Households' Willingness to Pay for Improved Solid Waste Management Service in Sululta Town, Ethiopia

A Thesis Submitted to the Department of Economics in Partial Fulfillment of the Requirement for the Degree of Master of Science in Economics (Natural Resource and Environmental Economics)

By: Dereje Tola

October 2020

Addis Ababa, Ethiopia

College of Business and Economics

Department of Economics

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This is to certify that the thesis titled "Households' Willingness to Pay for Improved Solid Waste Management Services in Sululta Town, Ethiopia" prepared by Dereje Tola submitted in partial fulfillment of the requirements for the Degree of Master of Science in Economics (Natural Resource and Environmental Economics) which complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Declaration

I, the undersigned, declare that the thesis titled "*Households' Willingness to Pay for Improved Solid Waste Management Service in Sululta Town, Ethiopia*" is my original work and done by me for the degree of Master of Science in Economics (Natural Resource and Environmental Economics) under the guidance and supervision of Adane Tuffa (PhD). This thesis has not been presented for a degree in any university and that all source of materials used for the thesis have been duly acknowledged.

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Dereje Tola

Date _____

Abstract

***Background**: Waste is an unavoidable consequence of the consumption and production activities of a society; thus, proper handling of waste is becoming a serious problem of cities all over the world especially in developing countries where financial and technical scarcity is very serious. This study was undertaken to examine households' willingness to pay for improved solid waste management services in Sululta town using data from a cross-sectional survey of 392 randomly selected households.*

***Method**: A cross-sectional study design was used to answer the objective of the present study. The survey was conducted using a direct face-to-face interview method by employing the double-bounded followed by open-ended value elicitation format to estimate households' mean willingness to pay. The probit and Tobit models were used to investigate the determinants of households WTP. The data management and analysis was undertaken using STATA version 14.1. A p-value of 5% was used to declare statistical significance.*

***Result**: About 94 percent of the total respondents were willing to pay for improved solid waste management. The results of the probit model revealed that total monthly income of households, house ownership and households who lived in the area for shorter period have positive and significant effects on the household's willingness to pay for the improved SWM service. Perceiving current situation of solid waste management as good and age of household head have negative and significant effects on the households' WTP response for the improved SWM. In the Tobit model, total monthly income and households who lived in the area for shorter period have positive and significant effect on household's maximum willingness to pay. However, being female is negatively and significantly affect MWTP for improved service. The mean WTP values obtained from open-ended and double-bounded value elicitation formats are about 59.2 ETB and 77.6 ETB per month for a household respectively.*

***Conclusion**: This study recommended that the mean WTP can be used as a guide for the municipality to determine the economically acceptable fee. The local authorities should work hard on awareness creation for the residents about the impacts of poorly managed solid waste on the environment and human health through mass media and campaign. In order to create a clean and healthy environment in the town, both the local authorities and residents of the town should cooperate and take the responsibility of SWM.*

Key words: Willingness to pay, Improved solid waste management, Contingent valuation, Double-bounded, Sululta town

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Firstly, I would like to thank the Almighty God for his support and permission to accomplish this study. Secondly, I would like to forward my sincere gratitude to my advisor Adane Tuffa (PhD) for his invaluable advice as well as comments for this study. Thirdly, it is also my pleasure to take this opportunity to thank my beloved family: my wife Diribe Gemachu; my lovely children Fenet, Sinboni and Nimona Dereje for allowing me to stay away from them patiently and for their support and encouragement. Lastly, I would like to express my gratitude to my friend Tariku Dejene for his support during the data analysis.

Table of Contents

List of Figures

List of Tables

Abbreviations and Acronyms

AWTP	Average Willingness to Pay
CM	Choice Modelling
CS	Compensating Surplus
CV	Compensating Variation
CVM	Contingent Valuation Method
DBDC	Double-Bounded Dichotomous Choice
EEEW	Electrical and Electronic Equipment Waste
ETB	Ethiopian Birr
EV	Equivalent Variation
FDREPCC	Federal Democratic Republic of Ethiopia Population Census Center
GHC	Ghanaian Cedi
HPM	Hedonic Pricing Method
ISWM	Improved Solid Waste Management
MSWM	Municipal Solid Waste Management
MWTP	Maximum Willingness to Pay
SFEDB	Sululta Town Finance and Economic Development Bureau
SUBP	Seemingly Unrelated Bivariate Probit
SWD	Solid Waste Disposal
SWM	Solid Waste Management
TCM	Travel Cost Method
UNEP	United Nations Environmental Program
USD	United States Dollar

Ush	Ugandan Shilling
WBI	World Bank Institute
WHO	World Health Organization
WTA	Willingness to Accept
WTP	Willingness to Pay

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

According to the United Nations Environment Program (UNEP, 2004), solid waste generation is an increasing global environmental and public health problem. Currently, world cities generate about 1.3 billion tons of solid waste per year and this volume is expected to increase to 2.2 billion tons by 2025 where the generation rates will more than double over the next twenty years in lower income countries. In addition to this, solid waste management costs will increase from today's annual $205.4 billion to about $375.5 billion in 2025 which will be the most severe problem with more than five-fold and four-fold increases in low income countries and lower-middle income countries, respectively (Kaza et al., 2018)

Due to lack of appropriate planning, inadequate governance, resource constraints, and ineffective management of solid waste, especially insufficient collection and improper disposal is a major concern for many rapidly growing cities in developing countries (Chuen-khee & Othman, 2010).

Continuing population growth and urbanization in developing countries is making the provision of urban environmental services very difficult. The most difficult challenge many cities in the developing world are facing today in relation with environmental health service is the proper management of solid waste (Aklilu, 2002). In developed countries, waste management has become a large problem with landfills growing to enormous sizes and recycling rates remaining minimal or even unknown. This, in turn, creates foul smells and favorable habitats for mosquitoes and other vectors that could spread a large number of diseases such as encephalitis, dengue fever and malaria (Mulu & Abraha, 2012).

Waste management issues are coming to the forefront of the global environmental agenda at an increasing frequency, as population and consumption growth result in increasing quantities of waste (Yohanis & Genemo, 2015). While cities are generating an ever-increasing volume of waste, the effectiveness of their solid waste collection and disposal systems are declining. For instance, in urban centers throughout African regions, less than half of the solid waste produced is collected, and 95 percent of that amount is either indiscriminately thrown away at various dumping sites on the periphery of urban centers,

or at a number of so-called temporary sites, typically empty lots scattered throughout the city (Galgalo et al., 2019).

The composition of different wastes has varied over time and location, with industrial development and innovation being directly linked to waste materials (Dika et al., 2019). 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 due to the hygienic problems as a result of the negative externalities it generates (Solomon, 2007; Ghani et al., 2014).

Wastes that are not well managed can affect the environment in terms of the contamination of the atmosphere, soil and water. This can cause severe problems for humans and animal populations. It can also affect human health in particular by causing convulsion, dermatitis, irritation of nose/throat, anemia, skin burns, chest pains, blood disorders, stomach aches, vomiting diarrhea and lung cancer which may lead to death (Alabi, 2004).

Ethiopia has experienced rapid urbanization and increasing urban population in the last few years due to more rural-urban migration and rising per capita incomes (FDREPCC, 2007). Presumably, increased demand for infrastructure and public services (Chakrabarti & Sarkhel, 2003) accompanies this growth, but this has not been the case. Many towns in Ethiopia lack the financial resources and institutional capacity to provide the most basic municipal infrastructures and services, including solid waste management.

Collection and disposal of waste has always been the responsibility of government authorities in the past (Harris et al., 2001), hence, waste management is a service for which state and local governments are responsible (Cointreaus-Livine, 1994; Alabi, 2004). The inability of the government to manage solid waste collection and disposal effectively arose perhaps from the misconception of this task as a public responsibility.

Bartone (2001) gave three possible reasons why the private sector could be a solution in the area of solid waste management, where there is very low service coverage and inefficiencies. The first reason is that the private sector may offer a means of enhancing efficiency and lowering costs. Secondly, the private sector may be able to mobilize additional funds and lastly the private sector could be well situated to draw international experiences and introduce proven and cost effective technologies.

As an emerging town, Sululta has serious problems of solid waste management. The municipality of the town undertakes the management of solid wastes. The service rendered by the municipality is not adequate owing to many factors, the main being financial constraint (SFEDB, 2019). In order to avoid this problem, it is important to include the participation of households who are the main sources of solid waste as well as the main sufferers of the negative effects of unmanaged solid wastes. However, additional funds are needed to engage private actors in this sector.

The municipality alone cannot cover this and contributions are needed from households in the town. This study examined the general features of the existing waste management, households' willingness to pay for improved solid waste management and the extent to which demographic and socioeconomic factors affect the household's willingness to pay for improved solid waste management services in Sululta town by applying contingent valuation method (CVM).

1.2 Statement of the Problem

The rapid expansion of urban agricultural and industrial activities, stimulated by population growth, has produced large amounts of solid and liquid wastes that pollute the environment and destroy resources. Changing economic trends and rapid urbanization also complicate solid waste management (SWM) in developing countries. Consequently, solid waste is not only rising in quantity but also changing in composition (from less organic matter to more paper, packaging materials, plastics, glasses, metal, and other substances), and is aggravated by low collection rates (Bartone & Bernstein, 1993).

Waste is an unavoidable consequence of the consumption and production activities of a society; thus proper handling of waste is becoming a serious problem of cities all over the world especially in developing countries where financial and technical scarcity is very serious (Aklilu, 2002). Solid waste management is a universal issue affecting every single person in the world. Individuals and governments make decisions about consumption and waste management that affect the daily health, productivity, and cleanliness of communities. Poorly managed waste is contaminating the world's oceans, clogging drains and causing flooding, transmitting diseases via breeding of vectors, increasing respiratory problems through air borne particles from burning of waste, harming animals that consume

waste unknowingly, and affecting economic development such as through diminished tourism (Kaza et al., 2018).

At present, Sululta town municipality is allowing jobless youths to participate in waste management via door-to-door collection using pushcart and donkey or horse cart. To get the service households are expected to store solid wastes they generate in plastic bags or other temporary storage inside their home and hand over to these private solid waste collectors. Due to the insufficiency of service coverage, what is observed is different; that is, there are wastes that are dumped on the street, in the drainage and in the forest. In addition, burning in the village is a common practice. The collected waste is also disposed improperly on uncontrolled disposal site near agricultural and residential areas. Due to this, different waste debris has been carried away by the wind from the disposal sites and thus trashes surrounding farms and homesteads.

Waste management can be the single highest budget item for many local administrations in low-income countries, where it comprises nearly 20 percent of municipal budgets, on average. In middle-income countries, solid waste management typically accounts for more than 10 percent of municipal budgets, and it accounts for about four percent in high-income countries. Budget resources devoted to management can be much higher in certain cases. Costly and complex waste operations must compete for funding with other priorities such as clean water and other utilities, education and health care (Kaza et al., 2018).

The participation of local communities or service receivers is important in providing solutions to problems of SWM (Dagnew et al., 2013). Thus, households who are the primary producers of solid waste and suffer from the effects of uncollected solid waste should be able to participate in improving SWM. This participation could include financial or other forms of contributions by households in order to modernize and improve solid waste management that can minimize the problems associated with inappropriate solid waste management. This approach requires information on the willingness to contribute of households living in the town towards improved SWM.

Many studies have conducted on the willingness of households to pay for improved SWM in Ethiopia and the rest of the world. These studies identified the factors that affect households' willingness to pay for SWM service. For instance, factors that significantly

affect households' willingness to pay are level of income, level of education, age, (Banga, et al., 2011; Bhattarai, 2015), awareness of environmental quality (Dagnew et al., 2013; Maskey & Singh, 2017), sex, amount of solid waste generated, number of children, access to SWM (Endalew & Tassie, 2018). In addition, occupation type, level of satisfaction and education attainment (Selamawit et al., 2019; Alhassan et al., 2017) and households awareness about the impacts of poorly managed solid waste, plan of households to live in the area permanently and duration of residence in the area (Tamru, 2019) are also significantly affects households' willingness to pay.

However, to the best of my knowledge there is no study conducted in the study area on improved solid waste management. Therefore, this study was aimed at assessing the household's willingness to pay for improved solid waste management (SWM) and the associated demographic and socioeconomic factors that determine household's willingness to pay for improved solid waste management service in Sululta town.

1.3. Objectives of the Study

1.3.1. General objective of the study

The general objective of this study is to estimate the household's willingness to pay for improved solid waste management services using the contingent valuation method in Sululta town.

1.3.2. Specific Objectives of the Study

- To assess the current situation of solid waste management in the town
- Assess the impacts of poorly managed solid waste on the environment and health of households
- Identify factors that may affect willingness to pay of household's for improved solid waste management service;
- Estimate mean and total willingness to pay for improved solid waste management (improved environmental quality);

1.4. Significance of the Study

The increase in population and continuous urbanization increases solid waste generation in quantity and composition. To cope up with the adverse effects of the increased waste such

as: public health, environmental and aesthetic problems proper management is crucial. Therefore, this study attempts to assess the stakeholders demand side preferences to improve the current solid waste management. The outcome of this study can serve as an input for sound policy formulations to fill the gap between the demand and the supply for better solid waste management services since this is the first study conducted on solid waste management in Sululta town. It can also be used as a base information for other research that might be conducted in the study area.

1.5. Scope of the Study

The study is limited to the analysis of households' willingness to pay for improved solid waste management service of residential solid wastes only. It does not include other types of solid waste such as industrial, commercial and agricultural wastes. The sample for the study covers only household heads from four Kebele's of the town.

1.6. Organization of the Study

The remaining part of the study is organized as follows. Chapter 2 deals with a review of related literature. Chapter 3 presents the methodology of the study. Chapter 4 is concerned with discussions and findings of the research. Finally, the last chapter presents summary, conclusions and recommendations.

CHAPTER TWO: REVIEW OF RELATED LITERATURES

This chapter discusses the theoretical and empirical literature related to solid waste management, and economic valuation methods.

2.1. Theoretical Review

2.1.1. Definition of Basic Terms and Concepts

Waste: According to Penido et al. (2009) waste is defined as movable material that is perceived erroneously to be of no further use. Once discarded, it may cause no problem, a nuisance, or a hazard. In addition, waste can generally be described as any item or material that is generated and disposed of or intended to be disposed of by a person that has custody of it (Hajkowicz, et al., 2006). 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. However, definitions of waste exist based on conditions under which they occur.

Solid waste: 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 that is outside the scope this study. According to The Federal Democratic Republic of Ethiopia (FDRE, 2007), proclamation No. 513/2007 solid waste management proclamation "solid waste" means anything that is neither liquid nor gas and is discarded as unwanted. This could be refuses from residential, commercial or any institutes as yard sweeping, food remains, ash and chat leftover, saw dust, piece of papers, glasses, metals, batteries, plastic, grass and vegetables, bone of animals, dead animals and other materials that cause poor environmental situation.

Valuation: it is the process of putting monetary values on goods and services, many of which have no easily observed market prices.

Willingness to pay (WTP) is the maximum sum of money the individual would be willing to pay for rather than do without an increase in some good such as an environmental amenity. This sum is the amount of money that would make the individual indifferent

between paying for and having the improvement and forgoing the improvement while keeping the money to spend on other things (Freeman et al., 2014)

Willingness to accept (WTA) is the minimum sum of money the individual would require to forgo voluntarily an improvement that otherwise would be experienced; it is the amount that would make a person indifferent between having the improvement and forgoing the improvement while getting extra money (Freeman et al., 2014). It is designed to ask for an individual's minimum willingness to accept compensation for a decrease in the quality or quantity of the resource (Othman, n.d.)

2.1.2. Types and Sources of Solid Wastes

The knowledge about sources of solid wastes along with the information of the types will help in the process of operation of the functional elements associated with solid waste management. The types and sources of solid waste can be classified based on the sector of economy for generating them and points of origin of the material.

Based on the sector of economy responsible for generating them (Eldon & Bradley, 2006) categorized sources of solid waste into four broader kinds as mining, agricultural, industrial and municipal solid waste. Based on points of origin of the materials Rand et al. (2000) argues that there are six types of municipal solid wastes namely: domestic waste, commercial waste, industrial waste, institutional waste, street sweepings, and constructions and demolition wastes. The types and sources of solid wastes are summarized as follows in Table 1.

Table 1: Types and Sources of Solid Waste

Types of waste	Sources	Examples
Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, metals, ashes, etc.
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants	Housekeeping wastes, packaging, food wastes, hazardous wastes, etc.
Commercial	Stores, hotels, restaurants, markets, office buildings.	Paper, cardboard, plastic, wood, glass, metals, etc.
Institutional	Schools, hospitals, prisons, government centers	Same as commercial
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete
Agricultural	Dairies, poultry farms, livestock and other agricultural activities like vegetable cultivations	Bio-degradable components, i.e., organic materials
Municipal services	Street cleaning , landscaping, parks, beaches, etc.	Industrial process wastes, scrap materials, off-specification products, slag tailings

Source: Adopted from (Assefa, 2017)

2.1.3. Solid Waste Management

According to FDRE (2007), solid waste management is defined as the collection, transportation, storage, recycling or disposal of solid waste, or the subsequent use of a disposal site that is no longer operational.

Ogwuelka (2009) defines municipal waste management as the collection, transfer, treatment, recycling, resources recovery, and disposal of solid waste in urban areas. The goals of municipal solid waste management are to promote the quality of the urban

environment, generate employment and income and protect environmental health and support the efficiency and productivity of the economy.

2.1.3.1. Types of Solid Waste Management

The four most common methods of municipal solid waste management are landfilling, incineration, composting and anaerobic digestion. Incineration, composting, and anaerobic digestion are volume-reducing technologies.

Landfilling 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 humans and natural systems. Incineration is the high-temperature combustion of wastes. Non-combustible wastes should 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 startup 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 would be landfilled, or incinerated. These methods reduce the volume of wastes that can landfilled, and the final products can potentially 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).

2.1.4. Environmental Valuation of Environmental Goods and Services

According to Kolstad (2000), some environmental goods and services in the past have been assigned zero or low values, due to the difficulties involved in assigning economic values to such commodities or the assumption that they are free goods. Thus, it is important to integrate environmental values into economic decision-making processes because failure to do so can have adverse implications for not only current generations but also future generations.

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 (Bateman et al.; 1992). The basic strategy for environmental valuation is the 'commodification' of the services that the natural environment provides. The services are used by households and firms and are treated as arguments in utility and production functions, respectively (Perman et al., 2003).

Assigning of monetary values to non-marketed goods and services is referred to as valuation. A good or service has economic value if it has a positive contribution to human wellbeing. Yet, the positive contribution of a non-marketed good or service to an individual's wellbeing is determined by whether or not it satisfies his or her preferences (Pearce & Ozdemiroglu, 2002). In the absence of markets or market prices, other ways of obtaining estimates of the values of such resources are required. In response to this, economists have devised a variety of empirical tools for estimating the monetary values of environmental goods and services whose markets are not easily observed. Hence, to measure the value people attach to goods, which do not have a perfect market, or any market at all; we need to understand the concept of value.

The Economic Concept of Value

According to Freeman et al. (2014),

> *The economic theory of value is based on the ability of things to satisfy human needs and wants or to increase the wellbeing or utility of individuals. Under this view of welfare, the economic value of something is a measure of its contribution to human wellbeing. The economic value of resource-environmental systems, then, resides in the contributions that the variety of ecosystem functions and services make to human wellbeing. ... The theory also assumes that people know their preferences, and that these preferences have the property of substitutability among the market and the non-market goods making up the bundles. Value measures based on substitutability can be expressed in terms of either willingness to pay (WTP) or willingness to accept compensation (WTA).*

Total Economic Value

Given their existing preferences or tastes, individuals will possess a number of held values that 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 et al., 1992)

Use values are values that individuals attach to using up of resource or an environmental attribute by an individual. It can be categorized into direct, indirect and option use values. Direct use values refer to both consumptive and non-consumptive use that involve some observable interaction between human beings and the environment (Lee et al., 2010). Consumptive uses involve extracting a component of the ecosystem for an anthropocentric (consumption) purpose whereas non-consumptive use involves the direct use of services provided directly by the ecosystems without extraction such as the provision of recreational opportunities and scenic vistas. Indirect use values are values that are derived indirectly from ecological functions such as flood control, ground water recharge and water filtration. Option value is the value gained from keeping the option to use the good or service at some point in the future; sometimes it is treated as a special case of use value (Dixon, 2008). Non-use values refer to all values people hold that are not associated with the use of an ecosystem good or service; rather people may benefit from the knowledge that an ecosystem simply exists unfettered by human activity. Nonuse values are all remaining values aside from use values including bequest and existent values (Lee et al. 2010).

2.1.5. Techniques of Environmental Valuation

Generally, valuation methods could be broadly classified into revealed preference and stated preference methods (Freeman et al, 2014; Othman, 2002).

2.1.5.1. Revealed Preference Method

Revealed preference techniques are based on the observation of the individual choices in existing markets that are related to the environmental amenities that is the subject of valuation. In this case, it is said that economic agents ‘reveal’ their preferences through their choices. The two main methods in this approach is the travel cost and the hedonic pricing methods.

a. The Travel Cost Method

The travel cost method (TC) is mostly relevant for determining recreational values related to environmental services. It assumes the cost that the individual incurs in visiting a recreational site which can be used to estimate his/her valuation of that site. The approach involves asking question where the individuals' come from and the cost they incurred. Hence, the information collected is related to the number of visits to generate a demand curve for the recreational site under question. The information collected in a travel cost survey includes travel cost (petrol, food and other travel related expenses), income, alternative site and personal motivations.

The demand curve is then constructed using several assumptions, including that people will respond to the cost of travelling in the same way that they would respond to a site entry fee, and that the marginal (highest cost) visitor derives no benefit from visiting in excess of the cost they incur. The demand curve is used to estimate the amount of consumer surplus associated with visiting the site, or to examine how visit rates and consumer surplus might change if entry fees were increased (Moons, 2003; cited in Assefa, 2017).

Weakness of Travel Cost Method

Some of the problems that arise when using the travel cost method to make empirical estimates are; firstly, the assumption that the recreational value of a place is directly related to travel costs incurred in getting there could be an oversimplification. Secondly, it is only capable of measuring that subset of values for which people are willing to pay (through the medium of incurring travel costs to visit the site with attributes for which we seek valuations). Thirdly, it is suited to estimating the value of particular sites or location but not suited for measuring other kinds of goods or services.

b. Hedonic Pricing Method

The hedonic pricing method is used to estimate the value of environmental amenities that affect prices of marketed goods. This method is based on 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. In this method, 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 (Bennet & Blamey, 2001)

Weakness of Hedonic Pricing

The main limitation of the hedonic pricing is that it is applicable in areas where the property market is well developed and the property owners are aware of the environmental attributes or impacts and consider them in their assessment of property values. The other limitations are that it requires high degree of statistical expertise and factors such as taxes and interest rates are not accounted in the hedonic pricing equation. The fact that this method cannot be used to estimate non-use value is also another limitation (Bennet & Blamey, 2001).

2.1.5.2. Stated Preference

The stated preference path 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 benefits and costs.

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

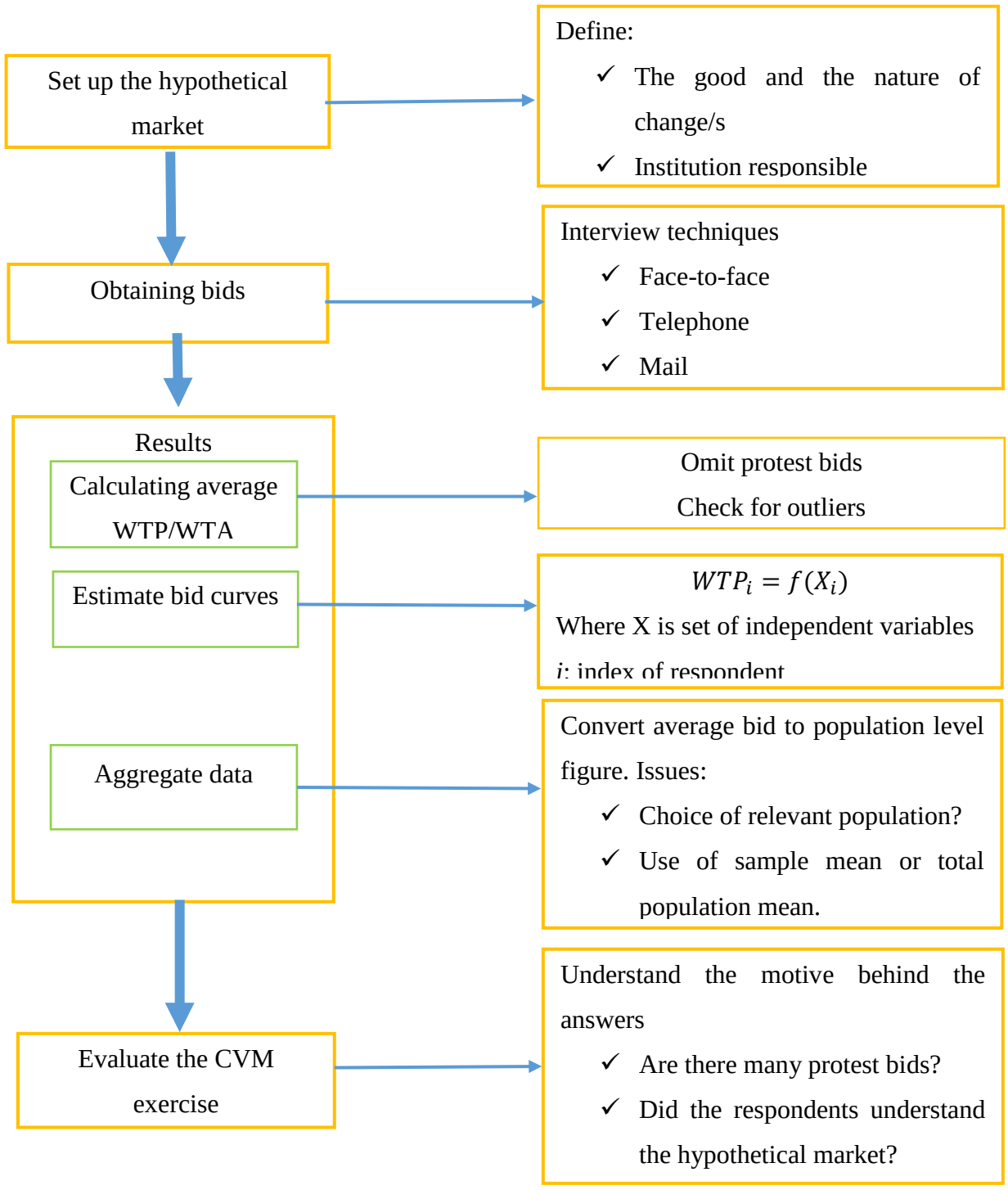
The most commonly applied methods are contingent valuation method (CVM), choice modeling/choice experiment (CM), and conjoint analysis. Both revealed and stated preference methods have their own advantages and disadvantages. Both methods can measure use values. Unlike revealed preference methods, stated preference methods such as contingent valuation and choice modeling are the most widely used methods and have been used to measure use and non- use values. Stated preference is the only option when there is no proxy market to value non-marketed goods and services (Hanemann, 1994; Perman, et al., 2003).

a. Contingent Valuation Method

Contingent valuation method is a non-market valuation method commonly used to find the economic value of environmental commodities. The valuation is termed contingent because the information sought from the survey respondents is conditional up on some particular hypothetical market context. This method involves delivering questions for a randomly selected sample of the population whether they are willing to pay or willing to accept for a clearly defined change in the provision of a good or service, or to prevent the change (Bolt et al. 2005). In the case of solid waste services, the goal of the economic analysis is to identify whether the households served would collectively be willing to pay enough of their money to finance the costs of the service (Chuen-khee & Othman, 2010). There are four most widely used value elicitation formats in CVM, such as open-ended, bidding game, payment card, and single-bounded or double-bounded dichotomous choice. The open-ended method is the first and earliest method used in which respondents are asked to state their maximum WTP for the good or service that is being valued. In the case of the payment card, respondents are asked to choose the stated WTP amount that is presented on the card with a visual aid. Hence, respondents put a tick on the monetary value that they are willing to pay and put a cross on those amounts that they are not willing to pay. Bidding game is another value elicitation format in which respondents are asked iteratively to state their WTP until a yes answer changes into a no or a no answer changes into a yes answer. In the case of dichotomous or discrete choice format, randomly assigned prices are distributed to each respondent for the non-marketed good or service in question. Then each respondent gives a yes or no answer for the stated WTP amount in case of single-bounded, and the respondent is asked higher or lower bids if he or she says yes or no, respectively in case of double-bounded (Bolt et al., 2005).

There are four main steps for designing a CV study (see Figure 1). Setting up the hypothetical market for the non-marketed good or service is the first step in which the valuation scenario should be well defined. The second step is obtaining bids using several survey techniques such as face-to-face interviews, telephone interviews, and mailed questionnaires. The third step is presenting the results of the analysis such as average WTP or WTA and the factors that affect WTP or WTA. Evaluating the CVM exercise is the final

step that entails an appraisal of how successful the application of CVM has been Bolt et al. (2005)



Source: Bolt et al. (2005)

Figure 1: Flow Chart of Designing a Contingent Valuation Study

Strengths and Weaknesses of CV Method

Contingent valuation has been the most commonly used stated preference method for non-market valuation and provides sufficient flexibility to enable the estimation of total economic values associated with environmental impacts (Jin et al., 2006). CV method is also preferable to estimate values when an item cannot be easily defined in terms of attributes or characteristics (Johnston et al., 2017). However, the method is criticized for different types of potential biases it may face during the CV survey (Tietenberg & Lewis, 2012). The first one is strategic bias that arises when respondents provide biased answers in order to influence a particular outcome. Moreover, respondents may not be willing to respond to the survey questions or to state their actual WTP for the proposed project due to strategic reasons such as if there is a free-rider situation.

Respondents may understate their true WTP for the non-marketed good or service in question if they think the proposed project will be implemented and they want to benefit from the project by thinking others will pay and this is called free-rider problem. The second one is information bias that arises when respondents are forced to value non-marketed goods or services in which they have little or no information as well as experience about the good or service in question. The quantity and quality of information provided to the respondents and the way the questions are constructed affects their WTP for the good or service in question. The third is starting point bias that arises when the WTP response of the respondents is affected by the way of determining the initial bids. The fourth one is hypothetical bias that arises when the hypothetical market is not carefully designed that leads to the divergence between the hypothetical responses and the actual payment.

The inappropriate selection of payment vehicle has also an impact on the response of respondents that force them to understate or overstate their true WTP. The fifth bias is the gaps between willingness to pay and willingness to accept compensation. Respondents state a higher and lower monetary value in the case of WTA compensation and WTP questions, respectively, for a non-marketed good or service in question.

b. Choice Modelling (CM) Method

The conjoint techniques have a conceptual foundation in Lancaster (1996), who developed his characteristics approach to the analysis of product demand (Bennett & Blamey, 2001). A common feature of this type of approach is the requirement that survey respondents consider alternatives that are described in terms of their component characteristics or attributes with different level.

The Strengths and Weaknesses of CM

Choice modeling has both strengths and weaknesses relative to the other stated preference techniques notably the CVM. Among the strengths, the most significant is the techniques' ability to produce a rich database on people's preferences to generate statistically robust model of choice. Thus, policy makers 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. CM faces some specific problems. The first one is its ability to yield a rich data set by enabling a more complex questioning process that places greater strain on respondent's cognitive capacity. The other one is if CM respondents make choices that are conditional on their expectations regarding the choices of other respondents, they may choose from those options they think have a reasonable chance of 'winning' even when this excludes their most preferred option.

According to Johnston et al. (2017), the selection between contingent valuation (CV) and choice modeling (CM) techniques such as choice experiments (CEs) is complex and should be based on respondent perceptions of the change being valued, the decision objective being considered, and the type of information required. When making a decision to choose between CV and CEs, three primary considerations are recommended: First, will the change to be valued affect specific characteristics of the item or the item as a whole, and what are the information needs of decision makers? Second, do respondents think of (and value) the change in terms of individual attributes, or as a whole? Third, how does the information presentation format affect respondents' understanding of the item to be valued? (Johnston et al., 2017).

2.2. Empirical Literature Review

The reviewed literature indicates that CVM can be used in different areas when market prices are missing and CVM is a better environmental valuation method, for it can capture both use and non-use values.

In this section, we review the most relevant empirical literature that can help us to identify the potential socioeconomic, demographic and environmental factors that can explain willingness to pay for the good under consideration.

Bhattarai (2015) studied to estimate households' willingness to pay for improved solid waste management based on a cross sectional survey of randomly selected 220 households in Banepa municipality, Nepal. The study used face-to-face interview method to collect information from the respondent. The single bounded dichotomous choice contingent valuation with open-ended follow up question was employed to elicit willingness to pay. Out of the total sampled household heads, 83 percent were willing to pay for improved solid waste management. The result showed that the mean willingness to pay is Rs 166 (USD 1.69) per household per month whereas median willingness to pay is Rs 160 (USD 1.63). The logit model results revealed that bid amount and being male respondent affects households WTP for improved solid waste management negatively and significantly. The age of respondent, household size, level of education of respondent, household income and present waste collection service affect households' WTP for improved solid waste management positively and significantly.

Alhassan et al. (2017) conducted a study to examine the effect of socio-economic, socio-psychological and situational factors on households' willingness to pay for improved solid waste management services in Accra and Tamale metropolises in Ghana. A three stage stratified probability sample design was used to collect data from 855 randomly selected households. The study used open-ended and iterative bidding game contingent valuation to elicit household's willingness to pay for improved solid waste management in the two locations. Tobit model was used to analyze factors that affect willingness to pay and the maximum amount of money that individuals were willing to pay. The results of the model revealed that educational attainment, total household income, occupation type, level of satisfaction with SWM services, attitude, subjective norm and location of the respondent

are positively and statistically significant at 1% in the entire study area. However, male household was negatively and statistically significant at 1%. The result also revealed that the mean monthly WTP per household was 15.71 GH₵, 8.99 GH₵ and 13.13 GH₵ for Accra, Tamale and the entire study area respectively.

Banga et al. (2011) studied on households' willingness to pay for improved solid waste collection service in four divisions (Nakawa, Kawempe, Rubaga, and Makindye) based on a sample of 381 households in Kampala, Uganda. The study used the double-bounded contingent valuation followed by open-ended question to elicit household's willingness to pay for improved solid waste collection service in the town. The survey also used the direct interview method to collect data from each heads of household. The result showed that 79 .8% of sampled households were willing to pay for door-to-door waste collection service.

The Spike (Probit) result showed that household income, tenure, education level, age of respondent, whether the household ever paid for garbage collection, whether solid waste is viewed by the household as the major problem and household located in Kawempe are the main factors determining the households decision of whether to pay or not for the door-to-door solid waste collection service. Income, education, whether households view solid waste as major problem, tenure and pay (whether household has ever paid for waste collection in any form) positively affected the decision to pay for improved SWM service. However, the age variable was negative and significant at 1% level of significance. From the coefficients of location dummies, only Kawempe has a positive and significant coefficient. The variables whether household reported solid waste as a major problem, whether household ever paid for waste collection in any form, gender, waste, household size are found not to significantly influence the amount a household is willing to pay for solid waste collection services. The mean WTP is Ush 2288 and Ush 2439 for open-ended question and unconditional mean WTP estimate, respectively.

Tamru (2019) conducted a study using a cross-sectional survey of 381 randomly selected respondents to investigate households' willingness to pay for improved municipal solid waste management (MSWM) in Dilla town. The survey was conducted using a direct face-to-face interview method. The study used the double bounded dichotomous choice contingent valuation method followed by the open-ended question to elicit household's

willingness to pay for improved solid waste management. The probit and Tobit models were used to investigate the determinants of households WTP maximum willingness to pay, respectively. The findings of the study showed that about 91.6 percent of the total respondents were willing to pay for improved MSWM. The results of the probit and Tobit models showed that income of households and awareness of respondents about the impacts of poorly managed solid waste on the environment have positive and significant effects on the households WTP response for the initial bids and on the household's maximum willingness to pay (MWTP), respectively. Age of the respondents and satisfaction with the existing system variables have positive and negative significant effects on the households WTP response for the initial bids, respectively. The solid waste generated by households, plan of households and duration variables have positive and significant effects on the households MWTP. The mean WTP values obtained from open-ended and double-bounded value elicitation formats are about 10.7 ETB and 12.36 ETB per month for a household, respectively.

Selamawit et al (2019) studied households' willingness to pay for improved solid waste management and associated factors among households in Injibara town, North West Ethiopia on 903 randomly selected household heads using multi-stage and systematic random sampling procedure. A pretested and standardized interviewer administered and semi-structured questionnaire was used to collect the data. The study used contingent valuation with iterative bidding game format to elicit household's willingness to pay. Tobit model was used to analyze factors that affect willingness to pay and the maximum amount of money that individuals were willing to pay. The finding of the study indicated that 81.06% were willing to pay for the service. The average amount of money the participants would be willing to pay per month was 29.7 ETB ($1.07). The study also revealed that male respondents, educational status, Occupation, amount of solid waste generated, distance from dumpsite, satisfaction with existing service and wealth status were positively and significantly affect households willingness to pay whereas age of an individual affects household's willingness negatively and significantly.

Endalew & Tassie (2018) conducted a study on urban households demand for improved solid waste management service in Bahir Dar city, Ethiopia by collecting a data from a sample of 350 households using multistage sampling technique. The study was conducted

to assess the solid waste management system and households' willingness to pay for improved solid waste management service and to analyze factors affecting households' willingness to pay in the city. Double-bounded CVM followed by the open-ended question was used by this study to elicit the households' WTP for improved SWM services. The study also employed face-to-face interviews, key informant interview and focus group discussion to collect data. Ordered probit model was used to analyze determinants of households' WTP for improved SWM services. Based on the findings of the study, 86.3 percent of the respondents were willing to pay for improved SWM services with 13 ETB mean WTP per month. In addition to this, the model result revealed that education level of household head, monthly aggregate income, access to SWM service, disease outbreak, number of children and quantity of waste generated per week positively and significantly affected households' WTP. However, male household head had a negative and significant effect on households' WTP i.e., female-headed households are more willing to pay than male-headed households are.

Dagnew et al. (2013) studied households' willingness to pay for improved urban waste management using contingent valuation method by employing single-bounded dichotomous choice format followed by open-ended follow up question. They used a cross-sectional survey data of 226 randomly selected household's from a list of households residing in six local administrations in Mekelle city. The study also employed a face-to-face interview to collect data from the respondents. Probit and Tobit models were used to identify the determinants of households' WTP for improved solid waste management system and to analyze the mean WTP of households. The empirical analysis using the probit model suggests that household income and respondents' awareness of environmental quality increase the likelihood of respondents' willingness to pay whereas older respondents are less likely to pay. In the Tobit regression, the level of solid waste generated by the household per week, education of household head, environmental awareness, house ownership, type of solid waste service demanded by the households, income of households, and marital status of household head are positively associated with WTP, while household perception of current SWM is negatively associated with WTP. The mean WTP for improved solid waste management from the single-bounded format and open-ended format was 11.89 ETB and 7.88 ETB per month per household, respectively. When compared to

the then sanitary fees, this mean WTP was much higher and gave an opportunity to increase the sanitary fee to get sufficient funds to improve the SWM in the city.

Ayenew et al. (2019) investigated household willingness to pay for improved solid waste management in Shashemene town, Ethiopia using a multistage sampling technique in order to collect data from 190 households. The study also used double-bounded followed by open-ended value elicitation formats to elicit households WTP for improved SWM. The logit model was employed to investigate the factors that affect households' WTP for improved SWM. The bivariate probit model and the maximum WTP response from the open-ended question were used to estimate mean WTP. The output of the study showed that the current solid wastes management is very poor. The mean WTP values obtained from double-bounded and open-ended value elicitation formats were USD 16 per year and USD 14 per year for a household respectively. The income of households, level of education, and amount of solid waste generated were the significant factors that affect households WTP positively. Household size, age of respondents, and amount of bids were the factors that significantly affect households WTP negatively.

Maskey & Singh, (2017) conducted a study on household's willingness to pay for improved waste collection service in Gorkha municipality of Nepal on 401 selected households using a stratified sampling method from all 15 wards. The study was conducted using face-to-face interview method and open-ended value elicitation format of contingent valuation method to elicit households' WTP. The logit and Tobit regression model was used to determine factors influencing WTP and the maximum amount households are willing to pay for improved waste collection service, respectively. The majority of households 61% were willing to pay an average amount of NRs. 73.38 (0.72 US$) per month. Results of the logit model revealed that monthly household income, education of household head, environmental awareness and waste collection service are factors that significantly and positively influence households' WTP for improved solid waste collection service. Except for education of household head, all these variables significantly and positively influence the maximum amount of money households are willing to pay for improved solid waste collection service in the Tobit model.

Tesfa, (2019) studied on households' willingness to pay for water hyacinth control to Lake Tana using a stratified sampling technique from 398 households in Bahir Dar city, Ethiopia by applying contingent valuation method. The face-to-face interview and the payment card elicitation method was used to collect data from households in the city. The Tobit model was used to analyze factors that influence the maximum willingness to pay for water hyacinth control for a one-time donation. The majority (96%) of the households in Bahir Dar are willing to pay for water hyacinth control for a one-time donation. The Tobit regression result showed that variables such as households income, household size, number of households member having a job, education and awareness of water hyacinth as a problem are positively and significantly influence the maximum willingness to pay for the water hyacinth control for a one-time donation. The results of the study also showed that the mean and total contribution for the water hyacinth control was about 1,011.4 ETB and 77,624,226.2 ETB, respectively.

CHAPTER THREE: METHODOLOGY

3.1. Description of the Study Area

Sululta town was established in 1929 E.C. It has served as an administrative town of Sululta Woreda. The town is found in Oromia Regional State Special Zone surrounding Finfine. It has an area of 4,470.5 hectares and is located 23 kilometer from Addis Ababa to the north. Geographically, Sululta town is located between $38^{0}7579'$E longitude and $09^{0}1784'$N latitude and has an altitude ranging from 2600-3200 meters above sea level. The average annual rainfall ranges from 800-1200 millimeters (mm) and the mean annual temperature ranges from 18-22 degree Celsius (°C) (SFEDB, 2019). Sululta town is bordered by Addis Ababa city in the southern part, Sululta Woreda in the northern, western and eastern directions, respectively. The estimated total population of the town is 136,075 of which 65,888 and 70,187 are males and females, respectively. The town has four Kebeles namely Sululta 01, Kaso Weserbi, Nono Mana Abbichu and Wale Lube with a total population of 45,535, 39,768, 30,587 and 20,185, respectively (SFEDB, 2019).

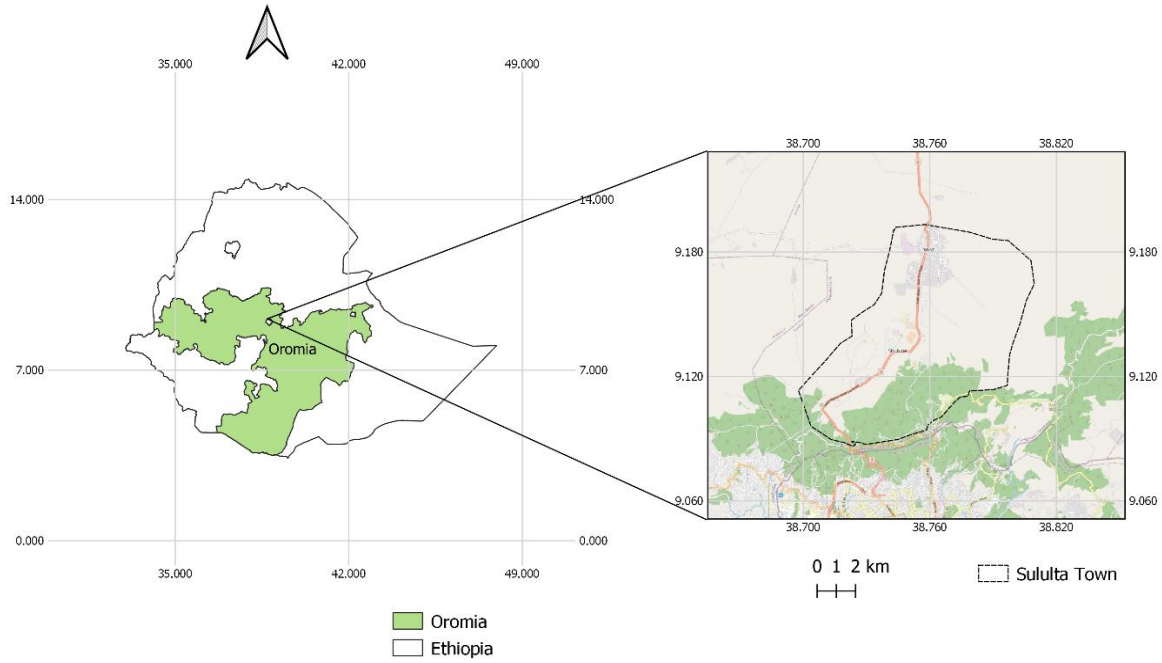


Figure 2: Map of the Study Area

3.2. Sampling Techniques and Survey Administration

This study depends on a cross-sectional data survey on households of Sululta town to assess the willingness to pay for improved solid waste management services. Stratified sampling technique was used to collect data from households from the four Kebeles (the smallest administrative unit in the country) of the town. The study covered all the four Kebeles of the town. Thus, the sample size for this study was calculated using a simplified formula for proportions that was introduced by using Cochran(1977).

$$n = \frac{z^2 pq}{e^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where,

n is the sample size,

z is the selected critical value of desired confidence level taking 95% confidence level,

p is the estimated proportion of an attribute (households willing to pay for the improved solid waste management service) that is present in the population assuming the maximum variability which is equal to 50% ($p = 0.5$), $q = 1 - p$ and

e is the desired level of precision with $\pm 5\%$.

The initial sample size calculated for the present study was 385. However, after a consideration of 4% non-response rate, the sample size was adjusted to 400 households. The number of households in the town was calculated by dividing the total number of population by five which is the average family size of the country (CSA & ICF, 2017). The total 400 sample households were selected from the four Kebeles based on the household share of each Kebele household number of the town. The allocated sample sizes for each of the Kebele are shown in Table 2.

Table 2: Sample Selection from Total Households of Sululta Town

Kebele	Population	No. of household	% of total household	Selected sample size (400 * %)
Sululta 01	45,535	9,107	33.5%	134
KesoWeserbi	39,768	7,954	29.2%	117
Nono M/Abichu	30,587	6,117	22.5%	90
Wale Lube	20,185	4,037	14.8%	59
Total	136,075	27,215	100.00	400

Source: Sululta Town Finance and Economic Development Bureau and own calculation

The data for this study was collected from each selected households by counting 68 houses going in zigzag way. The required information for this study was collected from April 8 to May 01, 2020 using a direct face- to face interview method. In order to collect the information from the respondents' four economics undergraduates, one engineering graduate and one Master of Science in natural resource and environmental economics student participated as enumerators. The researcher supervised the daily activities of the data collection and provided feedback to the enumerators on daily basis. The data was collected in Afan Oromo, the widely spoken language in the area, and in Amharic.

In order to determine the starting bid price, discussion was held with the focus group discussion (FGD) which included the municipality official, the community representative and members from service provider in the town. In addition, a pilot survey on 20 randomly selected households living in Sululta town was also conducted. The pilot survey was conducted in a different area where the main survey was conducted to avoid sample duplication and information contamination. The pilot survey was conducted in order to determine four initial bids or starting point prices using open-ended questions, to determine the payment vehicle for the CV scenario, and to revise the final questionnaire before the main survey is conducted. Based on the results of the pilot survey, the four initial bids were 20 ETB, 50 ETB, 80 ETB, and 100 ETB. Out of the 20 surveyed households during the pilot survey, all of them were WTP for improved solid waste management. Among the willing households in the pilot survey, 65 percent (13) chosen to pay for the improved solid waste management service on the service provision monthly to the service provider.

The main survey was conducted by dividing the randomly selected respondents from each Kebele into four based on the initial bid prices. All respondents within each Kebele have an equal chance to get the four initial bids. One hundred questionnaires were distributed for every initial bid.

Table 3: Questionnaire Distribution Based on Initial Bid

Kebele	Selected sample size	Distributed questionnaire based on initial bids			
		ETB 20	ETB 50	ETB 80	ETB 100
Sululta 01	134	33	33	34	34
KesoWeserbi	117	29	30	29	29
Nono M/Abbichu	90	23	23	22	22
Wale Lube	59	15	14	15	15
Total	100	100	100	100	100

3.3. Design of Survey Questionnaire and Valuation Techniques

The design of the survey followed the recommendations from the National Oceanic and Atmospheric Administration (NOAA) Panel (Arrow et al., 1993; Mitchell & Carson, 1989), and consisted of four sections. The first section is about respondent's awareness of the current situation with solid waste in the town. The second section of the survey covered general environmental and health related problems and the proposed SWM improvement scheme. The improved SWM scenarios detail: the services to be provided, the reliability of services, the current waste management problems in the town, the hypothetical improved condition, and how each consumer would pay for the improvement (payment vehicle). The third section of the survey probed respondents about their willingness to pay, and the fourth section asked the respondents about their socioeconomic and demographic conditions.

This study employed contingent valuation that uses survey techniques in order to elicit household's willingness to pay for improved solid waste management in Sululta town. The double-bounded dichotomous choice elicitation format followed by open-ended elicitation format was used in order to elicit WTP of households for improved SWM in the town. The double-bounded dichotomous choice elicitation format with follow-up question was first proposed and implemented by (Mitchell & Carson, 1989). The double-bounded dichotomous choice is better than the single-bounded dichotomous choice format in terms of increasing efficiency in three ways (Haab and McConnell, 2002). First, it provides information about respondents WTP. Second, a "Yes" followed by a "No" and a "No" followed by a "Yes" response of the respondents for the sequential offer bids provides clear bound on WTP. Third, for the "No-No" and "Yes-Yes" combinations, there is also

efficiency gain from the further WTP questions even though the responses do not provide a clear bound on the WTP of a respondent.

According to Hanemann et al., (1991), there are four possible responses from the respondents such as both answers are "Yes", both answers are "No", a "Yes" followed by a "No" and a "No" followed by a "Yes". Suppose the initial and follow-up bid values are t_i^1 and t_i^2, respectively. Hence, the response of each respondent falls under the four categories. First, if the respondent says "Yes" to the initial and follow-up bids $t_i^2 \leq WTP < \infty$. Second, if the respondent says "No" to the initial and follow-up bids $0 < WTP < t_i^2$. Third, if the respondent says "Yes" to the initial bid and "No" to the follow-up bid, $t_i^1 < t_i^2$ and $t_i^1 < WTP < t_i^2$. Fourth, if the respondent says "No" to the initial bid and "Yes" to the follow-up bid, $t_i^2 < t_i^1$ and $t_i^2 \leq WTP < t_i^1$ (Lopez-Feldman, 2012; Haab and McConnell, 2002).

According to Hanemann et al., (1991), the likelihood of the four outcomes are $\pi^{YY}, \pi^{NN}, \pi^{YN}$ and π^{NY}. Suppose t_i^1, t_i^{2u} and t_i^{2l} represents the initial bid, second upper bid and second lower bid for respondent i, respectively. Assuming the respondent always wants to maximize his or her utility, the formulas for these likelihoods are presented as follows.

$$\pi^{YY}(t_i^1, t_i^{2u}) = prob\{t_i^1 \leq maxWTP \text{ and } t_i^{2u} \leq maxWTP\}$$

$$= prob\{t_i^1 \leq maxWTP | t_i^{2u} \leq maxWTP\}$$

$$= prob\{t_i^1 \leq maxWTP\}$$

$$= 1 - G(t_i^{2u}, \theta) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

$$\pi^{NN}(t_i^1, t_i^{2l}) = prob\{t_i^1 > maxWTP \text{ and } t_i^{2l} > maxWTP\}$$

$$= G(t_i^{2l}; \theta) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

$$\pi^{YN}(t_i^1, t_i^{2u}) = prob\{t_i^1 \leq maxWTP \leq t_i^{2u}\}$$

$$= G(t_i^{2u}; \theta) - G(t_i^1; \theta) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

$$\pi^{NY}(t_i^1, t_i^{2l}) = prob\{t_i^1 \geq maxWTP \geq t_i^{2l}\}$$

$$= G(t_i^1; \theta) - G\left(t_i^{2l}; \theta\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

Where $G(.)$ represents cumulative distribution function (CDF) and θ represents the parameters of this distribution. Therefore, the log-likelihood function for the set of responses given a sample of N respondents can be formulated as follows.

$$LnL^s(\theta) = \sum_{i=1}^{N} \left\{ d_i^{YY} ln\pi^{YY}(t_i^1; t_i^{2u}) + d_i^{nn} ln\pi^{nn}\left(t_i^1; t_i^{2l}\right) + d_i^{YN} ln\pi^{YN}(t_i^1; t_i^{2u}) \right.$$
$$\left. + \; d_i^{NY} ln\pi^{NY}\left(t_i^1; t_i^{2l}\right) \right\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

Where $d_i^{YY}, d_i^{NN}, d_i^{YN}\ and\ d_i^{NY}$ are binary-valued indicator variables, $d_i^{YY} = 1$ if the respondent says "Yes" to the first and second higher bid and $d_i^{YY} = 0$ otherwise. $d_i^{NN} = 1$ if the respondent says "No" to the first and second lower bid and $d_i^{NN} = 0$ otherwise; $d_i^{YN} = 1$ if the respondent says "Yes" to the initial bid and "No" to the second higher bid and $d_i^{YN} = 0$ if the response is otherwise; $d_i^{NY} = 1$ if the respondent says "No" to the initial bid and "Yes" to the second lower bid, and $d_i^{NY} = 0$ if the response is otherwise. The maximum likelihood (ML) estimator for the double-bounded model is the solution to the first order condition:

$$\frac{\partial LnL^s(\hat{\theta})}{\partial \theta} = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 7$$

3.4. Contingent Valuation Scenario

A hypothetical market scenario was described to the respondents in order to help them to elicit their WTP for improved SWM service in Sululta town. The impacts of poorly managed solid waste and the importance of improved SWM was described to the respondents before the interview. The scenario was expressed as follows:

> In Sululta town, due to the rising human population, increased economic activities, changing consumption patterns and urbanization, there is a rapidly growing problem of sanitation due to unsound solid waste disposal. However, attention is not given to the problem and due to this; the sanitation of the town has become a serious issue from time to time. If adequate attention is not given to the management of solid waste generated in the town, it causes an adverse effect on the environment, human health and the economy.

Therefore, the aim of this study is to improve environmental conditions of residents of the town and to recommend solution for the existing problem based on your information. The proposed idea is to collect solid waste products from each household's home twice weekly by individuals organized by Micro and Small Enterprise (MSE) who use horse or donkey driven carts to transport it safely to the disposal site, and make quality compost from decomposable solid waste. The non-decomposable solid wastes are managed separately by recycling those that can be recycled and the non-recyclables are taken to the landfill located to the eastern side of the town.

The benefits you derive from this improved solid waste management (environmental quality) are more attractive and pleasant human settlement, social amenity and cleaner environment. Because of proper and regular disposal of waste, we might get safe drinking water, control of rodents and flies, reduction in bad odor predominant in most parts of the town. This kind of service will be delivered on regular and sustainable basis if you agree to pay some amount of money for the operators of this activity on monthly basis on service provision. Therefore, we would like you to think carefully about your monthly expenditure on other goods and services before deciding on what amount your household can pay for support of the new solid waste management (SWM) service in the town. If the regular improved SWM service is provided to you, are you willing to pay for this service?

Here, each respondent receives one randomly selected initial bid from the four initial bids. If the individual responds "yes" to the initial bid, he or she was asked the second higher bid, which was twice the initial bid. If the respondent says "no" to the initial bid, he or she was asked the second lower bid, which was half of the initial bid. After the respondent answered the second round question by saying either "yes" or "no", he or she was asked to state his or her maximum WTP per month for the service.

3.5. Data Analysis

Descriptive analysis was used in the study in order to determine the measure of dispersion and central tendency of the collected data. The determinants of household's willingness to pay for improved SWM were analyzed by employing probit and Tobit regression models. Moreover, the study used the '*doubleb'* command created by (Lopez-Feldman, 2012) to

estimate the average WTP from the double-bounded format. All analyses were conducted using STATA version 14.

3.5.1. The Probit Model

Probit model was used in this study in order to identify the determinants of household's WTP for the improved solid waste management in Sululta town. The probit model is based on the assumption that there exists an underlying latent or unobservable variable y^*. The error term is normally and independently distributed with zero mean and constant variance of one, and independent of explanatory variables (Cameron & Trivedi, 2005). According to Verbeek (2012), the Probit model can be specified as follows:

$$y_i^* = x'_i\beta + \varepsilon_i\,, \qquad i = 1, 2, \dots, N, \quad \varepsilon_i \sim NID(0,1) \dots\dots\dots\dots\dots\dots\dots 8$$

$$y_i = 1 \qquad if\ y_i^* \geq t_i^1$$

$$y_i = 0 \qquad if\ y_i^* < t_i^1$$

Where y_i^* is unobserved actual WTP of households for an improved SWM service in Sululta town. In addition, y_i is actual WTP of households for the service that takes binary responses; t_i^1 represents initial bid offered arbitrarily to respondent i; x_i is the vector of independent variables that affect households WTP; β is a vector of coefficients and ε_i is error term that assumed to follow a standard normal distribution.

Since the dependent variable is a non-linear binary response model, the model cannot be estimated using ordinary least squares. Hence, maximum likelihood methods are necessary for estimation of limited dependent variable models. Therefore, this study employed maximum likelihood method to estimate parameters of the probit model. Maximization of the log-likelihood function of the probit model with respect to the parameters β leads to the maximum likelihood estimators. The coefficients of the explanatory variables reveal the signs of the partial effects of each X_i on the response probability (Wooldridge, 2012).

$$LogL\,(\beta, \sigma) = \sum_{i=1}^{N} y_i\, log\Phi\left(\frac{x_i'\beta}{\sigma}\right) + \sum_{i=1}^{N} (1 - y_i) \log\left(1 - \Phi\left(\frac{x_i'\beta}{\sigma}\right)\right) \dots\dots\dots 9$$

In order to identify the factors determining the WTP from the double-bounded dichotomous value elicitation format, this study employed bivariate probit model.

According to Greene (2003), the bivariate probit model is a natural extension of the probit model. The system of equation can be estimated as seemingly unrelated bivariate probit (SUBVP) model, if the error terms in the bivariate probit model follow normal distributions (Haab and McConnell, 2002). Hence, this study used SUBVP model in order to determine the relationship between the bids offered and other covariates with WTP from the double-bounded dichotomous value elicitation format. The general specification of the bivariate probit model for this study can be described as follows (Greene, 2003; Cameron & Trivedi, 2005).

$$y_{1i}^{*} = x'_{1i}\beta_1 + \varepsilon_1; \quad y_{1i} = \begin{cases} y_{1i}^{*} = x'_{1i}\beta + \varepsilon_1 & if\ y_{1i}^{*} \geq t_i^1; \\ 0 & otherwise \end{cases} \ldots\ldots\ldots\ldots\ldots 10$$

$$y_{2i}^{*} = x'_{2i}\beta_2 + \varepsilon_2; \quad y_{2i} = \begin{cases} y_{2i}^{*} = x'_{2i}\beta + \varepsilon_2 & if\ y_{2i}^{*} \geq t_i^2; \\ 0 & otherwise \end{cases} \ldots\ldots\ldots 11$$

$$E(\varepsilon_1|x_1, x_2) = E(\varepsilon_2|x_1, x_2) = 0$$

$$Var(\varepsilon_1|x_1, x_2) = Var(\varepsilon_2|x_1, x_2) = 1$$

$$Cov(\varepsilon_1, \varepsilon_2|x_1, x_2) = \rho$$

Where y_{1i}^{*} and y_{2i}^{*} are i^{th} respondents unobserved true WTP; y_{1i} and y_{2i} are actual WTP of respondents that takes binary responses for the initial and follow-up bids offered and other explanatory variables; t_i^1 and t_i^2 are the initial and follow-up bids offered for respondent i respectively. Besides, x_1 andx_2 are vectors of exogenous variables; β_1 and β_2 are vector of parameters to be estimated; ε_1 and ε_2 are their respective error terms, assumed to follow normal distributions with mean zero and variance one for the first and second equations of the bivariate probit model; ρ is the correlation coefficient that denotes the covariance between the error terms.

3.5.2. The Tobit Model

The Tobit model or censored regression model is an extension of a Probit model that expresses the observed response y_i in terms of an underlying latent or unobserved latent variable y_i^{*} that satisfy the classical linear model assumptions (Gujarati, 2004; Wooldridge, 2004). This model was used in order to analyze the factors that affect households maximum willingness to pay (MWTP) obtained from the respondents using open-ended value elicitation format. The standard Tobit model can be formulated as follows.

$$y_i^* = x'_i\beta + \varepsilon_i\,, \qquad i = 1,2,\dots,N, \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 12$$

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

$$y_i = 0 \quad if\ y_i^* \le 0,$$

Where y_i^* is the unobserved MWTP of a household for improved SWM service, y_i is dependent variable that is actual MWTP of a household for improved solid waste management service, x_i is the vector of explanatory variables which affect households maximum WTP. β is a vector of parameters and ε_i is disturbance term and, assumed to be normally and independently distributed with zero mean and constant variance σ^2 and is independent of x_i (Verbeek, 2012). The maximum likelihood method was used for this study to estimate the Tobit model. The log-likelihood function of the Tobit model can be written as follows.

$$logL_1(\beta,\sigma^2) = \sum_{i\in \mathrm{I}_0} \log P(y_i = 0) + \sum_{i\in I_1} [\log f(y_i|y_i > 0) + \log P(y_i > 0)] \dots\dots\dots\dots 13$$

Where,

$f(.)$ is a generic notation for the density function,

The last equality follows from the definition of conditional density. The index I_0 and $\mathrm{I}_1$are defined as the set of those indices corresponding to the zero and the positive observations respectively. The maximum likelihood estimation can be obtained via maximizing the function with respect to β and σ (Verbeek, 2012)

$$logL_1(\beta,\sigma^2) = \sum_{i\in \mathrm{I}_0} log\left[1 - \Phi\left(\frac{x'_i\beta}{\sigma}\right)\right] + \sum_{i\in \mathrm{I}_0} log\left[\frac{1}{\sqrt{2\pi\sigma^2}} exp\left\{-\frac{1}{2}\frac{(y_i - x'_i\beta)^2}{\sigma^2}\right\}\right] \dots 14$$

Where $\Phi(.)$ is the standard normal cumulative distribution function (CDF)

3.5.3. Variables Selection for the Model

The dependent variable used for the econometric model in this study is households willingness to pay (WTP) for improved solid waste management service and households maximum willingness to pay (MWTP) for improved solid waste management, respectively. The selection of explanatory variables for the probit and Tobit models was based on theoretical considerations and previous studies, i.e., significant variables used in other studies on household's willingness to pay for improved solid waste management. The description of variables used in this study is presented in Table 4 below.

Table 4: Description of Explanatory Variables

Variables	Description	Unit of measurement
Income	Monthly household expenditure	Ethiopian Birr (ETB)
Environmental awareness	Awareness of the respondent about the impacts of poorly managed solid waste on the environment	1 = Aware 0 = Not aware
Health effect of improper waste	Whether improper solid waste generated affect households making members unable to engage in productive works due to sickness	1= Yes 0 = No
Amount of solid waste generated	Amount of solid waste generated by the household	In sacks (50 kg) per week
Current situation of SWM	Households perception on current solid waste management	1 = Good 0 = Otherwise
Sex	Gender of the household head	1 = Male 0 = Female
Age	Age of the household head	Years
House ownership	The ownership of the house the household lives in	1 = Owned 0 = Rented
Duration of residence	Period of time the household lived in the town	Years

Variables	Description	Unit of measurement
Marital status	The marital status of the household head such as married, unmarried, divorced and widowed	1 = Married 0 = Otherwise
Education	The level of education attained by the household head	1 = primary & above 0 = Otherwise
Households plan	The plan of a household to live permanently or temporarily in the town	1 = Permanently 0 = Temporarily
Household size	Number of adults and children feeding from the same source	Number of individuals

Income: This variable refers to the total monthly income (total monthly expenditure used as proxy) of household in Ethiopian Birr (ETB). Many studies found that income is positively and significantly related to households WTP for improved SWM (Endalew & Tassie, 2018; Selamawit; 2019; Tamru, 2019; Alhassan; 2017). In this study, income is one of the major determinants of households WTP and hypothesized to affect positively households WTP for improved SWM in Sululta town.

Awareness (Awarenv): Awareness of households about the impacts of poorly managed solid waste on the environment has a significant effect on the respondents' WTP for improved SWM service. Theoretically, households with higher awareness about the impacts of unsound solid waste disposal on the environment tend to provide positive and have higher WTP values. As in other studies in the literature, households' awareness about the impacts of poorly managed solid waste is expected to affect positively their WTP for improved SWM service in Sululta (Tamru, 2019; Dagnew, et al., 2013).

Health effect (Heffect): This variable refers to whether improper solid waste generated affect households daily life via making members unable to engage in productive works due to sickness or not. It is expected that households whose members are unable to engage in productive works due to sickness caused by improper solid waste generated are more willing to pay for the improved solid waste management service. Thus, this study expects a positive relationship between health effect and WTP.

Amount of solid waste generation (Amountswg): This variable refers to the amount of solid waste generated by a household in sacks (50 kilograms) per week. It is expected that households' willingness to pay for improved SWM increase as the amount of solid waste generated increases. Thus, in this study solid waste generation variable is expected positively to affect households WTP. As in other studies in literature, amount of solid waste generated is positively and significantly related to households WTP for improved SWM (Tamru, 2019; Ayenew et al.,2019).

Current situation of SWM (Csitu): This variable refers to the perception that the household head has on how the solid waste is managed in the area. It is assumed that households who perceive solid waste management as well are less willing to pay for the improved service. Thus, this study assumes that there is a negative relationship between the current situation of solid waste management and WTP for households who perceive solid waste management as good in Sululta town (Dagnew et al., 2013).

Sex: This variable refers to the sex or gender of the household head. It is assumed in many societies that, women have more preference for improved solid waste management and are responsible for the management of household sanitation, child care and food preparation. Therefore, this study expects the positive relationship between female household head and the households WTP for improved SWM service and thus, female-headed households are more willing to pay for improved SWM as findings of other studies indicated (Endalew & Tassie, 2018; Bhattarai, 2015)

Age: This variable refers to the age of the household head in number of years. Studies conducted on households WTP for improved SWM found that age of household affects the willingness to pay significantly. Hence, this study expects the age of the household head to affect positively the household's WTP for improved SWM as other studies in the literature (Alhassan et al., 2017; Selamawit et al., 2019).

House Ownership (Hownership): This variable refers to whether the household live in owned or rented house. Respondents that own a house are expected to care more for their homes than those who live in rented houses. Hence, the household will be more willing to pay for better SWM as compared to a household that lives in a rented house (Banga et al., 2011; Dagnew et al., 2013). This study expects the positive relationship between house

ownership and WTP variables. Thus, those people who owned their own house will be more willing to pay for improved SWM than people who live in a rented house.

Duration of Residence (Duresidence): This variable refers to the number of years that a household lived in Sululta town. Households who lived for a longer period will be more willing to pay for improved SWM (Tamru, 2019). Hence, this study expects the positive relationship between the duration households stayed in the town and their WTP for improved SWM service.

Current Marital Status (Cmarr): This variable refers to the marital status of the household head categorized under married and otherwise. Married households generate more amount of solid waste and thus, are more willing to pay for improved SWM as compared to those household heads who are unmarried, divorced or widowed (Alhassan,et al., 2017). As a result, this study expects the positive relationship between marital status and WTP of households.

Education (Educ): This variable refers to the level of education the household head attained on formal education. Educated people better understand the impacts of improper solid waste management on the environment and are more willing to pay for improved solid waste management service. Thus, the level of education of a household head is expected to affect positively households WTP for improved SWM as in other similar studies in the literature (Alhassan et al., 2017; Banga et al., 2011).

Household Plan (HHpresidence): Households may have a plan to move from their current residence to other places or urban areas due to many reasons. For instance, inter-communal conflict is one reason that forces households to move from one to another place. Internal displacement in Ethiopia is increasing in recent years due to the inter-communal conflict in several parts of the country. Displacement of people in the county has significant negative effects on the lives and livelihoods of people (UNOCHA, 2019). As in other studies, this study expects that households who planned to live permanently in the town are more willing to pay than those who planned to live temporarily in the town (Tamru, 2019).

Household size (HHsize): This variable refers to the total number adults and children currently living in the house and feeding from the same source. When the number of

individuals in a household increases, the amount of solid waste generated will rise and thus the household head will be more willing to pay for improved SWM service (Tesfa, 2019; Bhattarai, 2015). Therefore, household size is expected positively to affect households WTP in this study.

3.5.4. Mean and Aggregate WTP Estimation

One of the main objectives of estimating empirical WTP model based on the CV survey response is to draw central measure or mean and median of the willingness to pay distribution (Hanemann, 1984). Two options such as the mean and the median can be used to calculate the average willingness to pay (AWTP) across respondents (Perman et al., 2003). So far, there is no consensus on the choice between the mean and the median as the better and appropriate measure of welfare. The median is affected less by a few very high WTP responses that are known as outliers. The mean WTP is the theoretically correct measure and is relevant in the case of cost-benefit analysis. Whereas, the median is important in the case of public choice or the economic analysis of political decisions due to its more weight on the majority (D. Pearce & Ozdemiroglu, 2002). Therefore, this study used mean WTP to estimate AWTP of respondents from the responses of both open-ended and double-bounded value elicitation formats since the proposed project is related to cost-benefit analysis.

The treatment of outliers and protest responses significantly affects the median and especially the mean WTP. There are two ways of treating outliers in CVM and one of the two ways can be used to solve the problem (Gunatilake, 2003). In the first approach, the selection of outliers is determined by the researcher by putting a criterion on the share of WTP of respondents from their income (Freeman et al., 2014). The decision is deleting all MWTP values of respondents greater than '*x*' percent of their income where the researcher determines the x percent. In the second way, high valuations are reduced to some maximum plausible amount. This study used the first way of treating outliers considering an '*x*' value of 5% of the household income. Protest responses are usually excluded from the calculation or estimation of mean WTP (Perman et al., 2003).

There is no established procedure for classifying protest responses as protest zero bids to exclude them from the WTP estimation (Meyerhoff & Liebe, 2006). This study treated

protest zero bid as protest responses of respondents. However, all protest zero bids were not excluded from the estimation of mean WTP. The real protest zero bids were distinguished based on the households response to the debriefing questions asked to state their reasons for unwilling to pay for improved SWM service. The mean WTP obtained from open-ended value elicitation format is the sum of each respondent's maximum willingness to pay (MWTP) divided by the total sample size.

$$Mean\ WTP = \frac{\sum_i^n MWTP_i}{n} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 15$$

Where n is the total sample size and $MWTP_i$ is the maximum willingness to pay of respondent i obtained from the open-ended value elicitation format. To calculate the mean WTP from the double bounded discrete value elicitation format, the '*doubleb'* command created by (Lopez-Feldman, 2012) is used. Since the '*doubleb'* command directly estimates, $\hat{\beta}$ the WTP formula is simply $\tilde{z}'\hat{\beta}$. In case with no control variables WTP is simply the constant. With the inclusion of the covariates, the WTP evaluated using the average values for the explanatory variables. After the estimation of mean WTP value, the next step is converting mean WTP to the total population level. This step is an aggregation of WTP by multiplying the mean WTP by the relevant total population (Perman et al., 2003). The relevant total population for this study is the total number of households living in Sululta town. Hence, the total or aggregate WTP is mean WTP multiplied by the total number of households (N).

$$Total\ WTP = Mean\ WTP \times N \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 16$$

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Descriptive Analysis

The 400 questionnaires used in the survey were distributed to the randomly selected respondents based on the four initial bids. Out of the total 400 distributed questionnaires, 392 questionnaires were successfully completed. Eight questionnaires were not successfully completed and excluded from the analysis part making the response rate 98%.

4.1.1. Demographic and Socioeconomic Characteristics of Respondents

The survey results showed that 217 (55.4%) and 175 (44.6%) of the total respondents were male and female, respectively. The educational attainment of the respondent showed 132 (33.7%), 107 (27.3%), 89 (22.7%) and 64 (16.7%) have primary, secondary, above secondary and no education, respectively. The occupation of the respondents showed that 174 (44.4%), 94 (24%), 59 (15%), 26 (6.6%), 23 (5.9%) and 16 (4%) are self-employed, unemployed, civil servants, traders, farming and others (daily laborer and pensioner, etc.), respectively. The marital status of respondents revealed that 332 (84.7%) of the respondents are married. The other remaining 33 (8.4%), 17 (4.3%) and 10 (2.6%) are single, widowed and divorced, respectively. The house ownership status of the respondents showed that 302 (77%) have their own house and 90 (23%) percent have rented from others (Table 5).

The survey revealed that the majority, 360 (91.8%) of the respondents had a plan to live in the town permanently whereas 32 (8.2%) had a plan to live in the town temporarily. Those respondents who have planned not to live in the town for a long period were asked to mention the reason that forced them to leave the town. Out of 32 respondents who planned to live temporarily in the town, 19 (59.4%), 8 (25%), and 5 (15.6%) have selected “searching for better livelihood in other places”, “the environmental situation or condition is not suitable to live in” and “the political situation does not invite to live ”, respectively (Table 5).

Table 5: Respondent's Characteristics: Summary of Categorical Variables

Variables	No.	Percent
Sex		
Male	217	55.4
Female	175	44.6
Educational Attainment		
Primary	132	33.7
Secondary	107	27.3
Above secondary	89	22.7
No education	64	16.3
Occupation		
Self-employed	174	44.4
Unemployed	94	24.0
Civil servant	59	15.0
Trader	26	6.6
Farming	23	5.9
Others	16	4.0
Marital Status		
Married	332	84.7
Single	33	8.4
Widowed	17	4.3
Divorced	10	2.6
House Ownership		
Own	302	77.0
Rented	90	23.0
Plan to Reside Permanently		
Yes	360	91.8
No	32	8.2

Source: Own Survey

The survey result in Table 6 below reveals that the average age of the respondents is 37.3 years with a minimum of 18 years and maximum of 85 years. Furthermore, the study results also showed that the mean number of years that household lived in the area (town) is 16.4 years with a minimum of one year and maximum of 72 years. The average total monthly income of the household is 5,563.2 ETB with a minimum and maximum of 850 ETB and 28,740 ETB respectively. The mean household size is 4.2 with a minimum of one and maximum of 11 members.

Table 6: Respondents Characteristics: Summary of Continuous Variables

Variables	**Mean**	**Std. Dev.**	**Min**	**Max.**
Age	37.3	10.7	18	85
Household Size	4.2	1.7	1	11
Time Spent in the Area	16.4	16.2	1	72
Total Monthly income	5,638.2	3,690.2	850	28,740

***Source**: Own Survey*

4.1.2. Households' Response for Current Situation of SWM in Sululta Town

The result in Table 7 below shows that a large number of respondents 320 (81.6%) said females are the responsible person for solid waste management in the household. A small number of respondents 56 (14.3%), 12 (3.1%), and four (1%) said males, children and others such as individuals hired for solid waste collection, respectively are the responsible persons in the household for the management of solid waste. About half 197 (50.3%) and a little more than one-fourth 111 (27.5%) and 78 (19.8%) of the respondents evaluated that the current situation of solid waste management as bad, very bad and good, respectively *(Table 7)*.

Table 7: Households response to questions about SWM and evaluation of current SWM in the town [n=392]

Responsible person for SWM in the household	**No**	**Percent**
Females	320	81.6
Males	56	14.3
Children	12	3.1
Others	4	1.0
Evaluation of current situation of SWM		
Bad	197	50.3
Very bad	108	27.5
Good	78	19.8
I can't judge	7	1.8
Very good	1	0.3
I don't know	1	0.3

Source: Own Survey

The average solid waste generated per week by households is 0.79 sack with a minimum of 0.25 sack and a maximum of four sacks. Table 8 shows the majority which is about 246 (61.3%) and 205 (51.2%) of the total respondents practiced open air burning of solid waste in or outside of their compound and collected by service providers, respectively. About 101 (25.3), 37 (9.3%) and 27 (6.7%) of the total respondents use private disposal well, throw in an open space or on the street and use other methods of disposal (such as burying, use as compost, etc.) respectively. Here, we observe that the total percentage of responses for the method of disposal is greater than 100 percent because many of the respondents used more than one methods of waste disposal. The respondents were also asked about who is the responsible body for solid waste management in the town. The results of the survey showed that 283 (70.7%) and 277 (69.3) of the total respondents said the municipality and the households are responsible for the solid waste management in the town, respectively. The remaining 13 (3%) of the total respondents said both the municipality and the households are responsible for the management of solid waste in the town *(Table 8).*

Table 8: Households response for methods of disposal and responsible body for SWM in the town

Method of Disposal	No.	Percent of Responses	Percent of Cases
Open air burning	246	39.8	61.3
Solid waste collectors take it	205	33.2	51.2
Private disposal well	101	16.3	25.3
Throw in an open space (on the street)	37	5.9	9.3
Dispose in nearby river	1	0.2	0.3
Throw into drainage	1	0.2	0.3
Others	27	4.4	6.7
Total	**618**	**100.0**	**154.5**
Responsible Body for SWM			
Households	283	49.4	70.7
Municipality	277	48.3	69.3
Others	13	2.3	3.3
Total	**573**	**100.0**	**143.3**

Source: Own Survey

The results in table 9 also show that 206 (52.5%) of the total respondents received solid waste collection service either from the municipality or the private service provider in the town. Among the respondents who received solid waste service, 131 (63.6%), 70 (34%) and five (2.4%) get the service once, irregularly and twice per week respectively. In addition, about 151 (73.3%) of the respondents are satisfied with current solid waste collection service provided to them in the town *(Table 9)*.

Table 9: Response of households who get SWM service and their satisfaction

SWM Service in the Town (n=392)	No	Percent
Yes	206	52.5
No	186	47.5
Frequency of Service per week (n=206)		
Once	131	63.6
Irregular	70	34.0
Twice	5	2.4
Satisfaction with the SWM Service (n=206)		
Yes	151	73.3
No	55	26.7

Source: Own Survey

4.1.3. Households Response for Impacts of Unsound Solid Waste Management

Among respondents who were asked about the environmental impacts of unsound solid waste disposal 321 (81.9%) were aware of the impacts of unsound solid waste disposal in the town. Respondents were also asked whether they thought that the unsound waste disposal affects health of household's member or not. As a result, 297 (75.8%) of households thought the unsound solid waste disposal affects the health of members in the family (Table 10).

Table 10: Response of households' awareness on impacts of unsound SWM on environment (n=392)

Environmental Awareness	No.	Percent
Yes	321	81.9
No	71	18.1
Health Concern Among Members		
Yes	297	75.8
No	95	24.2

Source: Own Survey

4.1.4. Households Willingness to Pay for Improved SWM in Sululta Town

Based on the results of the study, about 369 (94%) of the total respondents were willing to pay for improved solid waste management in the town. However, the remaining 23 (6%) of the respondents were not willing to pay for the proposed project. The respondents were asked reasons for their willingness to pay or not for improved solid waste management in order to know whether they clearly understood the scenario or not. The unwilling 23 respondents were also asked their reasons for not willing to pay for the proposed scheme from the given list of alternatives. Depending on this, nine (39.1%) and seven (30.4%) of the unwilling respondents chosen "lack of income" and "it is the responsibility of the government to provide this service" from the given choice alternatives, respectively. Moreover, the remaining three (13%), and four (17.4%) of the unwilling respondents selected "satisfied with the existing service", and "have no faith in newly proposed service", respectively (Table 11).

Table 11: Households' willingness to pay for improved solid waste management

Willingness to pay	**No**	**Percent**
Yes	369	94
No	23	6
Total	**392**	**100**

Source: Own Survey

Table 12 below shows the WTP responses of households for the double-bounded value elicitation format. The results revealed that the number of "yes-yes" responses for the initial and follow-up bids decreases as the value of initial bids increases. In a well-developed CV survey, the number of "yes" answers should decline as the bid amount increases (Carson, 2000). Furthermore, the proportion of "yes-yes" answering pattern decreases as the bid amount is increased. The proportion of "no-no" answers increase as the bid amounts on the WTP question increased. At initial bid amount of ETB 20, there is no "no-no" response, implying that all the households who are willing to pay something are willing to pay at least ETB 10 (half) for solid waste management service. At the highest initial bid of 100 ETB, 22.2 percent answered "no-no" response. The remaining answering

patterns, "yes-no" and "no-yes" responses indicate that the respondents' willingness to pay lies between the initial bid amount and the increased and decreased bid amounts, respectively. Therefore, this result can be interpreted as a sign of the internal validity of the CVM answers, confirming the selection of an efficient bid design (Banga et al., 2011) (Table 12).

Table 12: Respondents' willingness to pay response for the initial and follow-up bids

Initial bid*	**WTP****				
	Yes-Yes	Yes-No	No-Yes	No-No	Total
20	61 (64.2)	32 (33.7)	2 (2.1)	-	95
50	21 (23.1)	37 (40.6)	29 (31.9)	4 (4.4)	91
80	10 (10.7)	33 (35.5)	41 (44.1)	9 (9.7)	93
100	8 (8.9)	25 (27.8)	37 (41.1)	20 (22.2)	90
Total	100 (27.1)	127 (34.4)	109 (29.5)	33 (9.0)	369 (100)

* Follow up price is either half or double of the initial bid

** Values in parenthesis are percentages

Source: Own Survey

4.2. Econometric Analysis

4.2.1. Specification Tests for the Probit and Tobit Models

Data exploration is an important first step in econometric analysis. Consequently, the correlation matrix generated using the data shows that there is no multicollinearity problem since the mean variance inflation factor (VIF) is 1.31 that is less than 10 for both the probit and Tobit models (*see appendix* 5 & 11). To account for the problem of heteroscedasticity of error terms, the robust standard error was used for the probit model. The '*linktest*' for joint model specification was used and it was found that the probability of *hatsq* is 0.317 and 0.443, which is equivalent to 31.7 percent and 44.3% for the probit and Tobit models, respectively, and it is good for model specification error (*see appendix* 4 & 10).

4.2.2. Probit Model Estimation Results

To show the relationship between the explanatory variables and households' willingness to pay for the improved solid waste management service, the probit model was used. The average marginal effects were used to interpret the coefficients of each significant variable. Variables such as environmental awareness (Awarenv), amount of solid waste generated (Amountswg), sex, health effect among the households (Heffect), currently married (Cmarr), education and households plan to live in the area (HHpresidence) are found to be not significantly affect households' willingness to pay for the improved solid waste management service.

The results of the model shows that income of the household affects households' willingness to pay for improved solid waste service positively and significantly at 1% level of significance. This relationship is consistent with the expected sign and the results of other findings mentioned in the literature (Dagnew et al., 2013; Banga et al., 2011; Tamru, 2019; Alhassan; et al., 2017). Households' who have more income are more willing to pay for the improvement and have higher probability of accepting the improvement in SWM. Keeping other variables constant, a one percent increase or decrease in households total monthly income leads to about 0.05% increases or decreases in the probability of accepting the improvement.

The current situation of solid waste management was found to be negatively and significantly relates to households' willingness to pay decision for the improvement at 1% level of significance. This result is consistent with the expected sign and results of other findings in the literature (Dagnew et al., 2013; Ayenew et al., 2019). This is because individuals who perceived the current situation of waste management as good might be satisfied with the current situation of solid waste management service and are less willing to pay and have less probability of accepting the improvement offered to them. Other things equal, households who perceived the current situation of solid waste management as good have 5.92% less probability of willingness to pay response for accepting the improvement as compared to household that perceived the current situation as worse.

Younger age household heads have a positive and significant willingness to pay for the improved SWM service at one percent level of significance compared to the elderly household heads. This might be because the younger age households demand improved quality of the environment and are more concerned for the improved solid waste management service. Younger household heads are more willing to pay and have higher probability of WTP for the improved SWM (0.17% higher). This result is consistent with the expected sign and the findings of other studies in literature (Endalew & Tassie, 2018; Selamawit et al., 2019).

House ownership affects individual's willingness to pay for the improvement positively and significantly at 1% percent level of significance. As expected, household's living in their own houses have higher probability of willing to pay for the improved SWM service than those who are living in rented houses. Other variables constant, the probability of accepting the improvement in SWM service for individuals who live in their house increase by 7.92% compared to those who live in rented house. This result is also consistent with the findings of other studies in the literatures (Dagnew et al., 2013; Banga et al., 2011). This may reflect a security aspect of willingness to pay, where the homeowners know that they will be staying in their homes for long, or if they decide to move the improved waste management in the area will have an increased value of their home.

Duration of residence in the area has an inverse and significant effect on willingness to pay for improved SWM service at one percent level of significance. Keeping other variables constant, households who lived in the area for a short period are more willing to pay and have about 0.19% higher probability of WTP for the improved SWM service compared to those that stayed for longer period in the area. This result is inconsistent with the expected sign but consistent with findings of other studies in literature (Tamru, 2019).

When household size is considered, its relation with WTP is quadratic and it negatively affects the likelihood of willingness to pay for improved solid waste service. Of note, its effect is not uniform for different family sizes. That is, for large family sizes, the impact tends to be positive than medium and small family sizes.

Table 13: Probit Model Regression Result

Dependent Variable: Households' WTP for the Improved SWM Service			
Explanatory variable	Coefficient	P>|z|	Average Marginal Effects
Lnincome	0.6014239	0.008***	0.0496751
Awarenv	0.3450735	0.269	0.0285016
Heffect	-0.2786668	0.338	-0.0230167
Amount of SWG	-0.2003892	0.337	-0.0165513
Csitu	-0.7165569	0.007***	-0.0591846
Sex	-0.1339147	0.571	-0.0110608
Age	-0.0225536	0.049**	-0.0018628
Hownership	0.9588354	0.010***	0.0791958
Duresidence	-0.0225488	0.003***	-0.0018624
Cmarr	0.1013351	0.765	0.0083699
Education	0.1966519	0.545	0.0162426
HHpresidence	0.3514178	0.348	0.0290257
HHsize	-0.5487122	0.028**	-0.0453214
HHsize2	0.0553845	0.023**	0.0045745
Constant	-0.8167412	0.718	
Number of observations	392		
Wald chi2(14)	78.41		
Prob > chi2	0.0000		
Pseudo R2	0.3169		
Log likelihood	-59.79663		

***, **, and * represents the level of significance at one, five and ten percent, respectively.

4.2.3. The Bivariate Probit Result

The results from the seemingly unrelated bivariate probit model (SUBP) revealed that coefficients of the initial and the follow-up bids are negative and statistically significant as expected. This shows that higher initial and follow-up bids lead to lower probability of accepting the offered bid. In addition, the correlation coefficient (ρ) is negative and

significantly different from zero. However, this correlation is not perfect. The correlation coefficient being less than one indicates that the random component of willingness to pay for the first question is not perfectly correlated with the random component from the follow-up question. (*See appendix* 12).

4.2.4. Tobit Model Estimation Result

The Tobit model reveals the relationship between the maximum willingness to pay (MWTP) of respondent's and the explanatory variables included in the model. Average marginal effects were used to interpret the coefficients of significant variables. Following are discussions of significant associations of explanatory variables with MWTP of respondent's.

The results from the model show that income positively and significantly related to the maximum willingness to pay of the respondent at 1% level of significance. Ceteris paribus, a 1% increase in the monthly total income leads to an increase in the probability of willingness to pay the maximum amount for the improved solid waste management service in the town by 0.09%. In addition, households' maximum willingness to pay increases by 19.36 ETB for all observations and 15.42 ETB for willing observations when the income of the households increase by 1%. This result is consistent with the expected sign and the findings of other studies in the literatures (Banga et al., 2011; Tamru, 2019; Bhattarai, 2015; Alhassan; et al., 2017).

Being female household head negatively and significantly affects the willingness to pay the maximum amount at 1% level of significance. Other things constant, females have about 7.29% less probability of willing to pay the maximum amount than males. Moreover, females are less willing to pay about 16.15 ETB for all observation and willing to pay 12.86 ETB for willing observation than the male counterpart. This finding is inconsistent with the expected sign but consistent with the results of findings of other studies in the literature (Bhattarai, 2015; Alhassan et al., 2017; Endalew & Tassie, 2018).

Duration of residence has also negative and significant effect on the willingness to pay the maximum amount at 5% level of significance. Households who lived in the area for a longer period have less willingness to pay the maximum amount than households who lived in the area for shorter period. Keeping other things constant, households with longer period

of residence have 0.17% less probability of willing to pay the maximum amount for the improved service. In addition, respondents who lived in the area for a longer period are willing to pay about 13.05 ETB less for all observation and 10.22 ETB less for willing observation than households with shorter period of residence. This result is consistent with the expected sign and results of other findings in the literature (Tamru, 2019)..

Table 14: Tobit Model regression Result for Households Maximum Willingness to Pay

Explanatory variable	Coefficient	P>|t|	Average Marginal Effects		
			1	2	3
Lnincome	22.24571	0.000***	0.0874972	19.3656	15.41827
Awarenv	7.162463	0.286	0.0281715	6.235153	4.964228
Heffect	1.83921	0.754	0.007234	1.601091	1.274737
Amount of SWG	2.048904	0.612	0.0080588	1.783636	1.420074
Csitu	-7.992192	0.216	-0.031435	-6.957459	-5.539304
Sex	-18.54852	0.001***	-0.0729554	-16.14708	-12.85579
Age	-0.2252166	0.440	-0.0008858	-0.1960583	-0.1560953
Hownership	8.229739	0.240	0.0323694	7.164251	5.703945
Duresidence	-0.4397946	0.028**	-0.0017298	-0.3828553	-0.304817
Cmarr	-1.096165	0.896	-0.0043115	-0.9542469	-0.7597405
Education	10.40697	0.167	0.0409329	9.059599	7.21296
HHpresidence	10.75317	0.265	0.0422946	9.360981	7.45291
HHsize	-5.047936	0.401	-0.0198546	-4.39439	-3.498672
HHsize2	0.5663058	0.328	0.0022274	0.4929873	0.3925006
Constant	-116.7566	0.010			

Number of observations	392	23 left-censored observations at MWTP<=0
Wald chi2(14)	65.40	369 uncensored observation
Prob > chi2	0.0000	0 right-censored observation
Pseudo R2	0.0162	
Log likelihood	-1980.7161	

***, **, and * represents the level of significance at one, five and ten percent, respectively.

1= Average Marginal Effects on the Probability of being Censored
2= Average Marginal Effects for the Censored Sample
3= Average Marginal Effects for the Truncated Sample

4.2.5. Mean WTP Estimation Result and Aggregate WTP

Depending on the response to the debriefing question, out of 23 respondents with zero valuation for willingness to pay, 11 were considered protest response to the valuation question. Thus, respondent who said, "I don't have faith in the proposed project", "It is the responsibility of the government to provide the service" were treated as protest zeros (invalid responses) and excluded from the valuation of the mean willingness to pay. Responses of respondents who said, "I cannot pay due to lack of income" and "I'm satisfied with the existing service" are included in mean WTP computation and considered as real or valid zero bids. The treatment of outliers has also a significant effect on mean WTP. The maximum WTP values of respondents greater than five percent of their income are considered as outliers in this study as mentioned in other studies (Alemu, 2000; Dagnew et al., 2013; Tamru, 2019). Thus, the maximum WTP of nine respondents is greater than five percent of their total income and these records were excluded as an outlier (invalid response) from the calculation of mean willingness to pay.

Out of the total 23 respondents who have zero WTP, 17.39 percent (4), and 30.43 percent (7) said, "I don't have faith in the proposed project" and "It is the government's responsibility to provide the service for free", respectively. The remaining 39.14 percent (9) and 13.04 percent (3) of the unwilling respondents said: "I cannot afford" and "I'm satisfied with the existing service", respectively. The total number of invalid responses from protest zero and outlier is 20. Hence, 372 respondents out of 392 total sample observations are included in mean WTP computation.

As shown in Table 16 below the mean WTP obtained from open-ended value elicitation format was about 59.7 ETB per month for a household with the 95% confidence interval showing 55.6 ETB and 63.8 ETB lower bound and upper bound, respectively.

Table 15: Mean Maximum WTP Estimation Result from Open-Ended Value Elicitation Format

	Mean	Std. Err.	[95% conf. Interval]	
MWTP	59.7043	2.082302	55.60971	63.7989

Source: Own Survey

The '*doubleb*' command estimation result in table 16 below was used to compute the mean WTP obtained from double-bounded value elicitation format. The delta method using Stata's '*nlcom'* (non-linear combinations of estimators) command was used to estimate mean WTP from the initial and follow-up bids response by including all covariates. The 95 percent confidence interval shows the lower and upper bounds. The results revealed that the mean WTP obtained from the double bound response was 77.6 ETB with the lower bound ETB 70.5 and the upper bound 84.6 ETB. Thus, the mean WTP obtained from double-bounded format is greater than the open-ended format. (*See appendix* 14).

Table 16: Mean WTP Estimation Result from Double-Bounded Value Elicitation Format

	Coefficient	Z	P>|z |	[95% conf. interval]	
Mean WTP	77.56169	21.50	0.000***	70.49189	84.63149

***, represents the level of significance at one percent

The total WTP of households is the total amount of money that will be used for providing improved SWM service in Sululta town. The total WTP is the mean WTP multiplied by the total number of households who have valid responses. Based on the 11 (2.8%) households with protest zeros and nine (2.3%) outliers which constitute a total of 20 (5.1%) invalid responses, about 762 and 626 were protest responses and outliers out of the total household number in Sululta town, respectively. Thus, 1,388 households were expected to have invalid responses from total number of households in the town. Here, households who were excluded from mean WTP calculation were also excluded from the total WTP calculation.

The total WTP per month from the open-ended format is computed by multiplying total number of households with valid response (25,827) by the mean maximum WTP (59.7 ETB) and is about 1,541,871.9 ETB. The total monthly WTP obtained from the double-

bounded value elicitation format is calculated by taking the mean WTP obtained from the double bounded responses (77.6 ETB) by the total number of households with valid responses and is about 2,004,175.2 ETB. Therefore, the actual willingness to pay of households in Sululta town may fall between these two amounts.

Table 17: Total WTP of Households

Total Number of Households	Households with Invalid Responses		Households with Valid Responses	Mean WTP per Month (in ETB)	Total WTP per Month (in ETB)
	Protest Responses	Outliers			
27,215	762 [a]	626 [b]	25,827 [c]	60.2	1,541,871.9[d]
27,215	762	626	25,827	80.9	2,004,175.2[e]

Source: Own calculation

[a]Out of a total observation (392), 11 (2.8%) are protest zeros. The protest response out of the total household number; i.e., 27,215 times 0.028 gives the number of households who are expected to have protest responses (762 households).

[b]Out of a total observation (392), nine (2.8%) are outliers. The number of households with outlier measure out of the total household number; i.e., 27,215 times 0.023 gives the number of households who are expected to be an outlier (626 households).

[c]The difference between total household number (27,215) and households who have invalid responses; 762 protest zeros and 626 outliers is households with valid response (25,827).

[d]Total WTP from mean of maximum WTP.

[e]Total WTP from mean of double-bounded WTP

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1. Conclusion

Waste is an unavoidable consequence of the consumption and production activities of a society; thus, proper handling of waste is becoming a serious problem of cities all over the world especially in developing countries where financial and technical scarcity is very serious. Due to lack of appropriate planning, inadequate governance, resource constraints, and ineffective management, solid waste, especially insufficient collection and improper disposal is a major concern for many rapidly growing cities in developing countries.

The objective of this study is to investigate households WTP for improved residential SWM in Sululta town. The study used CVM in order to estimate households WTP using double-bounded followed by open-ended value elicitation formats. The sample households were selected from the four Kebeles in the town using a stratified random sampling technique. Based on the household or population share of each Kebele from the total household or population number of the town, the study selected 134, 117, 90 and 59 households from Sululta 01, Keso Weserbi, and Nono Mana Abbichu and Wale Lube Kebeles, respectively. Out of the total 400 sample households, 392 households successfully completed the face-to-face interview.

The findings of the study showed that the generated solid waste from the town is poorly managed and the provision of SWM service of the town is limited to specific locations. Moreover, the current situation of the solid waste management in the town is very poor. The poor management of solid waste in the town created negative impact on human health and the environment such as water and air pollutions due to open burning and uncontrolled dumping of solid waste. Consequent to this, a good proportion (94%) of residents of the town were willing to pay for an improved SWM. Further, our analysis revealed that higher monthly income of households, age of younger household's head, household heads that perceived the current environmental situation is worst, household's head who owned house, shorter duration of residence in the area, and smaller household sizes predicted willingness to pay positively for the improved SWM service.

The mean WTP values obtained from open-ended and double-bounded value elicitation formats are 59.7 ETB and 77.6 ETB per month for a household, respectively. The total

WTP for improved SWM services obtained from open-ended and double-bounded value elicitation formats are about 1,541,871.9 ETB and 2,004,175.2 ETB, respectively. Additionally, the maximum WTP for SWM services was positively predicted by total monthly income of the respondents, male household heads, and shorter duration of residence.

5.2. Recommendation

This study derived the following recommendations from the findings of the study.

- The municipality of the town work hard to provide residential solid waste management services on regular basis to change unfavorable conditions of the current situation of solid waste management in sustainable way.
- In order to create a clean, safe, and healthy environment in the town, the local authorities or the municipality and concerned bodies of the town should design, implement and monitor a context specific SWM project.
- The municipality of the town should invest or create a conducive environment for private investment for the disposal of solid waste generated from the town for composting and recycling of the generated solid waste.
- The health bureaus of the town should work hard to create awareness on the impacts of improper solid waste disposal on the environment and human health. The health extension workers and health officers can perform this on different assemblies and using campaign and mass media particularly among the poor households, elderlies, and large household sizes.
- Since the majority of the residents practice, open burning in or outside their compound and open dumping of solid waste on an open space or on the street, the town's environmental protection and climate change bureau need to work on it to improve the adverse effects on the quality of the environment.
- The mean WTP of this study might be used as a guide by the municipality in order to determine an economically acceptable fee.

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APPENDICES

Appendix 1: Probit Regression Result

Probit regression

Iwtp	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Lnincome	.601	.228	2.64	.008	.155	1.047	***
Awarenv	.345	.312	1.11	.269	-.267	.957	
Heffect	-.279	.291	-0.96	.338	-.849	.291	
Amountswg	-.2	.209	-0.96	.337	-.61	.209	
Csitu	-.717	.264	-2.71	.007	-1.234	-.199	***
Sex	-.134	.236	-0.57	.571	-.597	.329	
Age	-.023	.011	-1.97	.049	-.045	0	**
Hrent	.959	.37	2.59	.01	1.684	.234	***
Dresidence	-.023	.008	-2.95	.003	-.038	-.008	***
Cmarr	.101	.339	0.30	.765	-.564	.767	
Educ	.197	.325	0.60	.545	-.441	.834	
Presid	.351	.375	0.94	.348	-.383	1.086	
Hhsizesize	-.549	.249	-2.20	.028	-1.037	-.06	**
Hhsizesize2	.055	.024	2.27	.023	.007	.103	**
Constant	-.817	2.262	-0.36	.718	-5.249	3.616	

Mean dependent var	0.941	SD dependent var	0.235
Pseudo r-squared	0.317	Number of obs	392.000
Chi-square	78.411	Prob > chi2	0.000
Akaike crit. (AIC)	149.593	Bayesian crit. (BIC)	209.162

**** p<.01, ** p<.05, * p<.1*

Appendix 2: Probit Model Goodness of Fit

Probit model for iwtp, goodness-of-fit test

number of observations = 392
number of covariate patterns = 392
Pearson chi2 (377) = 334.04
Prob > chi2 = 0.9456

Appendix 3: Average Marginal Effects for Probit

Average marginal effects Number of obs = 392
Model VCE : Robust
Expression : Pr (iwtp), predict ()
dy/dx w.r.t. : lnincome awarenv heffect amountswg csitu sex age hrent dresid cmarr educ presid Hhsizesize Hhsizesize2

Delta-method

	dy/dx	Std.Err.	Z	P>z	[95%Conf.	Interval]
Lnincome	0.050	0.017	2.880	0.004	0.016	0.084
Awarenv	0.029	0.026	1.090	0.276	-0.023	0.080
Heffect	-0.023	0.024	-0.950	0.340	-0.070	0.024
Amountswg	-0.017	0.018	-0.930	0.354	-0.052	0.018
Csitu	-0.059	0.023	-2.560	0.011	-0.105	-0.014
sex	-0.011	0.020	-0.560	0.574	-0.050	0.028
Age	-0.002	0.001	-1.970	0.049	-0.004	-0.000
Hrent	0.079	0.032	2.440	0.015	0.143	0.016
Dresid	-0.002	0.001	-2.790	0.005	-0.003	-0.001
Cmarr	0.008	0.028	0.300	0.765	-0.047	0.063
Educ	0.016	0.027	0.600	0.550	-0.037	0.069
Presid	0.029	0.030	0.970	0.333	-0.030	0.088
Hhsizesize	-0.045	0.022	-2.080	0.037	-0.088	-0.003
Hhsizesize2	0.005	0.002	2.100	0.035	0.000	0.009

Appendix 4: Linktest for Probit

Number of obs= 392
LR chi2 (2) = 56.42
Prob > chi2 = 0.0000
Log likelihood = -59.325674 Pseudo R2 = 0.3223

Iwtp	Coef.	Std.Err.	z	P>z	[95%Conf.	Interval]
_hat	1.325	0.387	3.420	0.001	0.567	2.084
_hatsq	-0.134	0.133	-1.000	0.317	-0.395	0.128
_cons	-0.117	0.294	-0.400	0.691	-0.694	0.460

Appendix 5: VIF for Probit Model

VIF		1/VIF
Lnincome	1.860	0.536
Awarenv	1.670	0.599
Heffect	1.540	0.649
Amountswg	1.430	0.699
Csitu	1.370	0.730
Sex	1.230	0.814
Age	1.220	0.820
hrent	1.210	0.823
Dresid	1.160	0.862
Cmarr	1.120	0.894
Educ	1.120	0.897
Presid	1.080	0.930
Hhsizesize	1.060	0.940
Mean vif	1.310	

Appendix 6: Tobit Model Regression Result

Tobit regression

Mwtp	Coef.	St.Err.	t-value	p-value	[95%	Interval]	Sig
Lincome	22.246	4.98	4.47	0	12.453	32.038	***
Awarenv	7.162	6.708	1.07	.286	-6.028	20.353	
Heffect	1.839	5.859	0.31	.754	-9.681	13.359	
Amountswg	2.049	4.031	0.51	.612	-5.878	9.976	
Csitu	-7.992	6.453	-1.24	.216	-20.681	4.696	
Sex	-18.549	5.538	-3.35	.001	-29.438	-7.659	***
Age	-.225	.291	-0.77	.44	-.798	.347	
Hrent	8.23	6.991	1.18	.24	-21.976	5.517	
Dresid	-.44	.2	-2.20	.028	-.833	-.047	**
Cmarr	-1.096	8.359	-0.13	.896	-17.532	15.34	
Educ	10.407	7.519	1.38	.167	-4.376	25.19	
Presid	10.753	9.633	1.12	.265	-8.189	29.695	
Hhsizesize	-5.048	6.01	-0.84	.401	-16.865	6.769	
Hhsizesize2	.566	.578	0.98	.328	-.57	1.703	
Constant	-116.757	44.863	-2.60	.01	-204.97	-28.543	***
Constant	48.873	1.817	.b	.b	45.3	52.445	

Mean dependent var	61.913	SD dependent var	50.380
Pseudo r-squared	0.016	Number of obs	392.000
Chi-square	65.403	Prob > chi2	0.000
Akaike crit. (AIC)	3993.432	Bayesian crit. (BIC)	4056.972

**** p<.01, ** p<.05, * p<.1*

Appendix 7: Average Marginal Effects on the Probability of Being Censored

Average marginal effects Number of obs = 392
Model VCE : OIM
Expression : Pr (mwtp>0), predict (pr(0,.))
Dy/dx w.r.t.: lnincome awarenv heffect amountswg csitu sex age hrent dresid cmarr educ presid Hhsizesize Hhsizesize2

Delta-method

	dy/dx	Std.Err.	Z	P>z	[95%Conf.	Interval]
Lnincome	0.087	0.020	4.290	0.000	0.047	0.128
Awarenv	0.028	0.026	1.070	0.286	-0.024	0.080
Heffect	0.007	0.023	0.310	0.754	-0.038	0.052
Amountswg	0.008	0.016	0.510	0.612	-0.023	0.039
Csitu	-0.031	0.025	-1.230	0.217	-0.081	0.018
sex	-0.073	0.022	-3.270	0.001	-0.117	-0.029
Age	-0.001	0.001	-0.770	0.439	-0.003	0.001
Hrent	0.032	0.028	1.170	0.241	-0.086	0.022
Dresid	-0.002	0.001	-2.180	0.029	-0.003	-0.000
Cmarr	-0.004	0.033	-0.130	0.896	-0.069	0.060
Educ	0.041	0.030	1.380	0.167	-0.017	0.099
Presid	0.042	0.038	1.110	0.266	-0.032	0.117
Hhsizesize	-0.020	0.024	-0.840	0.402	-0.066	0.027
Hhsizesize2	0.002	0.002	0.980	0.329	-0.002	0.007

Appendix 8: Average Marginal Effects for the Censored Sample

Average marginal effects Number of obs= 392
Model VCE : OIM
Expression : E (mwtp*|mwtp>0), predict (ystar(0,.))
Dy/dx w.r.t.: lnincome awarenv heffect amountswg csitu sex age hrent dresid cmarr educ presid Hhsizesize Hhsizesize2

Delta-method

	dy/dx	Std.Err.	Z	P>z	[95%Conf.	Interval]
Lnincome	19.366	4.284	4.520	0.000	10.968	27.763
Awarenv	6.235	5.836	1.070	0.285	-5.203	17.674
Heffect	1.601	5.100	0.310	0.754	-8.395	11.597
Amountswg	1.784	3.509	0.510	0.611	-5.094	8.661
Csitu	-6.957	5.611	-1.240	0.215	-17.955	4.040
sex	-16.147	4.793	-3.370	0.001	-25.542	-6.752
Age	-0.196	0.253	-0.770	0.439	-0.693	0.300
Hrent	7.164	6.080	1.180	0.239	-19.080	4.752
Dresid	-0.383	0.173	-2.210	0.027	-0.723	-0.043
Cmarr	-0.954	7.277	-0.130	0.896	-15.217	13.308
Educ	9.060	6.538	1.390	0.166	-3.754	21.873
Presid	9.361	8.379	1.120	0.264	-7.062	25.784
Hhsizesize	-4.394	5.230	-0.840	0.401	-14.645	5.856
Hhsizesize2	0.493	0.503	0.980	0.327	-0.492	1.478

Appendix 9: Average Marginal Effects for the Truncated Sample

Average marginal effects Number of obs = 392
Model VCE : OIM
Expression : E (mwtp|mwtp>0), predict (e(0,.))
Dy/dx w.r.t.: lnincome awarenv heffect amountswg csitu sex age hrent dresd cmarr educ presid Hhsizesize Hhsizesize2

Delta-method

	dy/dx	Std.Err.	Z	P>z	[95%Conf.	Interval]
Lnincome	15.418	3.452	4.470	0.000	8.652	22.185
Awarenv	4.964	4.651	1.070	0.286	-4.151	14.079
Heffect	1.275	4.061	0.310	0.754	-6.684	9.234
Amountswg	1.420	2.794	0.510	0.611	-4.056	6.896
Csitu	-5.539	4.471	-1.240	0.215	-14.302	3.223
sex	-12.856	3.844	-3.340	0.001	-20.390	-5.322
Age	-0.156	0.202	-0.770	0.439	-0.552	0.239
Hrent	5.704	4.844	1.180	0.239	-15.199	3.791
Dresid	-0.305	0.138	-2.200	0.028	-0.576	-0.033
Cmarr	-0.760	5.794	-0.130	0.896	-12.115	10.595
Educ	7.213	5.213	1.380	0.166	-3.005	17.431
Presid	7.453	6.676	1.120	0.264	-5.633	20.538
Hhsizesize	-3.499	4.164	-0.840	0.401	-11.661	4.663
Hhsizesize2	0.393	0.400	0.980	0.327	-0.392	1.177

Appendix 10: Linktest for the Tobit Model

Tobit regression Number of obs = 392
LR chi2 (2) = 66.00
Prob > chi2 = 0.0000
Log likelihood = -1980.4184 Pseudo R2 = 0.0164

Mwtp	Coef.	Std.Err.	T	P>t	[95%Conf.	Interval]
_hat	1.373	0.502	2.740	0.006	0.387	2.360
_hatsq	-0.003	0.004	-0.770	0.443	-0.011	0.005
_cons	-9.529	14.678	-0.650	0.517	-38.386	19.328
/sigma	48.9001818				45.327 52.474	

23 left-censored observations at mwtp<= 0
369 uncensored observations
0 right-censored observations

Appendix 11: VIF for Tobit Model

VIF		1/VIF
Lnincome	1.860	0.536
Awarenv	1.670	0.599
Heffect	1.540	0.649
Amountswg	1.430	0.699
Csitu	1.370	0.730
Sex	1.230	0.814
Age	1.220	0.820
hrent	1.210	0.823
Dresid	1.160	0.862
Cmarr	1.120	0.894
Educ	1.120	0.897
Presid	1.080	0.930
Hhsizesize	1.060	0.940
Mean vif	1.310	

Appendix 12: Seemingly Unrelated Bivariate Probit Model Result

Seemingly unrelated bivariate probit

answer1	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Ibid	-.027	.003	-10.22	0	-.032	-.022	***
Lnincome	.454	.162	2.80	.005	.136	.773	***
Awarenv	-.009	.199	-0.05	.963	-.399	.38	
Heffect	.229	.181	1.26	.208	-.127	.584	
Amountswg	.083	.115	0.73	.468	-.141	.308	
Csitu	.051	.188	0.27	.786	-.317	.419	
Sex	-.327	.165	-1.99	.047	-.65	-.004	**
Age	0	.009	0.01	.99	-.017	.017	
Hrent	.088	.217	0.40	.686	-.513	.337	
Dresid	-.006	.006	-1.04	.298	-.018	.005	
Cmarr	.017	.254	0.07	.946	-.48	.514	
Educ	.29	.207	1.41	.16	-.115	.696	
Presid	.122	.304	0.40	.689	-.475	.718	
Hhsizesize	-.214	.201	-1.06	.287	-.607	.18	
Hhsizesize2	.02	.019	1.03	.304	-.018	.057	
Constant	-1.549	1.342	-1.15	.248	-4.18	1.081	
answer2							
Fbid	-.006	.002	-2.44	.015	-.011	-.001	**
Lnincome	.109	.153	0.71	.478	-.192	.409	
Awarenv	.296	.186	1.59	.111	-.068	.66	
Heffect	.002	.166	0.01	.993	-.323	.326	
Amountswg	.136	.114	1.20	.23	-.086	.359	
Csitu	-.185	.18	-1.03	.303	-.538	.167	

Sex	-.229	.157	-1.46	.144	-.536	.078	
Age	-.006	.009	-0.63	.527	-.023	.012	
Hrent	.062	.205	0.30	.762	-.339	.464	
Dresid	-.011	.006	-1.98	.047	-.022	0	**
Cmarr	-.595	.252	-2.36	.018	-1.09	-.101	**
Educ	-.242	.22	-1.10	.273	-.674	.19	
Presid	-.025	.287	-0.09	.929	-.588	.537	
Hhsizesize	.339	.173	1.96	.05	-.001	.678	*
Hhsizesize2	-.021	.016	-1.30	.195	-.052	.011	
Constant	-.39	1.277	-0.31	.76	-2.893	2.113	
Athrho	-.523	.171	-3.06	.002	-.858	-.188	***

Mean dependent var	0.566	SD dependent var	0.496
Number of obs	369.000	Chi-square	139.372
Prob > chi2	0.000	Akaike crit. (AIC)	840.787

*** p<.01, ** p<.05, * p<.1

Appendix 13: The doubleb Regression Result

Number of obs = 360
Wald chi2(13) = 66.04
Log likelihood = -412.03336 Prob > chi2 = 0.0000

	Coef.	Std.Err.	z	P>z	[95%Conf.	Interval]
Beta						
lnincome	24.531	4.949	4.960	0.000	14.831	34.230
awarenv	3.816	6.533	0.580	0.559	-8.990	16.621
hconc	-1.630	5.893	-0.280	0.782	-13.180	9.920
amountswg	7.357	4.202	1.750	0.080	-0.879	15.593
csitu	-1.165	6.767	-0.170	0.863	-14.428	12.099
sex	-14.883	5.257	-2.830	0.005	-25.186	-4.580
age	0.080	0.299	0.270	0.790	-0.507	0.666
hrent	2.818	6.755	0.420	0.677	-10.421	16.057
duresid	-0.387	0.200	-1.930	0.053	-0.779	0.005
cmarr	-10.635	7.580	-1.400	0.161	-25.492	4.223
educ	4.739	7.578	0.630	0.532	-10.114	19.591
presid	11.437	9.475	1.210	0.227	-7.133	30.007
Hhsizesize	3.061	1.908	1.600	0.109	-0.679	6.801
_cons	-147.012	44.184	-3.330	0.001	-233.610	-60.413
Sigma						
_cons	40.586	2.112	19.220	0.000	36.448	44.725

First-Bid Variable: ibid
Second-Bid Variable: fbid
First-Response Dummy Variable: answer1
Second-Response Dummy Variable: answer2

Appendix 14: The doubleb Mean WTP Result

doubleb ibid fbid answer1 answer2 lnincome awarenv heffect amountswg csitu sex age hrent dresid cmarr educ presid Hhsizesize

nlcom(WTP:(_b[_cons]+A1*_b[lnincome]+A2*_b[awarenv]+A3*_b[heffect]+A4*_b[amountswg]+A5*_b[csitu]+A6*_b[sex]+A7*_b[age]+A8*_b[hrent]+A9*_b[dresid]+A10*_b[cmarr]+A11*_b[educ]+A12*_b[presid]+A13*_b[Hhsizesize]))

	Coef.	Std. Err.	Z	P>z	[95% Conf.	Interval]
WTP	77.56169	3.607106	21.50	0.000	70.49189	84.63149

Appendix 17: Questionnaire

ADDIS ABABA UNIVERSITY

DEPARTMENT OF ECONOMICS

A CONTINGENT VALUATION SURVEY QUESTIONNAIRE FOR VALUING IMPROVEMENT IN SOLID WASTE MANAGEMENT

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

Date _____ Interviewer's name _____

Interview started _____ ended_____ Interview number/code _____

Section 1: Questions about Current Situation of Solid Waste Management and Awareness of Respondents

1. How much solid waste do you produce per week? _____(in 50 Kg. sacks i.e., full/half)
2. How do you dispose the solid waste of your household?
   A. Private disposal well
   B. Open air burning
   C. Throw it on an open space or on the street

D. Dispose in nearby river

E. Throw into drainage

F. Solid waste collectors take it

G. Others, specify _____

3. If your answer for question number two, is F, who provides you this service?

   A. Sululta town municipality B. Private C. Others, specify_____

4. Do you get solid waste collection service in your area? A. Yes B. No

5. If "Yes" how often do you get the service per week? _____

6. Do you pay for the solid waste collection service? A. Yes B. No

7. If "Yes" how much do you pay for the service per month? ____ ETB

8. Are you satisfied with the current solid waste collection service?

   A. Yes B. No

9. Who is mainly responsible in managing solid waste services in your household?

   A. Females C. Children

   B. Males D. Others specify_____

10. How do you evaluate the current situation of solid waste management in the town?

    A. Very bad D. Very good

    B. Bad E. I can't judge

    C. Good F. I don't know

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

12. Who is responsible for the proper management of solid waste in the town in your view?

    A. The municipality B. the household C. Other, specify_____

13. Do you think that the unsound solid waste disposal is damaging members of your household's health? A. Yes B. No

14. If "Yes", have your household members suffered any one of the following disease due to solid waste?

	Diseases	Mark(x)
1	Common cold	
2	Asthma	

3	Typhoid fever	
4	Diarrhea	
5	Cholera	
6	Other _____	

15. Does the improper solid waste generated affect your household's daily life via making the members unable to engage in productive works, school or elsewhere due to sickness?

    A. Yes B. No

Section 2: The Environmental and Health Problem and Description of Scenario

In Sululta town, due to the rising human population, increased economic activities, changing consumption patterns and urbanization, there is a rapidly growing problem of sanitation due to unsound solid waste disposal. However, attention is not given to the problem and due to this; the sanitation of the town has become a serious issue from time to time. If adequate attention is not given to the management of solid waste generated in the town, it causes an adverse effect on the environment, human health and the economy.

Therefore, the aim of this study is to improve environmental conditions of residents of the town and to recommend solution for the existing problem based on your information. The proposed idea is to collect solid waste products from each households' home twice weekly by individuals organized by Micro and Small Enterprise (MSE) who use horse or donkey driven cart to transport it safely to the disposal site, and make quality compost from decomposable solid waste. The non-decomposable solid wastes are managed separately by recycling those that can be recycled and the non-recyclables are taken to the landfill located to the eastern side of the town.

The benefits you derive from this improved solid waste management (environmental quality) are more attractive and pleasant human settlement, social amenity and cleaner environment. Because of proper and regular disposal of waste, we might get safe drinking water, control of rodents and flies, reduction in bad odor predominant in most parts of the town.

Dear respondent, this kind of service will be delivered on regular and sustainable basis if you agree to pay some money for the operators of this activity on monthly basis on service provision. Therefore, we would like you to think carefully about your monthly expenditure on other goods and services before deciding on what amount your household can pay for support of the new solid waste management (SWM) service in the town. No answer given is right or wrong; but we would like just to know how your household would support this environmental improvement.

Section 3: WTP Questions

Considering the benefits that might accrue to your household and the town:

16. Would your household be willing to pay in support of the improvement in SWM?

    A. Yes B. No

    If "Yes", go to 17 and 21

    If "No", go to 22

17. Would you be willing to pay _____ ETB per month for the improvement in SWM?

    A. Yes B. No

    If "Yes", go to question 18

    If "No", go to question19

18. Would you be willing to pay _____ ETB per month for the improvement in SWM?

    A. Yes B. No

    Either "Yes" or "No" go to question 20

19. Would you be willing to pay _____ ETB per month for the improvement in SWM?

    A. Yes B. No

    Either "Yes" or "No" go to question 20

20. What is the maximum amount your household would be willing to pay? _____ETB per month.

21. Why is your household WTP in support of the improvement in SWM?

    A. The negative impacts of poorly managed solid waste will be minimized

B. The newly proposed SWM service makes the suitable to live in

C. The proposed idea will create clean, safe and healthy environment in the town

D. Other, specify _____

22. Why is your household not WTP in support the improved SWM service?

A. We cannot pay due to lack of income

B. We don't have faith in the proposed service

C. We are satisfied with the existing service

D. It is the responsibility of the government to provide the service

E. Other, specify_____

Section 4: Questions related to socio economic conditions of the households

23. Sex A. Male B. Female

24. Age _____ years

25. Level of education A. Illiterate B. Secondary C. Elementary D. Tertiary (college/university)

26. Occupation A. Civil servant B. Trader C. Self-employed D. Unemployed E. Others _____

27. Marital status A. married B. Single D. Divorced E. Widow/widower

28. Household size below 18 years_____ ; 18 years and above _____

29. The house you are living in is A. own B. Rented

30. How long have you been staying in the area? _____ (in years)

31. Monthly income of the household head _____

32. Monthly income from other members of the household and other sources _____

33. How much money does your household spend per month on the following items?

Items	**Amount per month (in ETB)**
Food	
Clothing	
Energy (electricity, charcoal, wood, etc.)	

House rent	
Medical cost	
School fee	
Transport	
Water	
Waste disposal	
Social affairs (Idir, Ikub, etc.)	
Others	
Total	

34. Are you planning to live in the town permanently? A. Yes B. No
35. If "No" to question 35, what is the reason?
    A. The town is not suitable to live in
    B. The political situation does not invite to live in the town
    C. Searching for better livelihoods in another place
    D. Others, specify_____

Name and address of the respondent

Name _____Kebele _____ H.No._____

For the enumerator

1. How the respondents understood the questions of the survey?
   A. Very good B. good C. moderate D. little E. was not understand
2. General observation of the enumerator

_____

_____

_____

_____

Thank you for your cooperation!