers,magazines,cartoons,cardboard						
Food wastage						
Yard wastage(vegetable peelings, onion seed coats ,Soil, dust grasses, etc)						
piece of thread, animal faeces, , used shoes, pieces of cloth, used car parts,						
Scrap iron						
Sheet of iron						
Others(specify)						

A. If any waste recovered how is it utilized?

_____

_____

_____

_____

_____

End. Thank you very much for your cooperation

Date _____

Interviewer name_____

Signature_____

Address_____

Interviewer's observations

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

Yes he/she considered the process of survey carefully----------1

Yes he/she considered the survey process carefully but didn't visualize it. ----------2

He/She seems visualizing. ----------3

He/she didn't think about it----------4.

To be filled in after completing interview.

Comments about the respondent:

_____

_____

_____

Comments about specific questions (attribute, attribute levels):

_____

_____

_____

_____

Any other comments:

_____

_____

_____

_____

Supervisor's observations:

_____

_____

_____

Name of the supervisor_____ Date_____

Annex1

Information on Urban Economic Establishment Census

Kifle-Ketema	Standard	Households	Population	Number of EAs	% of Standard
Arada	High	615		4	2
	Middle	14577		93	36
	Low	25827		160	62
	Total	**41019**	**198345**	**257**	
Addis Ketema	High	1723		13	4
	Middle	13244		92	32
	Low	29954		190	64
	Total	**44921**	**248228**	**295**	
Lideta	High	1254		7	4
	Middle	11898		69	37
	Low	19940		109	59
	Total	**33092**	**194347**	**185**	
Kirkos	High	2419		19	7
	Middle	17372		104	37
	Low	27194		157	56
	Total	**46985**	**208667**	**280**	
Yeka	High	4253		17	7
	Middle	30247		149	58
	Low	19721		91	35

	Total	**54221**	**268819**	**257**	
Bole	**High**	6340		46	24
	Middle	22759		107	56
	Low	9110		38	20
	Total	**38209**	**198403**	**191**	
Akaki Kaliti	**High**	828		4	3
	Midle	14577		70	48
	Low	14667		71	49
	Total	**30072**	**121163**	**145**	
Nifas Silik Lafito	**High**	2121		13	6
	Midle	28444		139	67
	Low	12413		54	27
	Total	**42978**	**232014**	**206**	
Kolfie	**High**	7211		34	15
	Midle	17330		78	33
	Low	28070		122	52
	Total	**52611**	**310844**	**234**	
Gulelie	**High**	721		4	2
	Midle	21107		112	48
	Low	27025		115	50
	Total	**48853**	**230722**	**231**	
		432961	**2211552**		

Source: Urban Economic Establishment Census (CSA)

All the sub-cities were categorized in to three standards: higher, medium and lower. The household standard of each sub-cities cluster was based on the following criteria:

1. Higher standard- the household standard was higher if the majority of the residents in each enumeration area (EA)[5] have good private compound with villa or apartment. They also reside in areas which were not crowded and had a good entry and exit roads. Generally the majority of the residents live in a good economic status.
2. Lower standard- the household standard was lower if the majority of the residents in the enumeration area (EA) have no good private compound houses. They live in a crowded area with poor access for entry and exit of roads. Generally the majority of the households live in a poor economic status.

EAs (Enumeration Areas) - is a unit of land delineated for the purpose of enumeration housing units and population with out omissions and duplication. It consists of 150 to 200 housing units in urban areas (CSA, 2004b).

3. Medium standard- the household standard was medium if the majority of the residents in each enumeration area (EA) are neither 1 nor 2 mentioned above. Generally the majority of the household were not in a good way of life but their health and social aspect were not at risk. The household in this category was neither at higher nor lower economic standards.

Declaration

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

Name: SOLOMON TARFASA

Signature: S. tarfasa

Date: 4/10/07