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Households' Preferences and Willingness to Pay for Improved Solid Waste Management Interventions Using Choice Experiment Approach: Debre Tabor Town, Northwest Ethiopia

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Abstract
Good Solid Waste Managemnt (SWM) practices are indispensable for maintaining quality environment and the health of urban dwellers in most developing countries, like Ethiopia. However, for successful implementation of adequate SWM options, households' preferences and their Willingness to Pay (WTP) should be taken in to consideration. The main aim of this study was to analyse the preferences of households' and estimate the WTP for improved SWM service attributes in the form of money income and labor effort using choice experiment approach. Multi-stage stratified random sampling design was used to draw sample households and primary data was collected from 220 households living in Debre Tabor town. In addition to the standard conditional logit model, the Random Parameter Logit Model (RPLM) and the Latent Class Models (LCM) were estimated to relax the independent of the irrelevant alternatives assumption and account preferences heterogeneity for various SWM attributes. The RPL results indicated that preferences for all attributes were heterogonous among households, a conclusion that was supported by the wide variation in LCM estimates between classes. Based on the implicit price,mode of transportation was the foremost attribute followed by solid waste disposal method, and service delivery institute and sorting of solid waste was the least important attributes. The welfare measure result showed that households were WTP a considerable amount of money for the improved SWM interventions scenario. The result further revealed that respondents with higher level of income, higher level of education and female headed households preferred the upswing SWM interventions. The finding showed that analyzing households' preferences is very important to prioritize among alternatives for the implementation of good SWM. Therefore, studying this aspect can contribute to the successful implementation of sound SWM practices. In order to achieve adequate SWM options, it is also recommended that the urban planner or concerned body need to take account households' preferences for improved SWM interventions.
Keywords: Choice Experiment Approach, Debre Tabor, Solid Waste Management , Willingness to Pay

1. Introduction

Safe and clean environment is an essential requirement for maintaining life on earth and creating human friendly environment is one of the most important issues in the world today (Khtak and Amin 2013). To meet the needs of rapidly growing population, it is obvious that production has to be increased by at least the population growth rate which leads to waste production that is beyond the absorptive capacity of the environment (Tarfasa, 2007, Subha, Ghani et al., 2014). A number of studies indicated a relationship between the generation of municipal solid waste and gross domestic product, population growth and urbanization (Modak, 2010, Wilson and Velis, 2014). Population growth, urbanization and greater exploitation of resources resulted in an increasing demand for environmental management. Particularly in developing countries urban areas, the people are facing sever challenges due to lack of healthy urban environment (Khtak and Amin 2013). Inadequate municipal solid waste management (SWM) is one of the major drivers to the degrading of environment quality in urban areas (UNPDDESA, 2005, Khattak, Khan et al., 2009, Wilson and Velis, 2014).

Efficient SWM plays a crucial role to improve environmental quality through increased amenity values, non-use values, and provision of source of livelihood (Behzad, Ahmad et al., 2011). However, managing solid waste is now becoming the major challenges of urban areas of all sizes, from mega-cities to small towns and large villages, which are home to the majority of human kind (Sankoh and Yan, 2013, Wilson and Velis, 2014). Due to increasing population in urban locations that creates situations where the generation of all forms of solid waste exceeds the capacity of effective collection and disposition (UNSAID, 2006, Das, Birol et al., 2008, Wilson and Velis, 2014). The resulting outcome is a severe threat to health and environmental quality deterioration(Balasubramanian, 2015).

Higher economic growth, population growth and rapid rate of urbanization in developing countries including Ethiopia has resulted in numerous environmental challenges (Commoner, 1991, Panayotou, 2000, Aruna.D, R. et al., 2013). Among the challenges, the continuous increase in the quantity and composition of solid waste is a major environmental problem (Amiga, 2002, Khattak, Khan et al., 2009, Yuan and Yabe, 2015). Municipalities in Ethiopia have experianced traditional practices to collect, dispose and reuse solid waste which is not aimed at promoting public health, environmental protection and alternative energy sources (Hailemariam and Ajeme, 2014). These form of SWM practices are now becoming the major causes to surface and ground water pollution, decline in cities and towns cleaness (Tsega and Reddy, 2013). Among the town, Debre Tabor is one of them and faces challenges associated with poorly managed solid waste operation (EPA, 2014).

Over the last few years, the quantity and composition of solid waste in Debre Tabor town has increased significantly. Albeit, solid waste generated in the town seems not to undergo any treatment before their final disposal. The service provider faced challenges to deal effectively in managing solid waste and to minimize its impact on economic, health of the resident and deterioration of the quality of the town yet.The existing SWM situation in the town is inefficient due to traditional mode of transportation, irregular waste picking up program, having few required equipments and no fence for dumpsites. Households are not satisfied by the prevailing solid waste service provision, and dispose their solid waste along vacant spaces. Generally, the urgent need of efficient SWM and the ever increasing problem of handling solid waste are still the main facet of the town. Accordingly, there is a need in addressing the aforementioned problems via deep investigation. Evaluating the demand side of SWM is the first move required to reduce the gap through designing an appropriate intervention packages. In this regard, the growing number of economic valuation studies on improved SWM from different part of the world reflect the increasing recognition of the importance of having good SWM. To find a solution for environmental and health related impact of poor SWM practices, enormous numbers of researches have been carried out in relation to economic valuation of SWM (Khtak and Amin 2013, Hagos, Mekonnen et al.,2012, Amiga, 2002, Hazra, Goel et al., 2015, Yuan and Yabe, 2015). In attaching value for environmental goods and services, most of precursor studies (Amiga, 2002,Tarfasa, 2007,etc..) undertaken in Ethiopia in relation to SWM have employed the contigent valuation method (CVM) and most of these researches conducted are carried out in selected cities and towns of Ethiopia. Moreover,due emphasis is not given for households contribution in the form of labor for achieving the proposed SWM interventions. Evidences on households' contributions, the generation and composition of solid waste in Debre Tabor town are scanty or rarely available and making difficult in setting effective SWM system for the town yet. Thus, conducting a study on SWM in the town, which is one of the fast growing town in Ethiopia is indispensable. In this vein, the main objective of this study was to evaluate households'preferences for SWM attributes of Debre Tabor town and to estimate their contribution both in the form of money and labor effort for various enhanced SWM interventions using CEA.

2. Description of the Study Area

EPA (2014) delineates the town is one of the oldest town in Southern Gondar Administration Zone situated in Amhara National Regional State of Ethiopia. It was established by Atsie Seyefe Aread in 1335 G.C. The town is located at North latitude11°51′and 38°1′ East longitude. It is suited 100 kilometers southeast direction from Gondar town and 50 kilometers East direction of Lake Tana and 667 km direction along Addis Ababa.The town was the capital of Ethiopia under Emperor Tewodros II and Yohannes IV. The climate of the town is *'Dega' and 'woyna dega'*. Average annual rain fall ranges between 1533 ml. Currently the town has been serving as seat of south Gondar administration zone, Debre Tabor town administration and farta district. The town administration is subdivided into four locally adminstrative kebeles(The smallest administrative unit in Ethiopia) with a total population of 78,706.

The expansions of commercial activities, health and educational institutions, and high fertility have duly increased the population of the town. This led to over-stressing urban infrastructure services including municipal SWM because of poor resources and hence inadequacies of the prevailing practices to collect, transport and disposed the solid waste. Putting bench mark information about existing situation of SWM system in the town can help to design appropriate SWM services, service charge rates, schedules and to write future concession agreements between the municipality and SWM service providers. In line with this, it is very important and timely to look for the possibility of sharing the cost of handling solid waste by households, and for this we need to evaluate the demand side of improved SWM. Therefore, this study is designed to generate demand side information, which is vital for decision making process.

3. Methodology

3.1. Sampling Design and Data

A multi-stage stratified random sampling design was employed to draw sample urban households in Debre Tabor town. In the first stage, the four Kebeles were grouped in to two categories. Each of the two Kebeles is common in infrastructure, the quantity of solid waste generated, and access to the provision of SWM services. In this regard, Kebele 2 and 3 were comprised the first group and Kebele 1 and 4 formed the second group. Then as a second stage using simple random sampling technique, two Kebeles were selected, namely Kebele 3 from group one and Kebele 4 from group two. In the third stage, five homogenous units were made within the selected

Kebeles. The category was based on the monthly service charge payment for the SWM service delivered.

Accordingly, nonpayer[1] (0 Ethiopian Birr (ETB[2]) per month and payer (ETB 8, 15, 20 and 25 per month) and majority of the households were nonpayer. Household heads from all categories with in the selected Kebeles with a total of 5,638 were envisaged. Considering the nature of households and the tradeoff between cost and precision level, 220 households were selected randomly from which primary data was collected using questionnaire. The first part of the questionnaire comprised the presentation of the choice sets, the SWM choice experiments. A valuation scenario description was provided to respondents ahead of the choice experiment question. Data on socioeconomic characteristics and environmental awareness were collected to complement the choice experiment data. Pretesting was carried out on a small number of sampling units before doing the final survey. A critical field observation was also done to garner auxiliary information on the existing dump sites, gulley, the surrounding of home and outskirt of the town. In so doing, the researcher used camera to delineate the current situation of SWM either taking photographs or video signals.Valuable secondary data was obtained from officials particularly from the town's cleaning and beautification department that are involved in the provision and planning of SWM services.

3.2 .The Theoretical Background and Applications of the Choice Experiment Approach (CEA)

The basis for most economic or microeconomic models of consumer behavior is the maximization of utility function subject to a budget constraint. Choice experiment is a recent innovation in stated preference method and its theoretical grounding were inspired by the Lancastrian microeconomic approach (Lancaster, 1966) in which individuals derive utility from the characteristics of the goods rather than directly from the goods themselves.

CEA originated in the fields of transport and marketing, where it was mainly used to study the tradeoff between the characteristics of transport projects and private goods respectively. This approach have a long tradition in those fields, and recently has been applied to non-market goods in environmental and health economics (Alpizar, Carlsson et al., 2001). The first study to apply CEA to non- market valuation was by (Adamowciz, Louviere et al., 1994). Since then there is an increasing number of research in environment and health sector using this approach due to the fact that the superiority of the method over Contigent Valuation Method (CVM) and the possibility of testing for internal consistency or validity, preferences are stable and transitive between the hyphothetical and the actual choice experiment (Alpizar, Carlsson et al., 2001). Moreover, this approach can do better in elicitation of preferences than CVM in measuring the marginal value of changes in the characteristics of environmental goods because it is easier to disaggregate values for environmental resources into the values of the characteristics that describe the resource (Hanley et al., 1998).The CVM gets the required answer for just one alternative to the status quo, whereas the CEA can generate estimates of the values of many different alternatives from the one time application (Alpizar et al, 2001, Adamowicz et al, 1994 and Bennett et al, 2001). As a result, from one set of choice data, the values of an array of alternative ways of reallocating resources can be estimated. This feature of the approach arises because it specifically investigates trade-off between attributes (Perman, Ma et al., 2003, Bennett, 2005). Thereon, CEA is a natural generalization of a binary choice CVM (Adamowicz, Louviere et al., 1998, Alpizar, Carlsson et al., 2001). This approach also provides a enormous amount of information elicited from each respondent as compared to CVM (Adamowciz, Louviere et al., 1994, Hanley, mourato et al., 2001). This huge amount of information enable a better understanding of the process underlying the statements of preferences made by respondents and the problems that may be associated with those processes. Finally, it is versatile in its application as the alternatives presented to respondents in the choice sets are hypothetical, the choice experiment analyst can design an application to estimate both use and non-use values of the environmental assets (Bennett, 2005).

3.3. The Econometric Base, Models and Analysis of Choice Experiment Approach

The econometric basis of CEA is from Random Utility Theory (RUT). The theory poses a notion that an individual consumers choose alternatives that provide them greatest utility (Adamowicz and Boxall , 2001). For RUT, the utility function for each respondent can be decomposed in to two components: the deterministic and the stochastic part (Adamowciz, Louviere et al., 1994, Hanley, Wrigh et al., 1998, Hanley, mourato et al., 2001, Othmal, 2002, Birol, Karousakis et al., 2006, Louviere, Flynn et al., 2010). RUT leads to families of probabilistic discrete choice models by putting different assumption on the distribution of the error term (Adamowic, Boxall et al. 1998, Green, 2003, Louviere, Flynn et al., 2010). For instance, the Conditional Logit Model (CLM) assumes that the stochastic component are Identically and Independently Distributed (IID) across

1 For this study, non-payers are those urban household heads who were not actually sharing the cost incurred to handle solid waste by the service provider, this might not be necessary due to lack of income & unwillingness to participate in SWM practices. Rather lack of access to the service offered (inefficiency of the service provider to visit the households house, lack of road and necessary equipment) and to some extent due to closeness to the dumpsite.

2 ETB is Ethiopia's national currency and during the survey, the exchange rate for one US dollar ($) was equal to ETB 21.45.

individuals and alternatives with a weibull distribution (Birol, Karousakis et al., 2006). A consequence of this assumption is the property of Independence of Irrelevant Alternatives (IIA). The IIA assumption states that the probability of choosing the ratio of two alternative is independent of the addition or the deletion of the other alternatives (Blamey, Gorden et al., 1999, Green, 2003). If IIA property is violated, the estimate of CLM model will be spurious, misleading interpretation. The test used to identify the existence of IIA assumption is Hausman test (McFadden, 1974).

Albeit the CLM does not violate the IIA property, there is also another problem with the specification, limitation in modeling variation in preference among respondents (Birol, Karousakis et al., 2006). This problem arises due to observed and unobserved heterogeneity. Conditional observed heterogeneity can be incorporated into the model by allowing for interaction terms either with the choice attributes or Alternative Specific Constant (ASC) but it could not detect unobserved heterogeneity. Thus an alternative method of estimation, which does not exhibit both the IIA and homogeneity preferences assumption are recommended, that is the Random Parameter Logit Model (RPLM)(Train, 1998, Alpizar, Carlsson et al., 2001). However, it should also be noted that even if unobserved preference heterogeneity can be accounted with the use of this model, it fails to explain the sources of heterogeneity (Adamowicz and Boxall , 2001). One solution to detect the sources of heterogeneity while accounting for unobserved heterogeneity would be by inclusion of respondents' socio-economic and environmental variables in the utility function as interaction terms with choice specific attributes and/ ASC (Adamowicz and Boxall , 2001, Birol, Karousakis et al., 2006)). This would enable RPLM model to pick up preference variation in terms of both unconditional and conditional preference heterogeneity and allow the parameters to randomly vary over individuals(Train, 1998). Furthermore, accounting for heterogeneity enables prescription of policies that take equity concerns into account (Birol, Karousakis et al., 2006). An understanding of who will be affected by a policy change in addition to understanding the aggregate economic value associated with such changes is necessary. Thus, the RPL model which accounts for unobserved, unconditional heterogeneity (Train, 1998), should be used in order to account for preference heterogeneity in pure public goods(Kontoleon, 2003)such as the SWM studies in this choice experiment.

Most recently, choice experiment practitioners have started employing the Latent Class Model (LCM) as an alternative model for accounting preference heterogeneity (Birol, Karousakis et al., 2006). This model revealed heterogeneity as a discrete distribution (Czajkowski, Kądziela et al., 2012), a specification based on the concept of endogenous or latent preference segmentation (Greene and David Hensher , 2002). In LCM, the population consists of a finite and identifiable number of segments of individuals, each characterized by relatively homogenous preferences (Birol, Karousakis et al., 2006). These segments, however, differ substantially in their preference structure. The underlying theory of the LCM posits that individual behavior rely on observable attributes and on latent heterogeneity that varies with factors that are unobserved by the analyst (Greene and David Hensher , 2002, Greene, 2012). It is assumed that individuals are implicitly sorted into a set of K classes, but which class contains any particular individual, whether known or not to that individual, is unknown to the analyst (Ibid).

Though choosing the number of classes in the LCM is challenging (Birol, Karousakis et al., 2006) it is better than RPL, there is no technical challenges and it is easier to understand and leads to more straight forward estimates and model interpretation is easier (Sagebiel, n.d). With the LCM, the choice modeler can provide names to the classes, see (Czajkowski, Kądziela et al., 2012).The number ofclasses can be chosen by the researcher but one has to keep in mind that the class probabilities are subject to a statistical procedure rather than behavioral assumptions (Kontoleon, 2003). To identify the optimal number of classes statistically, measures of fit like AIC or BIC are commonly used (Sagebiel, n.d).

According to (Hanley, Wright et al., 2000), after parameters estimation with a better fit models are accomplished, a WTP for each attributes and a measure of economic values can be derived. Given the attribute being sacrificed is a monetary attribute, the tradeoff estimated is known as marginal WTP (Perman, Ma et al., 2003). It demonstrate WTP by any particular respondent to receive more of the non-marketed environmnntal goods, in our case SWM attributes. However, the marginal WTP estimates convey information only for the WTP of each single attributes, it does not provide any information for the economic surplus arose from a change in status-quo to the proposed alternative scenarios package. Then, the welfare measure from the initial to the improved options can be estimated. Economic surplus measures the change in money income that would make an individual indifferent between the initial level of wellbeing and the new level of wellbeing by considering the individual has the right to choose the status-quo (Othman, 2002).This change in money income reflects the individuals' WTP to obtain an improvement in environmental quality.

Welfare measures for a given SWM interventions package can be estimated by using the estimated coefficients of the attributes in the RPLM with interaction and the levels of the attributes in the different alternative scenarios. By subtracting the value of the improved alternative options from the value of the original level of utility and multiplying the difference by the negative inverse of the coefficient of the monetary attribute yields the estimates of economic surplus.

3.4. Design of CEA and Application to Debre Tabor Town SWM Improvement

The issue of experimental design[1] is to maximize the efficiency of the survey via following various procedures & hence extracting information from the respondents subject to the number of attributes, levels and other characteristics of the survey such as cost and length of the survey (Vega and Alpízar, 2011). The central question is then how to select the attributes to be included in the stated preference experiment in order to extract maximum information from each individual (Carlssona and Martinssona, 2002).

The practical issue of CEA is that respondents are presented with a serious of alternatives, each varying in terms of the levels of attributes and they are asked to choose their most preferred alternative among several alternatives in a choice set (Hanley, mourato et al., 2001).The do nothing situation is usually included in each choice sets (Bennett, 2005). This is due to one of the alternative must always be in the respondents current feasible choice set to able to interpret the results in the standard welfare economics term (Alpizar, Carlsson et al., 2001, Hanley, mourato et al., 2001). In applying choice experiment to value the environmental goods and services, one should follow certain analytical stages (Adamowicz and Boxall , 2001, Adamowicz, Louviere et al., 1998, Alpizar, Carlsson et al., 2001, Hanley, mourato et al., 2001, Bennett, 2005): Characterization of the decision problem**,** selection of attributes and assignment of levels,choice of experimental design, construction of choice set, questionnaire development, sampling strategy and sample size, model estimation and reporting the result and policy analysis. In this study, the successful implementation of a CEA was passed all of the above steps.

Improvement in the provision of SWM services are believed to enhance environmental quality and the health of residents. However improvement in SWM per se is nothing, the improvement in SWM can be decomposed in to a combination of several attributes having different values. The demand driven approach was involved in selecting some demand and policy relevant attributes with their respective levels.

Table 3.1: SWM attributes, their levels and description used in the choice experiment

SWM Attributes	Description	Levels
Mode of transportation	The nature of the technology the service provider use to collect, transport and dispose solid waste.	**Status-quo**: Animal cart Improved one: Open truck with cart Improved two: Covered truck with cart
Segregation of solid waste at households level	The separation of solid waste by their nature where, solid waste which have the same characteristics can be put under the same category.	**Status-quo:** No segregation Improved one: Segregation of solid waste as bio and non-biodegradables Improved two: Segregation of solid waste as recyclables and non-recyclable
Service provider	Represent by whom the service would be provided	**Status-quo:** Private-public Improved one: Private institute service provider Improved two: Public institute service provider
Method of solid waste collection	The system used to collect solid waste	**Status-quo**:Door to door collection improved one:Curbside pick-up schedule Improved two:Community bins
Types of solid waste disposal options	Methods of solid waste disposal used	**Staus-quo**: Open landfill with illegal burying Improved one: Open landfill with incinration Improved two:Control tiping
price of delivering the service	Monthly payment levied on each household to cover the cost of handling solid waste	**Staus-quo$_1$**[2]: ETB0 & proposed value (ETB 3,5, 8, 10 per month). **Status-quo$_2$**: ETB 8 & the proposed value (ETB 10, 12, 15, 17). **Status-quo$_3$**:ETB 15 & proposed value (ETB17, 20, 22,25). **Status-quo$_4$**:ETB 20 & new value (ETB 21,23, 25,28). **Staus-quo$_5$**: ETB 25 & proposed values (ETB 27 , 28, 30,33 per month).

[1]The foundation for any stated preferences experiment is an experimental design. An experiment defined in scientific terms involves the observation of the effect upon a response variable, given the manipulation of the levels of one or more other variables. The manipulation of the levels of the variables does not occur in a haphazard manner rather by design. Hence the name "experimental design"(Hensher, Rose et al. 2005).

[2]During the survey, the price charged by the service provider was not unique to households, the choice experiment question was not the same and hence each group was confronted with different choice experiment question. Five different groups prevailed and this attribute did not have unique proposed value for all respondents. Consequently, for all status-quo levels an optimal choice sets or choice cards were prepared.

In depth interview with randomly selected households, small scale pilot study was held to identify preliminary attributes and their levels. Moreover, consultation with town's cleaning and beautification officials who specialized in SWM, leader of community based association and intense literature review were also implemented. Indeed, more weights were given for those households who were randomy selected followed by leader of community based association who have close intimacy with the households. The most relevant service attributes that were identified in the first stage of attributes selection and assignment of levels were seven. However, when the number of attributes are too many, it is difficult for households to choose from many choice sets (Hensher, Rose et al. 2005). Meanwhile, too few attributes cannot explain the value of SWM well because of small data set. Thus, considering these and consultation with concerned bodys, collection time, frequency of weekly solid waste collection were found to be insignificant and these attributes were droped in the second stage.

Finally, five SWM attributes were selected for the design of the choice experiment along with monthly service charge which is required to estimate wellfare changes. The selected attributes and their levels in the second stage of attributes identification and assignment of their levels are presented in Table 3.1. It was believed that the assigned levels of these attributes were feasible, realistic, easily understandable, span the wide ranges of households' preferences (Hanley, Mourato et al., 2001). After the relevant attributes and their levels were identified, the next step was construction of choice sets through experimental design. The combination of different levels of attributes yields different intervention scenario and then choice sets. However, the creation of these choice sets were not in haphazard manner. The random choice sets creation were expected to follow the standard L^{MN} experimental design, containing N alternatives of M attributes of L levels of each (Sanko, 2001). In constructing the choice set from design of experiment, we assured the following basic criterion (WHO, 2012, Jaynes, 2013). Orthogonality: no correlation between attributes levels.Main effect: majority of the variation in the dependent variables were explained by the effect of the variation in a single attribute than their interaction (The effect heredity principle). Level balance: the level of the attribute appeared in equal number of times. Minimal overlap: the levels of attributes were not repited with in the choice set.

The D-efficient design of experiment was applied using the optex procedure in SAS 9.0 to generate the number of individual profiles. In so doing, the status-quo levels of attributes were excluded (Woubishet, 2014). Thus, the number of SWM scenarios that could be generated from five attributes with two levels each and one attribute with 4 levels was 128 (2^5 *4) different alternatives. This full factorial design may lead to very large combinations which could not be practicable and it was more than the respondents could be expected to cope with. In such cases, there is a need to choose a subset of possible combinations (fractional factorial), reduce the number of runs in to manageable size.

Thus, from 128 possible combinations, 16 optimal individual profiles were created. Finally, choice sets were formed using individual profiles, 8 choice sets were constructed using the cyclical or foldover fractional factorial main effect design. Thus, respondents from different (Five) categories were given with eight choice sets where each choice set stood with three SWM interventions, one was the status-quo and the remaining were improvement in SWM interventions and respondents were asked to choose their foremost option from each choice set. In this way, the presentation of various alternative in a choice sets were an integral part of the questionnaire. One of the sample choice set is presented in Table 3.2.

Table 3.2: Sample choice set

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

SWM attributes	SWM intervention A	SWM intervention B	Business As Usual
Mode of Transportation	open truck with cart	Covered truck with cart	Animal cart
Sorting of solid waste	Sorting as bio & non biodegradables	Sorting as recyclable &nonrecyclable	No sorting
Service Delivery Institute	Private	Town's municipality	Private-public
Method of solid waste collection	Curbside	Community bin	Door to door
Method of solid waste Disposal	Control tipping	Open dump and inciration	Open dump and burying
Monthly Service Charge	**8**	**10**	**0**
Tick (X)	☐	☐	☐

4. Results and Discussion

4.1. Descriptive Statistics of the Survey Data

For this study a total of 220 household heads out of which 141 (64.09%) from non-payer and 79 (35.91%) from payer of the resident were interviewed. The total number of observation was 5280 elicited from 220 respondents and one-third of this number was the proportion of selecting one option among the three mutually exclusive interventions from each choice set. Thus, 1760 choice sets were provided from 220 completed questionnaire.

The socio-economic characteristics of the sample units are revealed in Table 4.1. The result showed 52.3% were female headed households and the average years of household stayed in the area was 48.3. The average family size of the household was 4.51. A wide range of responses were recorded for income starting from ETB 300 to 36,000 with mean of 5,450.89. This shows a high degree of income inequality, where very few people have high income while many are poor.

Table 4.1: Descriptive statistics for selected variables of the respondents

QualitativeVariables	**Lables**		**Percentage**	
Sex of the household head	1, if female, 0 otherwise		52.3	
Marital status of the household head,	1 if married, 0 otherwise		78.2	
Composition of the household,	1, if many of composition are children, 0 otherwise		30.9	
Housing arrangement of the household	1, if rented, 0 otherwise		18.2	
Educational level of the household head	1, if not attend any school, 0 otherwise		26	
Quantitative Variables	**Minimum**	**Maximum**	**Mean**	**Std.dv**
Age of household head	22	78	44.08	12.486
The number of family size	1	10	4.51	1.908
Time spent in the area in years	1	70	25.33	17.709
Monthly household income in ETB	600	36000	5450.89	5080.798

Source: Authors' Computation from Field Survey Data, 2016

Respondents were also solicited to rank the importance of various socio-economic sectors among others for source of government revenue. The result in Table 4.2 indicated that the environment sector on average was one of the most important area next to the public health services and public education and thus, ranked 3rd out of the included eight revenue generating sectors. Majority of the respondents stated, that the issue of solid waste are as important as several other environmental problems such as water, air and noise pollution. As a result, proper SWM is paramount significance aspect of human welfare and can be considered as one component of protecting environmental pollution, can scale-up households' welfare.

Table 4.2: Important sectors as sources of government revenue

Sectors	No of respondents	Mean	St.dv	Rank
Protecting the natural environment	220	3.20932	.0216856	3
Public health service	220	2.74086	.0224713	1
Public education	220	2.823073	.0224347	2
Crime prevention	220	5.126918	.0225856	6
Poverty/ unemployment reduction	220	5.276946	.0267377	7
Housing service	220	4.881985	.0288294	5
Expanding basic infrastructure	220	4.795416	.0324675	4
Public defense	220	7.027467	.0212004	8

Source: Authors' Computation from Field Survey Data, 2016

Almost all of the respondents reported that they were concerned with SWM issues in the vicinity, and considered themselves as actors to implement good SWM practices and aware of the importance of quality environment. Information on respondents' overall perception to the existing SWM practices were gathered, and about 7.3% rated the existing SWM practices as very good, 20.2 % as good, 36.17% deemed it average and 43.5 % as poor and the remaining 29.1 % of the respondent expressed it as very poor. This reflects the current condition of SWM system was the major challeges for the town environment and the residents of the town. On average each household produces nearly 50 kg of solid waste per month,which is really shudder.

The dominant type of solid waste generated (91.8%) comprised biodegradable[1]. This was due to the nature of the houses in the town is old without maintenance. Although it is known both open dumping[2] and open

[1] Examples of biodegradable solid waste generated in Debre Tabor town were ash, dust particles arose from sweeping house, vegetable peelings, vegetable and fruit related solid waste, onion coats, grasses and straw, food leftovers, stalk of chat and wood, papers, cartons and paper packaging materials etc..

[2] Of the respondents 36.4% used open dump (nearby dump, gulley, river, street and along the road side) and 21.8% used backyard with no lids, and mostly the solid waste is dispersed off by chickens and other domestic animals. This became the source of unpleasant view, odor and resulting for fly breeding sites. About 2.7 % replied that they used illegal burying; appropriate incineration of solid waste is hardly available in the study area. Lastly, 3.2% of the respondent employed worker

burning are causes to environmental pollution, they were the primary disposal methods of the households in the study area. About 35.4% of the respondents mentioned that they were the beneficiary of the services offered by the community based association. However majority of the respondents were not satisfied with the services delivered due to inefficient service provision, the provision of the service was far below residents' expectation. Respondents strongly complained about the scarcity of skip and proper transfer station site. Even the door to door collectors themselves dumped the solid waste on open spaces and nearby rivers. In addition, there was lack of environmental friendly, advisable and efficient solid waste disposal methods in the town. Picture 4.1 in the Appendix presented to illustrate the existence of these situations.

About 87.3% of households were willing to contribute in the form of labor for achieving proper SWM system in the town. The mean labor participation was 1.15 day per month, or ETB 12, 650 for the sampled household per month & ETB 695, 635 for the whole households per month. The implication was managing solid waste through community participatory approach can reduce operational cost, ensure timely collection, and transportation of solid waste. Active participation of the community had a paramount significance to improve sustainable SWM plans. Hence, any policy to bring about efficient SWM service needs to consider the households' participation in the form of labor effort too.

4.2. Results and Discussion of the Choice Experiment Data

The econometrics software package, LIMDEP10.0 NLOGIT5.0 was used to estimate the three discrete choice models: conditional logit, random parameter logit and latent class model (of the first two with basic and extended models[1]). In the basic model, the basic SWM services attributes in explaining respondents' choice for different SWM interventions were considered. In addition to the SWM attributes, socio-economic and environmental variables as the driving factor of respondents' choice for upswing SWM interventions were considered in the extended models.

In the first step, the simple conditional logit specification were estimated. Both the basic and hybrid CLM (Greene, 2012, Sagebiel, n.d) were statistically significant. However, estimates of the CLM is based on the IIA assumption and prefereneces homogeneity. The IIA assumption test results presented in Table 4.3 revealed that significance difference was observed from results obtained by holding the IIA assumption and relaxing it.The result indicated that the IIA assumption does not holds true for dropping any one of the option, and the null hypothesis were rejected and we refrained from interpreting CLM's estimates. Consequently, an alternative method of estimation, which does not exhibit the IIA assumption was applied to consider preference variations in terms of both unconditional preference heterogeneity or random heterogeneity and individual characteristics or conditional heterogeneity, that is the random parameter logit model (Train, 1998).

Table 4.3: Hauseman and Mc-Fadden test of IIA assumption for CLM

Intervention excluded	X-square	d.f	Number of observation skipped due to exclusion	Pr(C>c)	Remark
Intervention one	32.2	7	815	0.000003	Violated & H_0 was rejected
Intervention two	25.07	7	604	0.000739	Violated & H_0 was rejected
Intervention three	22.53	7	341	0.002079	Violated & H_0 was rejected
# of respondents	220				
# of observations	1760				

Source: Debre Tabor Town SWM Improvement Choice Experiment Survey

Before estimating the RPL model, the model requires an assumption about the distribution of the coefficients that make choices on what parameters to be randomly distributed and what parameters should be fixed (Hensher, Rose et al. 2005). Thus, all the choice attributes except the payment attribute (Hensher, Rose et al. 2005, Greene, 2012) were specified as random parameters drawn from a normal distribution and gave the reasonable fit model though the appropriateness of distributional assumptions of the random parameters comprised in RPL model is not yet tested (Hensher, Rose et al. 2005). In the estimation of both the basic and the hybrid RPL models a standard or intelligence Halton sequence was applied and 1000 replications (Ibid) were used for the simulation of the random parameters and the simulated log likelihood function was maximized using the BFGS estimator. The RPL models parameter estimates are presented in Table 4.4.

for transporting their solid waste to the out skirt of the town, but they didn't knew from where the worker was actually dumped it.

[1] In estimating the extended/ hybrid models the ASC was interacted with a set of socio-economic and awareness variables. Where ASC represent the welfare effect that was not captured by the product attributes considered and took value one for the improved SWM interventions, and zero otherwise.

Table 4.4: Result of the basic and hybrid RPL models

SWM attributes & Variables	Basic RPL Model Coeff.	St.err	P-value	Hybrid RPL Model Coeff.	St.er	P-Value
Random parameters in utility functions						
Collection system	-.21037	.36876	.5684	-.21696	.19323	.2615
Delivery Institute	-.28388***	.07465	.0001	-.27512***	.06652	.0000
Method of Disposal	.30235***	.07428	.0000	.26004***	.07162	.0003
Mode Transportation	.37481***	.08005	.0000	.33723***	.07481	.0000
Sorting of SW	-.18572**	.08946	.0379	-.17383**	.08364	.0377
Non- Random parameters in utility functions						
ASC	3.87744***	.41209	0.0000	9.15338***	2.05213	.0000
Price	-.17718***	.01690	.0000	-.17125***	.01592	.0000
ASC*Age				.04128*	.02318	.0750
ASC*Composition				.65849	.46960	.1608
ASC*Education				1.01999***	.14428	.0000
ASC*Income				.00018**	.8603D-04	.0334
ASC*Live				.00703	.01559	.6523
ASC*Martial Status				.17382	.30106	.5637
ASC*Ocurrenceof dzz				-.39267	.38620	.3093
ASC*Own House				-.69923***	.25163	.0055
ASC*Quantity SW				.02238***	.00747	.0027
ASC*Satisfaction				-12.8035***	2.73214	.0000
ASC*Sex				.79727*	.41435	.0543
ASC*Size				-.00426	.11093	.9694
Derived standard deviation of parameters distribution						
NsCOLSYS	3.91613***	.51097	.0000	2.62549***	.27420	.0000
NsDLVRY	.44718***	.12964	.0006	.32462***	.08953	.0003
NsMTDWD	44541***	.13109	.0007	.43399***	.11168	.0001
NsMODTRA	.63369***	.12752	.0000	.57627***	.11112	.0000
NsSORT	.36065*	.19138	.0595	.36228***	.10336	.0005
Summery statistics						
Number of observation	1760			1760		
Number of respondent	220			220		
Log likelihood function	-1253.36845			-1223.12773		
Null model	-1933.55763			-1923.67012		
Pseudo R^2	.3496			.3598		
iteration completed	25			47		
Chi-Square	1360.37836 [sig. 000000]			1343.07319 [sig.0000000]		
AIC	= 1.438			1.424		

Note: nnnnn.D-xx or D+xx => multiply by 10 to -xx or +xx. And ***, **, * ==> Significance at 1%, 5%, 10% level**.**

Source: Authors' Computation from Field Survey Data

The log likelihood function and the pseudo R^2 values showed the model improved the overall goodness of fit than the standard CLM. The explanatory power of the basic and hybrid RPL model was 35 and 36% respectively. Therefore, the model best explained the data with interactions from which the interpretation of all coefficients were made.The estimated result of these models revealed that the sign and significance level of the coefficients of attributes were similar with the result of CLM. The mean random parameter estimates of mode of transportation and method of solid waste disposal were significant and possess the expected positive sign. These were the same with results reported by Othman (2002), Tarfas (2007), and Berihun(2010). The implication was that improvements in the levels of these attributes increase the utility of respondents, ceteris paribus and thus the likelihood of selecting one of the improved options was higher than the status-quo. While, the mean random parameter estimates for service delivery institute and sorting of solid waste were significant with negative sign. Changes in the levels of these attributes were considered as disutility. Though majority of the solid waste generated in the town were biodegradable, households had shown reluctance for sorting of solid waste due to time and effort cost of sorting, lack of enough space and materials to sort, and rural-urban linkage in terms of demanding compostable solid waste. Thus, in order to improve sorting of solid waste and reduce household solid waste that would be going to disposal site, policy makers should promote intensive public awareness of the benefits of sorting, and provide resources which facilitate sorting at source. Alongside, market and recycling industry should be encouraged and developed which will generate employment opportunities and promote environmental friendly disposal method.

The ASC and price were significant and had a positive and negative signs respectively. The positive sign of the coefficient for ASC indicates that the utility of respondents on average increased as they move away from the existing situation to the suggested interventions. Whereas, the implication of the negative sign of the payment coefficient was that options with lower payment level were more preferred.This was consistent with respect to economic theory; an increase in the cost of the program reduce the demand for it.Furthermore, the derived standard deviations of all random parameters for both the basic and extended model were statistically significant and suggested the spreads of each of the random parameters around their respective means exhibit preference heterogeneity. The data supports choice specific unconditional unobserved preferences hetrogeneity for all attributes considered (Hensher, Rose et al. 2005). Different individuals possessed individual-specific parameter estimates that may be different from the sample population mean. Hence a single parameter estimate like that of the standard CLM was insufficient to represent all sampled respondents.

Among the included socioeconomic and awarness variables,the coefficients for the interaction of the ASC with age, educational level, income, quantity of solid waste generated per month, ownership of the house, satisfaction on the prevailing SWM, sex were statistically significant to affect households WTP and their sign were in previous intution. However, the coefficients for the interaction of ASC with time spent in the area, occurrence of disease as a result of miss-handling of solid waste at household level, family size, composition of family and marital status were found to be insignificant.

To obtain an enhanced understanding of how various segments of households are affected by the presence of improved SWM programs, the latent segmentation model was used which is a relatively new approach for accounting preference heterogeneity (Kontoleon, 2003). Albeit choosing the number of classes in the LCM is challenging (Birol, Karousakis et al., 2006). Arguing with classes instead of distributions of the population gives more scope for policy recommendations (Sagebiel, n.d).

A balanced assessment of the statistics (Kontoleon, 2003) should be done, and AIC statistics (Sagebiel, n.d) was used to determine the optimal number of segments and reported in Table 4.5. The started value was the usual basic CLM. The log likelihood and Pseudo R^2 statistics improved as more segments were added to the model, supporting the existance of multiple segments in the sample. However, the LCM with two segment solution provided the reasonable fit to the data since, though, AIC decreased and Pseudo R^2 increased as segments were added, the marginal changes were smaller from 2 to 3 and from 3 to 4 segment, and decreased when segment 5 and 6 were added to the model.

The relative size of each segment was estimated and provided the series of probabilities that each respondent belongs to either one of the two segments. The respondents were assigned to one of the segments on the basis of their largest probability score (Birol, Karousakis et al., 2006). It was found that 81.6% of the respondents belong to the first segment and 18. 4% belong to the second segment.

The result of the two segements LCM are reported in the Table 4.5. No matter which model is considered, the estimated coefficient of price was statistically significant and negative for the two classes. For segment one the utility coefficients for all SWM attributes were significant determinant of respondents choice. Alike the CLM and RPLM, the parameter estimates of the mode of transportation and method of solid waste disposal in the first segement were positive, suggested that households positively prefered these attributes to be part of the improved SWM program. Where as, method of solid waste collection, sorting of solid waste and service delivery institute were negatively prefered and improvements in these attributes increased the disutility of the respondent.

Segment two was distinct and the household were indifferent to all of the SWM services attributes considered in the choice experiment survey. Except the monetary attribute, the remaining SWM attributes were insignificant. The implication was that the existance of bipolar or bimodal preferences for some attributes between groups of the resident in the town. For instance, in segement one the parameters for method of solid waste disposal was positive and negative in class two though it was statistically insignificant.

Table 4.5: Criteria for determining the optimal number of segments and result of LCM

Test	Number of segments				
	2	3	4	5	6
Loglikelihood function	-1197.898	-1155.057	-1077.277	-1078.46	-1092.28
Chi-square	1471.318	1557	1712.56	1710.195	1682.554
AIC	1.378	1.339	1.259	1.27	1.295
Pseudo R^2	.377	.398	.4379	.436	.427

Result of LCM	Coefficients	Std.err	P-value
Utility parameters in latent class -->> 1			
ASC|1|	3.73361***	.32616	.0000
Collection system|1|	-.26770**	.13554	.0483
Delivery institute|1|	-.21249***	.05828	.0003
Method of SW disposal|1|	.29353***	.05966	.0000
Mode of transportation|1|	.38810***	.05791	.0000
Sort of SW|1|	-.14667*	.07587	.0532
Price|1|	-.13963***	.01448	.0000
Utility parameters in latent class -->> 2			
ASC2|2|	.71632	2.51599	.7759
Collection system|2|	.08926	.70478	.8992
Delivery institute|2|	-.14573	.57564	.8001
Method of SW disposal|2|	-.25152	.87911	.7748
Mode of transportation|2|	.44131	.71322	.5361
Sort of SW|2|	.65678	. 90156	.4663
Price|2|	-1.61837***	.32363	0.0000
Estimated latent class probabilities			
Average class probability for class one	.81545***	.02636	.0000
Average class probability for class two	.18455***	.02636	.0000

Note: ***, **, * ==> Significance at 1%, 5%, 10% level
Source: Authors' Computation from Field Survey Data

This was also held true for some of the other attributes across classes although they were insignificant. The existence of such kind of preferences by respondents for the same attributes could lead to insignificant parameters in simple standard models (Sagebiel, n.d). This was true for method of solid waste collection, which was significant for LCM, in class one and insignificant in CLM and RPL models. In conclusion, respondents in the first class were highly preferred the improved SWM options as ASC was highly significant. While, the second class respondents were indifferent between the status-quo and the improved options. This was reflected by the statistically insignificant estimate of ASC.

To find the best statistical fit for this data, we had tried out different utility specifications, chose one based on certain criteria and then began interpreting then estimation results. Indeed, comparison of the three models relied on the estimates of the basic model. It was not made for the three hybrid models as the estimated variance matrix of estimates in LCM was singular when the auxiliary variables were considered. Here we applied, choice experiment data result of the LCM was statistically superior over the basic CLM and RPLM in terms of the log likelihood function, pseudo R^2, the AIC and consideration of the bimodal preferences (Greene and David Hensher, 2002). This result may indicated the fact that the LCM can provide added information that was not conveyed in the other two models (Birol, Karousakis et al., 2006). However, the selection of the choice model relies on the purpose of the study and a priori assumption about the nature of the sampled households. Since identifying the socio economic driving factors of respondents choice for improved SWM interevention was one of the resesarch objective, interepretation of parameter estimates and welfare measures were based on the estimated result of the RPLM with interaction.

4.2.1. Estimation of the Marginal WTP Values and Compensating Surplus

The marginal WTP results can be obtained from the ratio of choice attributes to fixed monetary attribute.Thus, the distribution of the marginal WTP for an attribute is the same as the distribution of that attribute's coefficient (Hensher, Rose et al. 2005).The table below reports the implicit prices for each of the SWM attributes estimated using the Wald procedure (Delta method) (Karousakis and Birol, 2006, Greene, 2012). For comparisons, WTP were calculated using the estimates of all models. Thus, estimates of each attribute revealed that the WTP estimates from the three models were significant at 5% significance level (Except for the WTP for the solid waste collection system attribute for the CLM and RPLM). The relative importance of attributes remains consistent for basic and hybrid CLM, and RPLM.

Specifically, results from Table 4.6. revealed that the marginal WTP for mode of transportation was ETB 1.969. This means households on average were WTP an additional charge of ETB 1.969 per month if mode of transportation is improved from status-quo the suggested options. The marginal WTP for sorting of solid waste can be interpreted as the net increased in disutility (cost) worth ETB -1.015 associated to a change from the status-quo to the improved. It is natural that soring of soild waste is good for those households who are engaged in recycling and reusing activities. However in most developing countries like Ethiopia, market for reusable and recyclable materials are not well developed and residents in Debre Tabor town were not prefered and WTP for the improvement in this attribute. The implication in terms of relative importance of attributes, mode of transportation ranked top followed by solid waste disposal method, service delivery institute and sorting of solid waste. Thus, any policy maker intended to bring efficient and sustanable SWM can allocate scarce resources in favor of the foremost attributes.

Table 4.6: Mean marginal WTP for the three models of improved SWM interventions

SWM Attributes	Basic CLM	Hybrid CLM	Basic RPL	Hybrid RPL	Basic LCM Class1	Class2
	Coeff. (S.e, P-value)	Coeff. (S.e, P-value)	Coeff. (S.e,p-value)	Coeff. (S.e,P-value)	Coeff. (S.e,P-value)	Coeff. (S.e,P-value)
Collection system	-1.111 (.738,.1326)	-1.183 (.762, .1209)	1.187 (2.08,.5688)	-1.266 (1.145,.2687)	-1.917** (.07, .02)	.05 (.32,.21)
Delivery Institute	-1.513*** (.435, .000)	-1.5*** (.43, .0005)	-1.602*** (.433,.0002)	-1.606*** (.408,.0001)	-1.521*** (.15, .0000)	-.09 (.04, .78)
Method of Disposal	1.982*** (.442, .0000)	2.027*** (.438,.0000)	1.706*** (.432, .0001)	1.518*** (.430,0.0004)	2.1*** (.017,.0000)	-0.15 (.47,0.18)
Mode Transportation	2.694*** (.473,.0000)	2.694*** (.468,.0000)	2.115*** (.486,.0000)	1.969*** (.468,.0000)	2.78*** (0.12,.0000)	.27 (.68,.29)
Sorting of solid waste	-1.084** (.518, .036)	-1.025** (.516, .047)	-1.048** (.513,.0412)	-1.015** (.499,0.422)	-1.05* (.008,.09)	0.4 (.27, .44)

Note: ***, **, * ==> Significance at 1%, 5%, 10% level
Source: Authors' Computation from Field Survey Data

In order to compute the economic welfare, nine hypothetical alternative scenarios with their attribute levels were considered and compared with that of the "business as usual" scenario.

The welfare measure, compesating surplus indicates the amount that respondents are WTP in order to experience an improvement in their utility. As such, respondents were WTP ETB 55.183 per month when the levels of all attributes are highly improved, and would be higher for scenario 7 (58.41 per month), Table 4.7. The welfare of the society improves while there is improvent in solid waste management interventions. In conclusion, the CEA can be applied to evaluate a range of alternative resource use scenarios in SWM. Given the potential of choice experiment question and households preferences towards improved SWM, any concerned body would be able to identify the most feasible and policy relevant SWM scenarios that yields the greatest net benefit to the community. Then the mismatch between demand and supply side of SWM would be reconciled.

Table 4.7: Estimation of compensating surplus for various SWM intervention scenarios

	SWM attributes				Compensating Surplus
SWM Scenarios	Modeof transportation	Sorting solid waste	Disposal method	Delivery institute	ETB per month
Baseline	Cart	No sorting	Open dump &illegal burying	Private-public	-
1	Cart	Recyclable& non recyclable	Control tipping	Public	50.1
2	Open truck with cart	Bio & non bio degradable	Open dump &illegal burying	Private	52.3
3	Open truck with cart	recyclable & non recyclable	Open dump & icineration	Private	53
4	Open truck with cart	No sorting	Open dump& icineration	Private	55.33
5	Covered truck with cart	recyclable & non recyclable	Control tipping	Private	56.79
6	Covered truck with cart	No sorting	Control tipping	Public	57.213
7	Covered truck with cart	recyclable & non recyclable	Control tipping	Private-public	58.41
8	Open truck with cart	Bio&nonbiodegradable	Open dump& icineration	Private	54.316
9	Covered truck with cart	recyclable & non recyclable	Control tipping	Public	55.183

Source: Authors' Computition from Field Survey Data

5. Conclusion

It is undoubtedly important to note that adequate SWM is vital and provides remarkable benefits for the urban households that should be given top most priority in order to have quality environment and maintain the health of the residents. However, for successful implementation of adequate SWM plans, residents preferences and their WTP for improved SWM should be considered. The main aim of this study was to analyse the preferences of households' for improved SWM interventions and estimate the WTP using a CEA. Data from choice experiment survey questionnaire was collected from 220 households. In addition to the standard conditional logit model, the random parameter logit and the latent class logit model were employed. The result of the standard CLM and RPLM revealed that except solid waste collection system, all attributes were significant, and mode of transportation and method of solid waste disposal had positive sign, implyied the upswing in these attributes could boost the welfare of the respondents. Whereas, the service delivery institute and sorting of solid waste attributes had negative relationship to the WTP, respondents did not WTP for the improvement in these attributes. Moreover the result of this study indicated that factors related to socioeconomic and environmental variables were responsible for households' choice of any one of the improved SWM interventions.

Results from the RPL and LCM proved that heterogeneity prevailed over the whole sample and between classes respectively. Unlike other models, results from the first class in LCM revealed that all attributes were significant in which households had positive preference for mode of transportation and method of solid waste disposal and negative preferences for solid waste collection system, sorting of solid waste and delivery institute. Meanwhile, all attributes were insignificant in the second class and respondents were indifferent between the in situ condition and the improved SWM alternative scenarios. This reflects the existence of bipolar preferences' between groups of the resident. In general, it was found that a significant group of respondents preferred the improved SWM interventions.

The marginal WTP of the SWM attributes for the three models showed that respondents gave more value for mode of transportation followed by method of solid waste disposal. Further, the estimates of welfare measure, WTP for the improved SWM intervention confirmed the indispensability of proper SWM practices to the welfare of the community. This result can be used to reconcile the mismatch between the demand for the supply side of SWM. Therefore, any concerned body needs to take measures to improve the aggregate welfare by making improvements in the existing SWM practices. This would be true if due consideration are given to households' preferences for SWM interventions.

Finally, the methodological issue of the whole practices made in this study clearly showed that CEA can be successfully applied in the context of environmental valuation and developing countries. With careful identification of demand relevant attributes, construction of the optimal choice sets, appropriate identification and then specification of models, choice experiment can successfully be used in identifying households' preferences for proposed policy options and then forward policy relevant information about SWM alternative. The methodology is unexploited yet and researchers should deem this approach to investigate the public preferences for non-marketed environmental resources.

6. Policy Implications

Based on the result found, the following policy implications were forwarded. There is considerable preference heterogeneity within households in Debre Tabor town. Thus, any policy makers intended to bring efficient SWM should take into account information about households' preferences ahead of designing appropriate SWM plan in the town. The implication of households contribution for SWM attributes and options were that the service provider can generate income from households to enhance SWM system and at the same time reduce the cost of handling solid waste and then the disparity between the demand for and the supply side of the SWM can be settled. Households were also willing to participate in the form of labor and this can be much fruitful in improving SWM. Thus, any policy to bring about efficient SWM service needs to consider households' participation in the form of labor effort too.

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Appendix

Picture 4.1: Partial view of inadequate solid waste disposal methods in Debre Tabor town
Source: Author's photograph during main and pilot survey, 2016