Households' Willingness to Pay for solid waste collection Service in Burayu Town, Ethiopia

A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Art in Environment and Sustainable Development

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Addis Ababa, Ethiopia

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This is to certify that the thesis titled "Households' Willingness to Pay for solid waste collection Services in Burayu Town, Ethiopia" prepared by Chelkeba Degaga submitted in partial fulfillment of the requirements for the Degree of Master of Art in Environment and Sustainable Development 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 Solid waste collection Service in Burayu Town, Ethiopia*" is my original work and done by me for the degree of Degree of Master of Art in Environment and Sustainable Development under the guidance and supervision of Aseffa Seyoum (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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Chelkeba Degaga

Date _____

Abstract

Waste is an unavoidable result of a society's consumption and production activities; as a result, appropriate waste management is becoming a critical problem in cities all over the world, particularly in developing countries with severe financial and technical constraints. Using data from a cross-sectional survey of 323 randomly selected houses, this study examined householders' willingness to pay for solid waste collection service in Burayu town. The current study's goal was answered using a cross-sectional study approach. To estimate households' mean willingness to pay, the survey used a direct face-to-face interview method with a double-bounded followed by open-ended value elicitation style. The determinants of household WTP were investigated using the probit and Tobit models. STATA version 14.1, which was used for data administration and analysis, was used. The statistical significance was determined using a p-value of 5%. Solid trash collection service was willing to be paid for by 95.98% of the total respondents. The probit model demonstrated that a household's total monthly income, home ownership, and perception of the current state of solid waste management as poorer have positive and significant effects on the households' WTP reaction for SWC. Households that have lived in the area for a longer period of time, as well as the age of the household head, have negative and significant effects on the household's willingness to pay for SWC services. In the Tobit model, total monthly income has a positive effect on household's maximum willingness to pay, while households that have lived in the region for a longer time and are female have a negative and significant effect on household's maximum willingness to pay. WTP values produced from open ended and double bounded value elicitation formats for a household are around 59.70 ETB and 65.26 ETB each month, respectively. The mean WTP can be used as a guide for the municipality to calculate the economically appropriate fee, according to this study. Through mass media and campaigns, local governments should work hard to raise awareness among citizens about the negative effects of improperly managed solid waste on the environment and human health. In order to build a clean and healthy environment in the town, both the local government and the inhabitants should work together and accept SWC's responsibilities.

Key words: Willingness to pay, Solid waste collection, Contingent valuation, Double-bounded, Burayu town

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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	Solid waste collection service
MSWM	Municipal Solid Waste Management
MWTP	Maximum Willingness to Pay
SFEDB	Burayu 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

Solid waste generation is an expanding global environmental and public health problem, according to the United Nations Environment Program (UNEP, 2004). World cities currently generate roughly 1.3 billion tons of solid trash per year, with this figure anticipated to rise to 2.2 billion tons by 2050. In lower-income countries, generation rates will more than treble over the next twenty years by 2025.

Furthermore, solid waste management expenditures would rise from $205.4 billion today to around $375.5 billion in 2025, posing the most serious concern, with rises of more than five-fold and two-fold in poor and lower-middle income nations, respectively (Kaza et al., 2018)

Insufficient collection and incorrect disposal of solid waste is a major challenge for many quickly increasing cities in developing countries due to a lack of appropriate planning, weak governance, resource restrictions, and incompetent waste management (Chuen-khee & Othman, 2010).

Providing urban environmental services in developing countries is becoming increasingly difficult due to population expansion and urbanization. The correct management of solid waste is the most difficult task many cities in the developing world face today in terms of environmental health services (Aklilu, 2002). Waste management has become a major issue in industrialized countries, with landfills rising to vast proportions and recycling rates staying low or non-existent. As a result, foul odors and attractive habitats for mosquitoes and other vectors that can spread diseases including encephalitis, dengue fever, and malaria are created (Mulu & Abraha, 2012).

Trash management challenges are increasingly being brought to the forefront of the global environmental agenda, as population and consumption increases result in increased waste volumes (Yohanis & Genemo, 2015). Cities are producing a rising amount of waste, yet their solid waste collection and disposal systems are becoming less effective. For example, less than half of the solid waste produced in African cities is collected, and the remaining 95 percent is either thrown away indiscriminately at various

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

The composition of distinct wastes has changed over time and place, with waste materials being directly connected to industrial development and innovation (Dika et al., 2019). To meet the needs of a fast rising population, production must increase by at least the population growth rate, resulting in waste output that exceeds the environment's absorption capacity, causing sanitary issues as a result of the negative externalities it causes (Solomon, 2007; Ghani et al., 2014).

Unmanaged waste has the potential to pollute the atmosphere, soil, and water, posing a threat to the ecosystem. This can have serious consequences for both human and animal populations. It can also harm people's health by producing convulsions, dermatitis, nose/throat irritation, anemia, skin burns, chest pains, blood issues, stomach aches, vomiting diarrhea, and lung cancer, all of which can be fatal (Alabi, 2004).

Ethiopia has undergone fast urbanization and population growth in recent years as a result of increased rural-urban migration and rising per capita earnings (FDREPCC, 2007). This growth should therefore be accompanied by greater demand for infrastructure and public services (Chakrabarti & Sarkhel, 2003), but this has not been the case. Many Ethiopian towns lack the financial and institutional means to offer even the most basic municipal infrastructure and services, such as solid waste disposal.

Government authorities have always been in charge of garbage collection and disposal in the past (Harris et al., 2001), therefore waste management is a service that state and municipal governments are accountable for (Cointreaus-Livine, 1994; Alabi, 2004). The government's inability to efficiently manage solid waste collection and disposal may have stemmed from a misunderstanding of this work as a public responsibility.

Bartone (2001) proposed three reasons why the private sector could be a viable option in the domain of solid waste management, where service coverage and efficiency are extremely poor. The first reason is that the private sector could be able to help improve efficiency and cut expenses. Second, the private sector may be able to raise extra cash, and third, the private sector may be ideally positioned to learn from overseas experiences and implement proven and cost-effective technology.

Burayu, as a developing city, faces significant solid waste management challenges. Solid waste management is handled by the town's municipality. The municipality's service is inadequate due to a variety of causes, the most significant of which being financial constraints (SFEDB, 2019). To avoid this dilemma, it is critical to engage the participation of families that are both the primary generators of solid waste and the primary victims of mismanaged solid wastes' detrimental consequences. Additional finances, on the other hand, are required to involve private actors in this sector.

The municipality alone will not be able to finance this, thus contributions from local residents will be required. Using the contingent valuation method, this study investigated the general characteristics of existing waste management, households' willingness to pay for solid waste collection service, and the extent to which demographic and socioeconomic factors influence households' willingness to pay for solid waste collection service in Burayu town by applying contingent valuation method (CVM).

1.2 Statement of the Problem

The fast expansion of urban agricultural and industrial operations, fueled by population increase, has resulted in vast quantities of solid and liquid waste, polluting the environment and depleting resources. Solid waste management (SWM) in emerging countries is particularly complicated by changing economic trends and fast urbanization. As a result, solid waste is increasing in both quantity and content (from less organic matter to more paper, packaging materials, plastics, glassware, metal, and other things), and poor collection rates are exacerbating the problem (Bartone & Bernstein, 1993).

Burayu, one of the fastest growing cities in Ethiopia, is found adjacent to the capital Addis Ababa in a near distance. The city is also among the cities in Ethiopia which has a high population rise annually. Because of its closeness to the capital Addis Ababa, many people migrate to the city annually, which is one of the reasons to the rapid increase of population of the city. According to the Central Statistical Agency (CSA) census conducted in 2007; the forecasted population of the city in 2015 was 71,900. But Burayu City Administration Annual report of 2016 indicated that the city had a total population of 151,166 in that specific year. The rapid increase of population and the increasing economic growth of the city combined brought a large amount of solid waste. The piles

of wastes dumped illegally on open areas, in gullies, river courses, etc. are undisputable evidences of the poor solid waste management system of the city which has ultimately caused a foul-smell, blocking of drains and destroying the aesthetics of the city. This situation is believed to be the result of inadequate solid waste management system in the city.

Inadequate management of solid waste generated mainly from households is greatly affecting residents and the city itself in many ways. The solid waste which is left uncollected and dumped everywhere has affected the city's aesthetics and the environment. Sewerage channels and open areas are the primary locations were illegal dumping is frequent. Lack of storage containers and transportation equipment are also some of the problems associated with domestic solid waste management of the city. As the municipality reported only three trucks are exist and two of them are out of service due to technical problem. Therefore, the collected waste at temporary station is not transported on time to the final damp site.

Fig 1. Temporary station of solid waste

The waste dumping site which is located right in the middle of the city, where there are many legally registered households, brought many social and health impacts to residents living nearby the site. Moreover, the dumping practice by itself is very primitive method

of dumping waste, whereby advanced mechanisms like daily cover and leachate collection pipes are absent.

Currently, the municipality of Burayu allows jobless adolescents to engage in garbage management by collecting trash from their homes using a pushcart and a donkey or horse cart. To receive the service, residents must store solid waste generated inside their homes in plastic bags or other temporary storage and hand it over to these private solid trash collectors. What is noticed is different due to insufficient service coverage; wastes are thrown on the street, in the drainage system, and in the forest. Furthermore, fire is a typical occurrence in the village. The collected waste is also disposed improperly on uncontrolled disposal site near agricultural and residential areas. As a result, various waste debris has been swept away by the wind from disposal sites, littering farms and homesteads in the area.

Participation of local communities or service recipients is critical in finding solutions to SWC issues (Dagnew et al., 2013). As a result, families that produce the majority of solid waste and are affected by uncollected solid waste should be able to participate in improving SWM. This engagement could take the shape of monetary or other contributions from families in order to modernize and improve solid waste collection in order to reduce the problems connected with improper solid waste management. This strategy necessitates information on the desire of local residents to contribute to SWC service.

No surveys were conducted so far regarding the city's solid waste collection service. Thus, lack of information about household WTP for solid waste collection service is the major problem when it comes to designing a suitable solid waste management plan and share the burden of financial constraint for the city.

However, to the best of my knowledge, no study on solid waste collection service in the study region has been done. Furthermore, there is a paucity of demand-side data on whether residents are prepared to pay for the town's solid waste collection service. As a result, the purpose of this study was to determine the household's desire to pay for solid waste collection service in Burayu town, as well as the associated demographic and socioeconomic characteristics that influence household willingness to pay.

1.3. Objectives of the Study

1.3.1. General objective of the study

The overall goal of this study is to apply the contingent valuation method to evaluate the household's willingness to pay for solid waste collection service in Burayu town.

1.3.2. Specific Objectives of the Study

- To examine the town's present solid waste management issue.
- Identify elements that may influence a household's willingness to pay for solid waste pickup;
- Calculate the average and total willingness to pay for solid waste removal (better environmental quality).

1.4. Significance of the Study

Solid waste generation increases in amount and composition as the population grows and urbanization continues. To deal with the negative consequences of rising trash, such as public health, environmental, and aesthetic issues, proper waste management is required. As a result, the goal of this study is to examine stakeholders' demand-side preferences in order to enhance present solid waste management. Because this is the first study on solid trash collection service in Burayu town, the findings of this study can be used to inform appropriate policy formulations to close the gap between demand and supply for better solid waste management services. It can also be utilized as a starting point for future research in the topic field.

1.5. Scope of the Study

The study is limited to an examination of homeowners' willingness to pay for residential solid waste collection services. Other types of solid waste, such as industrial, commercial, and agricultural wastes, are not included. Only household heads from two Kebele's in the town were included in the study's sample.

1.6. Organization of the Study

The rest of the research is organized as follows. A survey of related literature is covered in Chapter 2. The study's methodology is presented in Chapter 3. The research findings

and discussions are covered in Chapter 4. The last chapter concludes with a summary, conclusions, and recommendations.

CHAPTER TWO: REVIEW OF RELATED LITERATURES

Theoretical and empirical literature on solid waste management, as well as economic valuation methodologies, are discussed in this chapter.

2.1. Theoretical Review

2.1.1. Definition of Basic Terms and Concepts

Waste is defined as transportable material that is mistakenly believed to be of no further use, according to Penido et al. (2009). It may provide no inconvenience, annoyance, or hazard once discarded. Furthermore, waste can be defined as any object or material that is generated and disposed of or intended to be disposed of by the person in charge of it (Hajkowicz, et al., 2006). Household waste, sewage sludge, waste from manufacturing activities, packing products, discarded autos, old televisions, yard waste, old paint containers, and so on can all be called waste. However, there are waste definitions that are based on the circumstances in which they occur.

Solid waste: is defined as non-hazardous industrial, commercial, and residential refuse, such as household organic trash, street sweepings, hospital and institutional garbage, and construction waste; animal and human feces are considered liquid waste, an issue that is beyond the focus of this study. According to proclamation No. 513/2007 solid waste management proclamation of the Federal Democratic Republic of Ethiopia (FDRE, 2007), "solid waste" refers to anything that is neither liquid nor gas and is dumped as undesirable. Yard sweeping, meal residues, ash and chat leftovers, and saw dust are examples of garbage from residential, business, and educational institutions.

Valuation: is the process of assigning monetary values to commodities and services that, in many cases, do not have readily available market prices.

Willingness to pay (WTP) is the greatest amount of money that individual would be ready to pay for an increase in some item, such as an environmental amenity, rather than do without it. This is the amount of money that would make a person choose between paying for and receiving the improvement and foregoing the upgrade and saving the money to spend on other things (Freeman et al., 2014)

Willingness to accept (WTA) is the minimum amount of money required for an individual to voluntarily forego an improvement that would otherwise be experienced; it is the amount that would make a person indifferent between having the improvement and foregoing the improvement in exchange for more money (Freeman et al., 2014). It is intended to elicit a person's minimum readiness to accept compensation for a reduction in the resource's quality or quantity (Othman, n.d.)

2.1.2. Types and Sources of Solid Wastes

Knowledge of solid waste sources, as well as information on waste types, will aid in the operation of the functional aspects involved in solid waste management. Solid waste can be divided into several forms and sources depending on the sector of the economy that produces it and the location of origin of the item.

Eldon and Bradley (2006) classified sources of solid waste into four main categories based on the sector of the economy responsible for its generation: mining, agricultural, industrial, and municipal solid waste. Using the origins of the materials as a guide Domestic garbage, commercial waste, industrial waste, institutional waste, street sweepings, and building and demolition wastes, according to Rand et al. (2000), are the six forms of municipal solid wastes. Table 1 summarizes the many forms and sources of solid waste.

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,	Same as commercial

	government centers	
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)

2.5.1 Waste generation

Waste generation refers to any activity in which materials are determined as no longer useful and are either discarded or gathered together. According to the World Bank's 2012 global review of solid waste management study, developed countries (Europe and North America) produce nearly half of the world's waste (2.2 kg/capita/day), while Africa and South Asia produce the least waste (0.65 kg/capita/day and 0.45 kg/capita/day, respectively).

2.1.3. Solid Waste Management

Solid waste management, according to FDRE (2007), is defined as the collection, transportation, storage, recycling, or disposal of solid waste, or the subsequent use of a decommissioned disposal site. Furthermore, according to Ethiopia's Federal Democratic Republic proclamation No. 513/2007, urban authorities must provide enabling conditions to encourage investment in solid waste management services. Prior to engaging in the collection, transportation, use, or disposal of solid waste, any person must obtain a permit from the concerned body of an urban government. The engagement of the lowest administrative levels and their respective local communities in the formulation and implementation of their individual solid waste management plans is also explicitly outlined in this proclamation. Each Region or city administration must establish its own schedule and prepare a solid waste management strategy and implementation report

based on it. The decree from 2007 also specifies how to deal with part of the solid waste generated.

Municipal waste management is defined by Ogwuelka (2009) as the collection, transportation, treatment, recycling, resource recovery, and disposal of solid waste in urban settings. Municipal solid waste management aims to improve the quality of the urban environment, provide jobs and money, protect the environment, and boost the economy's efficiency and production.

2.1.3.1. Types of Solid Waste Management

Landfilling, incineration, composting, and anaerobic digestion are the four most popular methods of municipal solid waste disposal. Volume-reduction technologies include incineration, composting, and anaerobic digestion.

The only true “disposal” way of controlling MSW is **landfilling**. It is also the most cost-effective, particularly in underdeveloped nations, where it often entails depositing garbage in a depression or abandoned mine. Landfills emit landfill gases and leachate, which can affect people and the environment.

Incineration is the process of combusting garbage at a high temperature. Before incineration, non-combustible trash should be separated. Incineration has several advantages, including a reduction in waste volume and the production of energy in the form of power and heat. However, incineration plant building and startup costs can be prohibitively expensive for developing countries.

Natural microbial organisms breakdown the organic part of MSW via composting and anaerobic digestion. The non-organic part would be disposed of in a landfill or burned. These processes limit the amount of waste that needs to be landfilled, and the end products can be used as agricultural fertilizers or turned into motor vehicle fuels. However, project implementation, like incineration, might be prohibitively expensive for low-income populations (Medina, 2002).

2.1.4. Environmental Valuation of Environmental Goods and Services

Kolstad (2000) claims that in the past, some environmental products and services were given zero or low values due to the difficulty of assigning economic values to such commodities or the idea that they were free goods. As a result, it is critical to include

environmental values into economic decision-making processes because failing to do so might have negative consequences for both present and future generations.

Since the late 1960s, a considerable body of environmental economics literature has evolved, embracing a variety of monetary valuation methodologies and techniques aimed at 'pricing' the range of environmental goods and services given by the biosphere. Due to the fact that many environmental goods and services are non-market commodities, market adjusted, surrogate, and simulated market methodologies were used to value them (Bateman et al.; 1992). The ‘commodification' of the services that the natural environment delivers is the core technique for environmental value. Households and businesses consume the services, which are considered as parameters in utility and production functions, respectively (Perman et al., 2003).

Valuation is the process of assigning monetary values to non-marketed products and services. If a product or service contributes to human well-being, it has economic value. However, whether or not a non-marketed good or service makes a positive contribution to an individual's well-being is determined by whether or not it fulfills his or her preferences (Pearce & Ozdemiroglu, 2002). Other methods of generating estimates of the values of such resources are required in the absence of markets or market pricing. As a result, economists have developed a number of empirical methodologies for assessing the monetary worth of environmental goods and services with difficult-to-observe marketplaces. As a result, to measure We must comprehend the concept of value in order to grasp the worth individuals place on commodities that do not have a perfect market, or even a market at all.

The Economic Concept of Value

According to Freeman et al. (2014),

> *The ability of things to satisfy human needs and wants, or to improve people's well-being or utility, is central to the economic theory of value. The economic value of anything is a measure of its contribution to human wellbeing under this concept of welfare. The economic worth of resource-environmental systems is thus determined by the various ecological activities and services that contribute to human well-being. The theory also posits that people are aware of their*

preferences and that these preferences are interchangeable. The bundles are made up of both market and non-market commodities. The willingness to pay (WTP) or the willingness to accept compensation (WAC) can be used to convey value metrics based on substitutability (WTA)

Total Economic Value

Individuals will have a number of held values as a result of their current preferences or tastes, which will result in items being allocated various assigned values. Economists begin by differentiating use values from non-use values in order to arrive at an aggregate measure of worth (total economic value) (Pearce et al., 1992)

Individuals link use values to the use of a resource or an environmental attribute by an individual. It can be divided into three categories: direct, indirect, and option usage values. Both consumptive and non-consumptive uses that include some observable interaction between humans and the environment are referred to as direct use values (Lee et al., 2010). Consumptive uses entail removing a component of the ecosystem for anthropocentric (consumption) purposes, whereas non-consumptive uses entail direct use of ecosystem services given without extraction, such as recreational activities and picturesque vistas. Values derived indirectly from ecological services such as flood management, groundwater recharge, and water filtering are known as indirect use values. Option value is the benefit derived from the ability to utilize the good or service at a later date; it is frequently viewed as a subset of use value (Dixon, 2008).

Non-use values relate to all values that individuals hold that are not linked to the use of an ecosystem good or service; instead, people may profit from knowing that an ecosystem exists free of human interference. All remaining values other than use values, such as bequest and extant values, are classified as non-use values (Lee et al. 2010).

2.1.5. Techniques of Environmental Valuation

In general, there are two types of valuation methods: revealed preference and asserted choice (Freeman et al, 2014; Othman, 2002).

2.1.5.1. Revealed Preference Method

Individual choices in existing markets that are related to the environmental amenities that are the topic of value are observed using revealed preference approaches. Economic actors are said to ‘reveal' their preferences by their choices in this situation. The trip cost and hedonic pricing approaches are the two basic strategies used in this approach.

a. The Travel Cost Method

The trip cost method (TC) is primarily used to calculate recreational values for environmental services. It assumes the cost of an individual's visit to a recreational location, which can be used to calculate his or her value for that site. The technique entails inquiring about the individuals' origins and the costs they incurred. As a result, the data gathered is linked to the number of visits in order to create a demand curve for the recreational facility in question. Trip cost (gas, food, and other travel-related expenses), income, alternative sites, and personal motives are all collected in a travel cost survey.

The demand curve is then built based on a number of assumptions, including that people will respond to the cost of travel in the same way they would to a site entry charge, and that the marginal (highest cost) visitor gains no advantage from attending beyond the cost they spend. The demand curve is used to calculate the amount of consumer surplus connected with visiting the site, as well as to investigate how visit rates and consumer surplus may alter if admission costs were raised (Moons, 2003; cited in Assefa, 2017).

Weakness of Travel Cost Method

Some of the issues that arise when utilizing the trip cost approach to produce empirical estimations include: first, the assumption that a place's recreational value is directly connected to the travel expenditures incurred to get there may be oversimplified. Second, it can only measure the set of values for which consumers are ready to pay a premium (through the medium of incurring travel costs to visit the site with attributes for which we seek valuations). Finally, it is appropriate for calculating the worth of specific sites or locations but not for gauging other types of commodities or services.

b. Hedonic Pricing Method

The hedonic pricing approach is used to determine the value of environmental amenities that have an impact on the cost of marketed commodities. Lancaster's characteristics theory of value provides the foundation for this strategy (1966). Environmental service flows are identified as part of a vector of attributes describing a marketed commodity, often housing, by the approach. When determining where to live, consumers examine the level of environmental quality (such as air quality) as well as other qualities of a house, therefore house prices are likely to fluctuate depending on the environmental quality (Bennet & Blamey, 2001)

Weakness of Hedonic Pricing

The fundamental drawback of hedonic pricing is that it can only be used in locations where the property market is highly developed and property owners are aware of environmental features or affects and take them into account when determining property values. Other drawbacks include the fact that it necessitates a high level of statistical competence and that taxes and interest rates are not factored into the hedonic pricing calculation. Another disadvantage is that this method cannot be used to estimate non-use value (Bennet & Blamey, 2001).

2.1.5.2. Stated Preference

People's replies to inquiries about their willingness to pay for a hypothetical situation are used in the expressed preference path. The ability of expressed choice approaches to assess the whole range of use and non-use environmental benefits and costs has piqued interest.

> *The underlying idea behind any expressed preference technique for assessing non-marketed environmental values is to quantify a person's willingness to pay a financial penalty in exchange for some prospective (non-financial) environmental benefit or prevent some potential environmental harm (Bennet & Blamey, 2001).*

The contingent valuation technique (CVM), choice modeling/choice experiment (CM), and conjoint analysis are the most widely used methods. The merits and downsides of both revealed and stated preference approaches are discussed. Both methods can be used

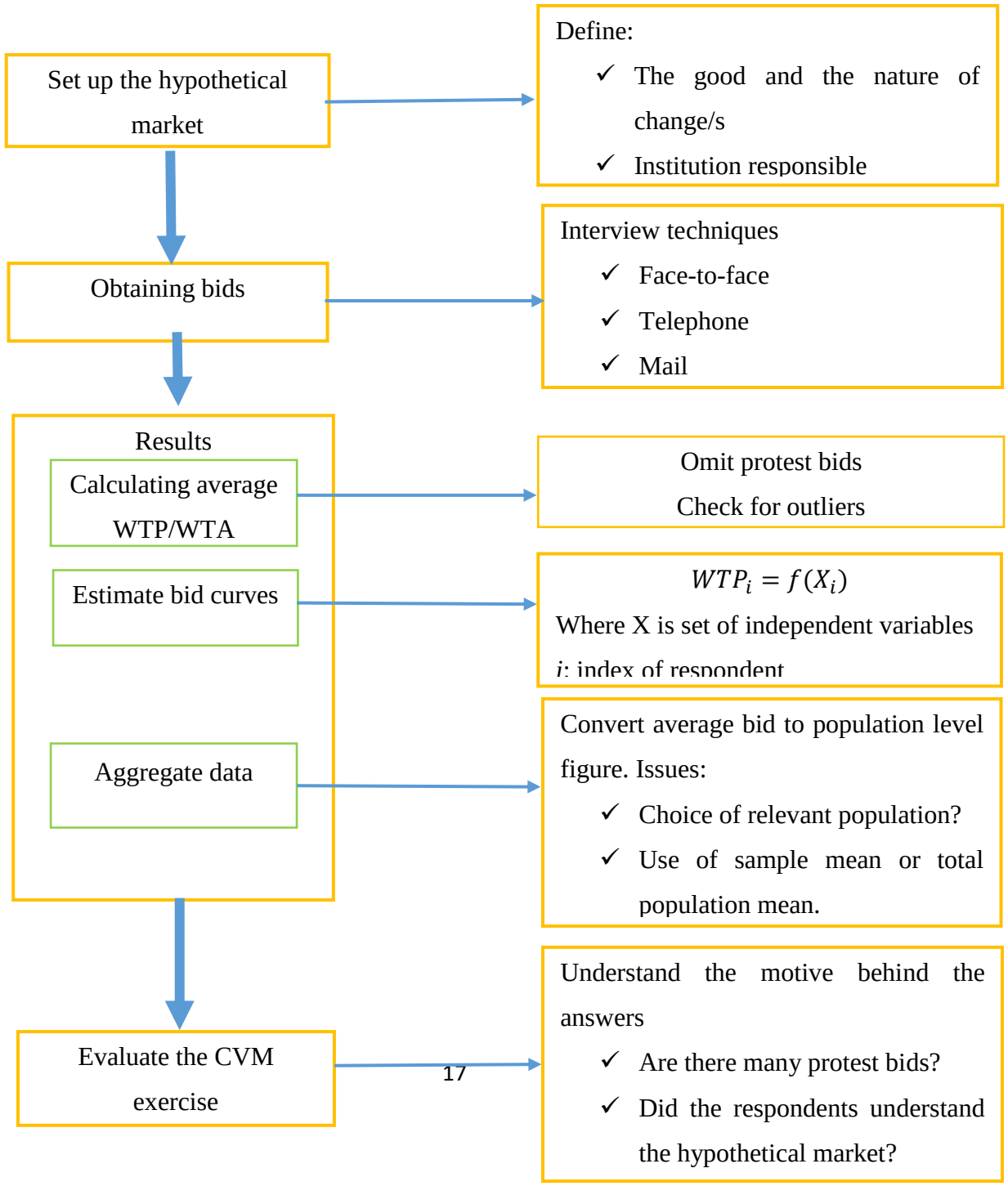
to calculate use values. Unlike revealed preference approaches, expressed preference methods like contingent valuation and choice modeling are the most extensively used methods for determining use and non-use values. When there is no proxy market to value non-marketed products and services, stated preference is the sole choice (Hanemann, 1994; Perman, et al., 2003).

a. Contingent Valuation Method

The contingent valuation method is a non-market approach to determining the economic value of environmental commodities. Because the information sought from survey respondents is conditional on a hypothetical market setting, the value is referred to as contingent. This method entails asking a randomly selected sample of the population if they are willing to pay or accept a clearly defined change in the provision of an item or service, or whether they are willing to oppose the change (Bolt et al. 2005). The purpose of the economic analysis in the instance of solid waste services is to determine if the families serviced would collectively be prepared to pay enough of their money to cover the costs of the service (Chuen-khee & Othman, 2010).

In CVM, open-ended, bidding game, payment card, and single-bounded or double-bounded dichotomous choice are the most commonly utilized value elicitation formats. The open-ended approach is the oldest and most widely used method, in which respondents are asked to declare their highest WTP for the product or service being rated. When it comes to the payment card, responders are requested to select the specified WTP amount that is displayed on the card with a assistive technology. As a result, respondents mark the sums they are willing to pay with a tick and cross the amounts they are not willing to pay. Another value elicitation style is the bidding game, in which respondents are asked to state their WTP iteratively until a yes response changes into a no answer or a no answer changes into a yes answer. In a dichotomous or discrete choice format, each responder is given a randomly assigned price for the non-marketed commodity or service in question. Then, in the case of single-bounded, each respondent gives a yes or no answer for the indicated WTP amount, and in the case of double-bounded, the respondent is asked for greater or lower bids if he or she responds yes or no (Bolt et al., 2005).

When creating a CV study, there are four essential steps to follow (see Figure 1). Setting up a hypothetical market for a non-marketed commodity or service is the first stage in creating a well-defined value scenario. The second phase is to collect bids via a variety of survey methods, including face-to-face interviews, telephone interviews, and mailed surveys. The third step is to show the analysis' findings, such as average WTP or WTA, as well as the factors that influence WTP or WTA. The final phase is to evaluate the CVM exercise, which involves determining how successful the implementation of CVM has been. Bolt and his colleagues (2005)



Source: Bolt et al. (2005)

Figure 1: Flow Chart of Designing a Contingent Valuation Study

Strengths and Weaknesses of CV Method

The most often used stated preference method for non-market valuation is contingent valuation, which allows for the assessment of overall economic values associated with environmental externalities (Jin et al., 2006). When an item cannot be simply characterized in terms of traits or characteristics, the CV approach is also preferred to estimate values (Johnston et al., 2017). The method, however, has been critiqued for the various forms of potential biases it may encounter during the CV survey (Tietenberg & Lewis, 2012). The first is strategic bias, which occurs when respondents give biased responses in order to affect a specific conclusion. Furthermore, respondents may be hesitant to answer survey questions or reveal their actual WTP for the proposed project for strategic reasons, such as a free-rider situation.

If respondents believe the proposed project will be implemented and they desire to gain from the project by assuming others will pay, they may understate their true WTP for the non-marketed commodity or service in issue. This is known as the free-rider problem. The second is information bias, which occurs when respondents are compelled to value non-marketed items or services about which they have little or no knowledge or expertise. The amount and quality of information offered to respondents, as well as the way the questions are worded, have an impact on their willingness to pay for the product or service in issue. The amount and quality of information offered to respondents, as well as the way the questions are worded, have an impact on their willingness to pay for the product or service in issue. The third type of bias is starting point bias, which occurs when the respondents' WTP response is influenced by the method used to determine the opening offers. The fourth is hypothetical bias, which occurs when the hypothetical market is not well-designed, resulting in a disparity between hypothetical replies and actual payments.

Incorrect payment vehicle selection has an impact on respondents' responses, forcing them to understate or inflate their genuine WTP. As a result, responders can pay their solid waste collectors directly to their coordinator on a monthly basis. The fifth prejudice is the disparity in willingness to pay and accept remuneration. In the case

of WTA compensation and WTP inquiries, respondents specify a higher and lower monetary value for a non-marketed commodity or service, respectively.

b. Choice Modelling (CM) Method

Lancaster (1996), who created his characteristics approach to product demand analysis, laid the conceptual groundwork for conjoint approaches (Bennett & Blamey, 2001). The necessity that survey respondents assess alternatives that are described in terms of their component qualities or attributes with varied levels is a common aspect of this type of methodology.

The Strengths and Weaknesses of CM

In comparison to other stated preference methodologies, such as the CVM, choice modeling offers both pros and limitations. The capacity of the strategies to construct a vast database of people's preferences in order to generate statistically robust models of choice is the most significant of the strengths. As a result, policymakers are better equipped to make informed decisions about both the provision and management of natural resources, which are more likely to result in net benefits for the community as a whole. CM has a unique set of issues. The first is its potential to generate a large data collection by allowing for a more sophisticated questioning process that puts more load on respondents' cognitive abilities. The other is that CM respondents may choose from those options they believe have a fair chance of 'winning,' even if this excludes their most desired option, if their choices are conditional on their expectations about the choices of other respondents.

According to Johnston et al. (2017), choosing between contingent valuation (CV) and choice modeling (CM) techniques like choice experiments (CEs) is difficult and should be based on respondent perceptions of the change to be valued, the decision objective to be considered, and the type of information required. When deciding between CVs and CEs, three key factors should be taken into account: (2017.) First, how will the change in value affect certain features of the item or the item as a whole, and what are the decision-makers' information requirements? Second, do respondents consider (and evaluate) the change in terms of individual characteristics or as a whole? Third, how does the format in

which information is presented alter respondents' understanding of the object being valued? (Johnston and colleagues, 2017).

2.2. Empirical Literature Review

According to the reviewed literature, CVM may be utilized in a variety of situations and at different countries in Africa as well as Ethiopia when market pricing are unavailable, and it is a better environmental valuation tool since it can capture both use and non-use values.

In this section, we examine the most relevant empirical literature that can assist us in identifying probable socioeconomic, demographic, and environmental characteristics that may influence willingness to pay for the commodity in question. The empirical literatures are organized based on their geographical location and chronological order.

Banga et al. (2011) used a sample of 381 homes in Kampala, Uganda to investigate families' willingness to pay for enhanced solid waste collection services in two divisions (Nakawa, Kawempe, Rubaga, and Makindye). To extract household willingness to pay for improved solid waste collection service in the town, the study used a double-bounded contingent value followed by an open-ended inquiry. The direct interview method was also employed to acquire data from each household head. The findings revealed that 79.8% of the homes polled were willing to pay for a door-to-door rubbish pickup service.

The Spike (Probit) result revealed that household income, tenure, education level, respondent age, whether the household has ever paid for garbage collection, whether solid waste is viewed as a major problem by the household, and whether the household is located in Kawempe are the main factors influencing the households decision to pay or not pay for door-to-door solid waste collection. Income, education, whether or not families consider solid waste to be a serious concern, tenure, and pay (whether or not the home has ever paid for trash collection in any manner) all influenced the decision to pay for improved SWM services. The age variable, on the other hand, was negative and significant at the 1% level of significance. The age variable, on the other hand, was negative and significant at the 1% level of significance. Only Kawempe shows a positive and significant coefficient among the location dummies' coefficients. The variables whether a household reported solid waste as a major problem, whether the household has

ever paid for waste collection in any form, gender, waste, and household size were not found to have a significant impact on the amount a household is willing to pay for solid waste collection services. For the open-ended question and unconditional mean WTP estimate, the mean WTP is Ush 2288 and Ush 2439, respectively.

Bhattarai (2015) used a cross-sectional survey of 220 randomly selected houses in Banepa municipality, Nepal, to evaluate households' willingness to pay for solid waste collection service. The respondent's information was gathered through a face-to-face interview. To extract willingness to pay, a single bounded dichotomous choice contingent valuation with an open-ended follow-up question was used. 83 percent of the household heads polled said they would be prepared to pay for solid waste pickup. The median willingness to pay is Rs 160 (USD 1.69) per household per month, whereas the mean willingness to pay is Rs 166 (USD 1.69) per home per month (USD 1.63). The logit model found that the bid price and being a male respondent have a negative and significant impact on households' willingness to pay for solid waste collection service. The age of the respondent, the size of the household, the respondent's level of education, household income, and the current garbage collection service all have a positive and significant impact on households' WTP for solid waste collection service.

Alhassan et al. (2017) investigated the impact of socio-economic, socio-psychological, and situational factors on households' willingness to pay for solid waste collection services in the Ghanaian metropolises of Accra and Tamale. Data was collected from 855 randomly selected households using a three-stage stratified probability sample method. To elicit household willingness to pay for solid waste collection service in the two locations, the researchers used an open-ended and iterative bidding game contingent valuation. The Tobit model was used to investigate the elements that influence willingness to pay as well as the maximum amount of money that people were willing to spend. Educational attainment, total household income, profession type, level of satisfaction with SWM services, attitude, subjective norm, and respondent location are all positively and statistically significant at 1% throughout the entire study area, according to the model's findings. Male households, on the other hand, were negatively and statistically significant at 1%. The average monthly WTP per household in Accra,

Tamale, and the total research region was 15.71 Ghana cedis, 8.99 Ghana cedis, and 13.13 Ghana cedis, respectively.

Maskey and Singh (2017) conducted a study on families' willingness to pay for improved waste collection service in Gorkha, Nepal, on 401 randomly selected houses from all 15 wards, using a stratified sample method. To elicit households' WTP, the study used a face-to-face interview method and an open-ended value elicitation style of the contingent valuation method. To evaluate factors impacting WTP and the maximum amount families are prepared to pay for better garbage collection service, the logit and Tobit regression models were utilized. The majority of households (61%) were willing to pay NRs. 73.38 (0.72 US$) each month on average. Monthly household income, education of the household head, environmental consciousness, and garbage collection service are characteristics that significantly and positively influence households' WTP for enhanced solid waste collection service, according to the logit model's findings. In the Tobit model, all of these characteristics have a significant and positive impact on the maximum amount of money families are prepared to pay for improved solid waste collection service, with the exception of the household head's education.

Dagnew et al. (2013) used the contingent valuation approach to investigate households' willingness to pay for improved urban trash management, adopting a single-bounded dichotomous option format followed by an open-ended follow-up question. They used data from a cross-sectional survey of 226 households chosen at random from a list of households in Mekelle's six local administrations. A face-to-face interview was also used to acquire data from the respondents. To determine the factors of households' WTP for solid waste collection service systems and to examine the mean WTP of households, Probit and Tobit models were utilized. According to the empirical research using the probit model, respondents' willingness to pay increases with household income and awareness of environmental quality, whereas elderly respondents are less likely to pay. The amount of solid waste generated by a household per week, the household head's education, environmental awareness, house ownership, the type of solid waste service demanded by households, household income, and household head's marital status are all positively associated with WTP in the Tobit regression, whereas household perception of current SWM is negatively associated with WTP. The mean WTP for solid waste

collection service was 11.89 ETB per month per household in the single-bounded model and 7.88 ETB per month per household in the open-ended format, respectively. When compared to the then-current sanitary rates, this mean WTP was significantly greater, allowing the sanitary fee to be increased in order to raise adequate funds to enhance the city's SWM.

Endalew & Tassie (2018) used a multistage sampling technique to collect data from 350 houses in Bahir Dar, Ethiopia, to conduct a study on urban households' demand for solid waste collection services. The purpose of the study was to evaluate the city's solid waste management system and homes' willingness to pay for solid trash collection service, as well as to look into the factors that influence households' desire to pay. This study used a double-bounded CVM followed by an open-ended question to elicit the households' WTP for improved SWM services. Face-to-face interviews, key informant interviews, and focus group discussions were also used to gather data for the study. The factors of households' WTP were investigated using an ordered probit model in order to improve SWM services. According to the study's findings, 86.3 percent of respondents were willing to pay for improved SWM services, with a monthly mean WTP of 13 ETB. In addition, the model found that the household head's educational level, monthly aggregate income, access to SWM service, illness outbreaks, the number of children, and the amount of waste generated per week all had a positive and substantial impact on households' WTP. Male household head, on the other hand, had a negative and substantial impact on households' WTP, indicating that female-headed households are more prepared to pay than male-headed families.

Tamru (2019) investigated households' willingness to pay for enhanced municipal solid waste management (MSWM) in Dilla town using a cross-sectional survey of 381 randomly selected respondents. A direct face-to-face interview method was used to conduct the survey. To extract household willingness to pay for solid waste collection service, the study employed the double bounded dichotomous choice contingent valuation method followed by an open-ended question. The drivers of families' WTP maximal willingness to pay were investigated using the probit and Tobit models, respectively. According to the study's findings, approximately 91.6 percent of all respondents were willing to pay for enhanced MSWM. The results of the probit and Tobit

models revealed that household income and respondents' awareness of the environmental impacts of poorly managed solid waste have positive and significant effects on households' WTP response for initial bids and their maximum willingness to pay (MWTP), respectively. The respondents' age and contentment with the present system had significant positive and negative effects on the households' WTP response for the initial bids, respectively. The amount of solid waste created by households, the household plan, and the duration variables all have a positive and significant impact on the MWTP of households. For a household, the mean WTP values from open-ended and double-bounded value elicitation formats are roughly 10.7 ETB and 12.36 ETB each month, respectively.

Selamawit et al. (2019) used a multi-stage and systematic random sample technique to study households' willingness to pay for solid waste collection service and associated characteristics in Injibara town, North West Ethiopia, on 903 randomly selected household heads. The data was collected using a pre-tested and standardized interviewer-administered semi-structured questionnaire. To elicit household willingness to pay, the study used contingent valuation using an iterative bidding game approach. The Tobit model was used to investigate the elements that influence willingness to pay as well as the maximum amount of money that people were willing to spend. According to the study's findings, 81.06 percent of respondents were willing to pay for the service. The average monthly amount that participants were willing to pay was 29.7 ETB ($1.07). Male respondents, educational status, occupation, amount of solid waste generated, distance from dumpsite, satisfaction with existing service, and wealth status were found to have a positive and significant impact on households' willingness to pay, whereas age has a negative and significant impact on households' willingness to pay.

Ayenew et al. (2019) used a multistage sampling technique to collect data from 190 houses in Shashemene town, Ethiopia, to explore household willingness to pay for solid waste collection service. To elicit households' WTP for enhanced SWM, the study used double-bounded followed by open-ended value elicitation formats. The logit model was used to look into the elements that influence a household's WTP in order to improve SWM. The mean WTP was calculated using the bivariate probit model and the maximum WTP response from the open-ended question. The study's findings revealed that the

current solid waste management system is ineffective. For a household, the mean WTP values derived using the double-bounded and open-ended value elicitation procedures were USD 16 and USD 14 per year, respectively. Household income, education level, and the amount of solid waste generated were all important factors that influenced households' WTP in a favorable way. Household size, respondents' age, and the number of bids received were the characteristics that had a negative impact on households' WTP.

2.3 Conceptual Framework of Study Area.

The conceptual framework encapsulates the ideas, assumptions, expectations, and theories that underpin and guide the study design. A conceptual framework, according to Miles and Huberman (1994), is a visual or written product that "explains, either graphically or in narrative form, the essential objects to be researched, the key components, concepts, or variables, and the hypothesized link between them."

Solid waste management can be a difficult task that relies heavily on organization and cooperation among households, communities, private businesses, and municipal governments, as well as the selection and implementation of appropriate technical solutions for waste collection, transfer, recycling, and disposal. A number of critical criteria will influence households' WTP for solid waste collection services. The dependent variable in this study is HH's WTP, which is represented as a categorical dummy variable with only two values. So, the study's conceptual framework centered on how to elicit families' WTP in order to improve SWM in the study area? What are the primary socioeconomic elements that influence a farmer's willingness to pay for improved SWM service? The researcher has established the following conceptual framework for the purpose of analysis based on the associated literatures.

In the case of Burayu town, this study will focus on households' WTP and determinants of households' WTP for solid waste collection services. The following conceptual framework summarizes the study's major focus and breadth (Figure 1).

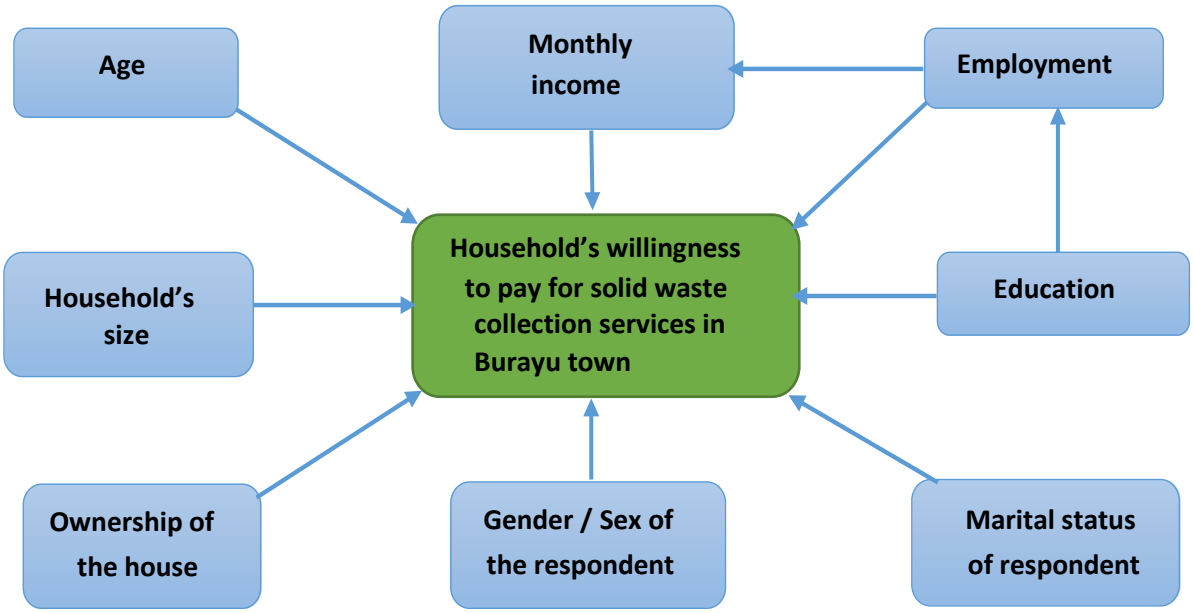


Fig. 1. Conceptual Framework of the Study (2020)

CHAPTER THREE: METHODOLOGY

3.1. Description of the Study Area

The city of Burayu is the subject of this investigation. Burayu is 10 kilometers from Addis Ababa in the Oromia National Regional State, Oromia Special Zone Surrounding Finfine. 9º02'30" North Latitude and 38º03'30"- 38º41'30" East Longitude are its astronomical coordinates. In 1953, the city was established. Burayu is one of the region's reform cities, with a city administration, municipal government, and six kebeles. In 2006, the city developed an Integrated Development Plan. Administratively, it is a part of Oromia State, and it shares three borders with other Oromia cities. Sebeta town is located in the south, Welemera district is located in the west, Sululta town is located in the north, and Addis Ababa city is located in the east.

Burayu's landscape appears to be plateau (flat land) and sub-high at best. Other seasonal elements of Burayu include a temperature of 14 degrees Celsius and an average yearly rainfall of 1188 millimeters. According to an article in the Ethiopian Herald (2016), Burayu has become one of Ethiopia's fastest growing cities in recent years. Burayu is one of Ethiopia's fastest-growing cities. According to a 2007 census conducted by the Central Statistical Agency, the city's population in 2015 is expected to be 71,900. However, according to the Burayu City Administration Annual Report for 2021, the total population of Burayu is 375,349. Burayu Gafarsa, Burayu Kata, Laku Kata, Gafarsa Guje, Gafarsa Nono, and Malka Gafarsa are the six kebeles that make up the city.

In order to obtain precise results, the study only covered two kebeles. However, the number and types of households chosen from each kebele were based on the population size of the kebele and the disparity in household income levels.

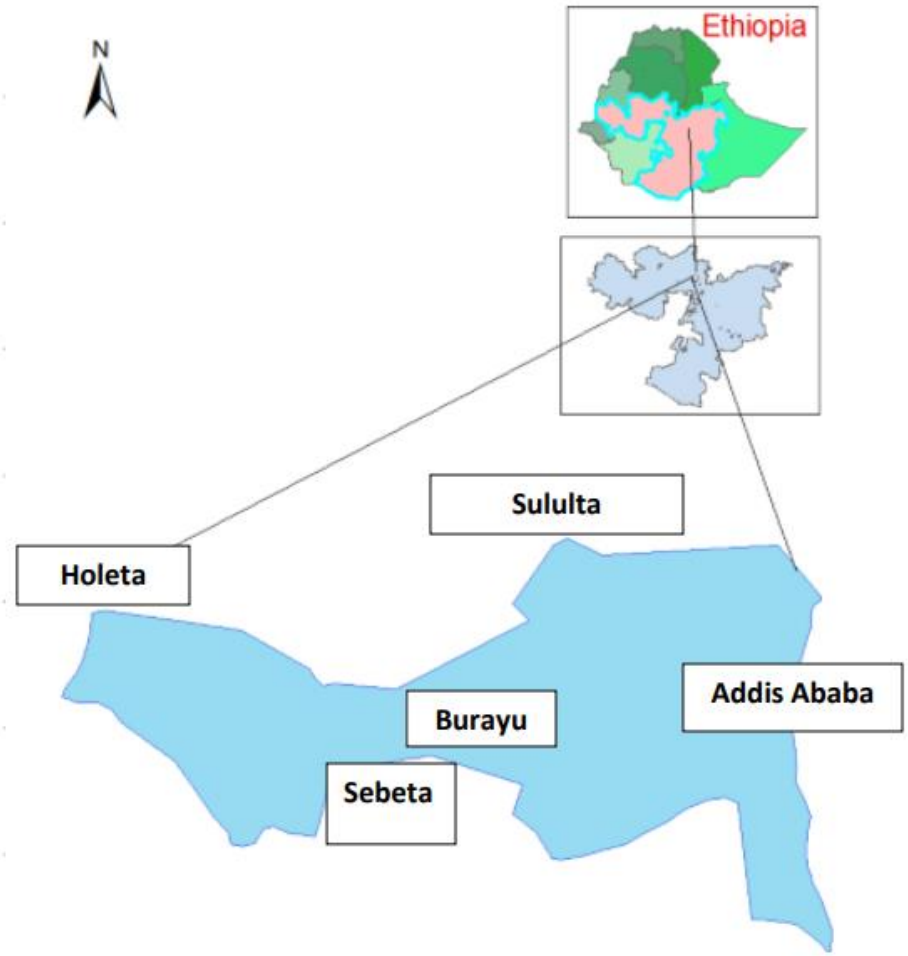


Figure 2 Map of the study area

3.2. Sampling Techniques and Survey Administration

To examine the willingness to pay for solid waste collection services, this study relies on a cross-sectional data survey of homes in Burayu town. Data was collected from families in the town's two Kebeles using a stratified sampling technique. The research was limited to the town's two Kebeles. As a result, the sample size for this investigation was calculated using Cochran's (1977) formula for simple random sampling, as shown below. Because of Cochran's (1977) formula, which connects the total sample size housing unit (n) with the necessary level of precision.

$$n = \frac{NZ^2pq}{D^2(N-1)+ Z^2pq} \quad \text{..... (1)}$$

According to the Burayu city government, the two kebeles (N) have a combined population of 172,356 people (i.e in Burayu Gafarsa & Gafarsa Gujje). Residential households account for 70% of the population registered legal dwelling units, with the other 30% consisting of a mix of commercial, institutional, and industrial structures. Our (P) value is 0.70 and our q value is 0.30 because we are focusing on residential housing units.

The total number of samples size (n) is then calculated from the 172,356 population (N) of two kebeles using the technique above.

Thus the sample size is; $n = \frac{172{,}356 * 1.96^2 * 0.7 * 0.3}{0.05^2(172{,}356-1)+ 1.96^2 0.7 * 0.3} = \frac{139608.36}{431.6975} = \underline{\mathbf{323}}$

The number of households in the town was determined by multiplying the total population by five, which is the country's average family size (CSA & ICF, 2017). Based on the household share of each Kebele household number in the town, a total of 323 sample households were chosen from the two Kebeles. Table 2 shows the sample sizes assigned to each of the Kebele.

Table 2: Sample Selection from Two kebeles Households of Burayu Town

Kebele	Population	No. of household	% of total household	Selected sample size (323 * %)
Burayu Gafarsa	91,314	18,262	52.98%	171
Gafarsa Guje	81,042	16,208	47.02%	152
Total	172,356	34,470	100	323

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

The data for this study was gathered by counting 20 dwellings in a zigzag pattern from each of the selected families. The essential data for this study was acquired utilizing a direct face-to-face interview method from May to June 2021. One economics undergraduate, two engineering graduates, and one Master of Science in natural resource and environmental economics student served as enumerators to collect information from the respondents. The researcher oversaw the data collection activities on a daily basis and

offered input to the enumerators. The information was gathered in Afan Oromo, the local language, as well as Amharic.

The focus group discussion (FGD) includes the municipality official, the community representative, and members from the town's service providers in order to decide the starting bid price. In addition, a pilot survey was conducted on 20 randomly selected families in Burayu town. To avoid sample duplication and information contamination, the pilot survey was conducted in a different region from the main survey. The purpose of the pilot survey was to use open-ended questions to determine first bids or starting point pricing, to determine the payment vehicle for the CV scenario, and to edit the final questionnaire before the major survey. The initial bids with the highest frequency of 50 ETB (80%) were chosen based on the findings of the pilot survey. During the pilot study, all of the 20 examined residences were WTP for solid waste collection service.

3.3. Design of Survey Questionnaire and Valuation Techniques

The survey was divided into four sections, as recommended by the National Oceanic and Atmospheric Administration (NOAA) Panel (Arrow et al., 1993; Mitchell & Carson, 1989). The first section asks if respondents are aware of the town's current solid waste status. The survey's second component focused on general environmental and health issues, as well as the proposed SWC improvement plan. The improved SWC scenarios include information on the services to be offered, their reliability, the town's current waste management issues, the hypothetical improved state, and how each customer would pay for the upgrade (payment vehicle). The survey's third portion inquired about respondents' willingness to pay, while the fourth section inquired about respondents' socioeconomic and demographic circumstances.

In order to elicit household willingness to pay for solid waste collection service in Burayu town, this study used contingent valuation, which employs survey techniques. To elicit WTP of families for enhanced SWM in the town, a double-bounded dichotomous choice elicitation format was used, followed by an open-ended elicitation format. The format of double-bounded dichotomous choice elicitation with follow-up question was designed and implemented for the first time by (Mitchell & Carson, 1989). In three ways, the double-bounded dichotomous choice format outperforms the single-bounded

dichotomous choice format in terms of efficiency (Haab and McConnell, 2002). For starters, it gives data on respondents' WTP. Second, respondents' responses of "Yes" followed by "No" and "No" followed by "Yes" for sequential offer offers put a clear bound on WTP. Third, even if the responses do not offer a clear bound on a respondent's WTP, there is efficiency gain from the additional WTP questions for the "No-No" and "Yes-Yes" combinations.

According to Hanemann et al., (1991), there are two 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 two 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 two 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.

$$\pi^{YY}(t_i^1, t_i^{2u}) = prob\{t_i^1 \leq max1q1qWTP \; and \; t_i^{2u} \leq maxWTP\}$$

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

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

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

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

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

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

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

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

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

Where G. denotes the cumulative distribution function (CDF) and θ denotes the distribution's parameters. As a result, the log-likelihood function for a set of responses given an N-person sample can be expressed as follows.

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

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

The respondents were given a hypothetical market situation to enable them extract their WTP for improved SWC service in Burayu town. Before the interview, the respondents were informed about the consequences of inadequate solid waste management and the significance of better SWM. The following is how the scenario was described:

> Because of the growing human population, increased economic activity, changing consumption habits, and urbanization in Burayu, there is a rapidly growing sanitation

problem due to improper solid waste disposal. However, no attention is paid to the matter, and as a result, the town's cleanliness has become a severe concern from time to time. If the management of solid waste generated in the community is not given sufficient care, it has a negative impact on the environment, human health, and the economy.

As a result, the goal of this study is to enhance the town's environmental circumstances and to offer a solution to the existing problem based on your knowledge. The proposed concept is to have individuals organized by Micro and Small Enterprise (MSE) collect solid waste products from each household's residence twice weekly, transport it safely to the disposal site using horse or donkey-drawn carts, and manufacture quality compost from decomposable solid waste. Non-decomposable solid wastes are managed separately, with recyclables being reprocessed and non-recyclables being sent to a landfill on the town's eastern outskirts.

More appealing and comfortable human settlement, social amenity, and a cleaner environment are the benefits you get from this Solid waste collection service (environmental quality). We may be able to obtain safe drinking water, control of rats and insects, and a reduction in the foul stench prevalent in most parts of town as a result of efficient and regular trash disposal. This type of service will be provided on a regular and sustainable basis if you agree to pay the operators of this activity a monthly fee for service supply. As a result, before considering how much your household can contribute to the town's new solid waste management (SWM) program, we'd like you to consider your monthly spending on other goods and services. Are you willing to pay for the better SWC service if it is offered on a regular basis?

Each respondent is given a single starting bid. If the person says "yes" to the first bid, he or she is requested to make a second higher bet, which is half of the first. If the reply replies "no" to the first bid, he or she will be invited to submit a second lower price that is half of the first. After the respondent answered "yes" or "no" to the second round question, he or she was asked to state their maximum monthly WTP for the service.

3.5. Data Analysis

In order to assess the measure of dispersion and central tendency of the obtained data, descriptive analysis was utilized in the study. Using probit and Tobit regression models, the drivers of a household's willingness to pay for enhanced SWM were investigated. Furthermore, the study employed (Lopez-Feldman, 2012)'s 'doubleb' command to estimate the average WTP from the double-bounded format. STATA version 14 was used for all of the analyses.

3.5.1. The Probit Model

In order to investigate the determinants of home WTP for the Solid Waste Collection Service in Burayu town, the Probit model was utilized in this study. The probit model is predicated on the assumption that there is a hidden or unobservable variable called y*. The error term is normally distributed and independent of explanatory variables, with a mean of zero and a constant variance of one (Cameron & Trivedi, 2005). The Probit model can be stated as follows, according to Verbeek (2012):

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

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

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

Where y_i^* is unobserved actual WTP of households for an improved SWM service in Burayu 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.

The model cannot be estimated using standard least squares since the dependant variable is a non-linear binary response model. As a result, for the estimation of limited dependent variable models, maximum likelihood approaches are required. As a result, the maximum likelihood method was used to estimate the probit model's parameters in this study. The maximum likelihood estimators are obtained via maximization of the probit model's log-likelihood function with respect to the parameters β. The signals of the partial effects of

each X_i on the response probability are revealed by the coefficients of the explanatory variables (Wooldridge, 2012).

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

This study used a bivariate probit model to discover the elements that determine WTP from the double-bounded dichotomous value elicitation format. The bivariate probit model, according to Greene (2003), is a natural extension of the probit model. If the error variables in the bivariate probit model follow normal distributions, the system of equations can be estimated as an apparently unrelated bivariate probit (SUBVP) model (Haab and McConnell, 2002). As a result, in order to establish the link between the bids offered and other covariates with WTP from the double-bounded dichotomous value elicitation format, this study used the SUBVP model. The following is a broad description of the bivariate probit model used in this investigation (Greene, 2003; Cameron & Trivedi, 2005).

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

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

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

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

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

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, also known as censored regression, is an extension of the Probit model in which the observed response y_i is expressed in terms of an underlying latent or unobserved latent variable y_i^* that meets the conventional linear model assumptions (Gujarati, 2004; Wooldridge, 2004). This model was used to investigate the factors that influence families' maximum willingness to pay (MWTP), as determined by open-ended value elicitation. This is how the normal Tobit model looks like.

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

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

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

Where y_i^* is the unobserved MWTP of a home for SWC service, y_i is the dependent variable that is the actual MWTP of a household for Solid waste collection service, and x_i is the vector of explanatory variables that affect the maximum WTP of a household. ε_i is the disturbance term, which is considered to be normally and independently distributed with zero mean and constant variance 2 and is independent of x_i (Verbeek, 2012). The Tobit model was estimated using the maximum likelihood method in this study. The Tobit model's log-likelihood function is stated 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 definition of conditional density leads to the last equality. The indices I_0 and I_1 are the set of indices that correspond to zero and positive observations, respectively. Maximize the function with respect to β and σ you'll get the greatest likelihood estimation. 2012 (Verbeek)

$$logL_1(\beta,\sigma^2) = \sum_{i\in I_0} log\left[1-\Phi\left(\frac{x'_i\beta}{\sigma}\right)\right] + \sum_{i\in I_0} log\left[\frac{1}{\sqrt{2\pi\sigma^2}}exp\left\{-\frac{1}{2}\frac{(y_i-x'_i\beta)^2}{\sigma^2}\right\}\right] \quad \ldots 14$$

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

And the marginal effect of variables on dependent variable was described as follow:

Marginal willingness to pay is given as follow:

$\boldsymbol{MWTP} = -\boldsymbol{\alpha}/\boldsymbol{bm}$ 15

Where $\boldsymbol{\alpha}$ is the intercept or coefficient of alternative specific constant, and $\mathbf{b_m}$ is the coefficient of the bid variable.

3.5.3. Variables Selection for the Model

The households willingness to pay (WTP) for solid waste collection service and households maximum willingness to pay (MWTP) for solid waste collection service were utilized as dependent variables in the econometric model in this study. The explanatory factors for the probit and Tobit models were chosen based on theoretical considerations and existing research, i.e., significant variables found in past studies on household willingness to pay for solid waste collection services. The following is a list of the variables that were used in this investigation.

Income: This variable relates to a household's total monthly income in Ethiopian Birr (total monthly expenditure is used as a proxy) (ETB). Many research have discovered that household WTP is positively and significantly connected to improved SWM (Endalew & Tassie, 2018; Selamawit; 2019; Tamru, 2019; Alhassan; 2017). Income is one of the primary factors of households WTP in this study, and it is expected to affect households WTP positively for enhanced SWM in Burayu town. It was calculated in ETB.

Household awareness of the environmental consequences of poorly managed solid waste has a considerable impact on respondents' willingness to pay for improved SWM services (Awarenv). In theory, households that are more aware of the negative effects of improper solid waste disposal on the environment are more likely to provide positive responses and have higher WTP values. Households' understanding of the effects of poorly managed

solid waste, as in other studies, is likely to positively affect their WTP for improved SWM service in Burayu (Tamru, 2019; Dagnew, et al., 2013). It takes the values 1 = aware if the household is aware and 0 = not aware if the household is not aware.

Health effect (Heffect): This variable indicates whether inappropriate solid waste generation has an impact on a household's everyday life by preventing members from engaging in productive activity owing to illness. Households whose members are unable to engage in productive labor as a result of illness caused by incorrect solid waste generation are predicted to be more inclined to pay for solid waste collection services. As a result, this research anticipates a beneficial link between health and WTP. It uses a 1 to indicate whether or not a household is affected, and a 0 to indicate whether or not the home is not affected.

Amount of solid waste generation (Amountswg): This variable refers to how many sacks (50 kilos) of solid trash a home generates each week. As the amount of solid waste generated increases, homeowners' willingness to pay for SWC service is likely to rise. As a result, the solid waste generation variable is projected to have a positive impact on household WTP in this study. The amount of solid waste generated is positively and strongly associated to households WTP for improved SWM, as shown in prior studies (Tamru, 2019; Ayenew et al.,2019). The number of people living together was counted.

Current Solid Waste Management Situation (Csitu): This variable refers to the household head's view of how solid waste is managed in the area. It is believed that households who have a positive attitude toward solid waste management will be less ready to pay for better service. As a result, this study proposes that there is a negative association between current solid waste management conditions and WTP for families in Burayu who consider solid waste management to be good (Dagnew et al., 2013). If there is a perception of present solid waste management, it is given a value of 1; otherwise, it is given a value of 0.

The **sex** or gender of the household head is represented by this variable. In many civilizations, it is thought that women have a higher preference for solid waste collection services and are in charge of domestic sanitation, child care, and food preparation. As a result, this study anticipates a positive link between female household heads' WTP for

improved SWM service, implying that female-headed households are more prepared to pay for improved SWM, as evidenced by prior studies (Endalew & Tassie, 2018; Bhattarai, 2015). It uses the numbers 1 for male and 0 for female.

Age: This variable refers to the number of years the household leader has been alive. The willingness to pay of families for enhanced SWM has been studied, and it has been discovered that the age of the household has a major impact on the willingness to pay. As a result, this study anticipates the household head's age to have a beneficial impact on the household's WTP for enhanced SWM, as have other studies in the literature (Alhassan et al., 2017; Selamawit et al., 2019). It was calculated in years.

House Ownership (Hownership): This variable indicates whether the household lives in a home that they own or one that they rent. Respondents who own a home are expected to take better care of their homes than those who rent. As a result, in comparison to a leased house, the household will be more prepared to pay for superior SWM (Banga et al., 2011; Dagnew et al., 2013). The favorable link between house ownership and WTP factors is expected in this study. As a result, those who own their own home will be more inclined to pay for improved SWM than those who rent a home. It accepts the values 1 for owned and 0 for rented.

Duration of Residence (Duresidence): This variable denotes the amount of years a family spent in Burayu. Households that have lived in their current location for a longer period of time will be more likely to pay for enhanced SWM (Tamru, 2019). As a result, this study anticipates a favorable association between households' length of stay in town and their WTP for increased SWM service. It was calculated in years.

Current Marital Status (Cmarr): This variable refers to the household head's marital status, which is divided into two categories: married and unmarried. When compared to those household heads who are single, divorced, or widowed, married households generate more solid waste and are thus more prepared to pay for improved SWM (Alhassan,et al., 2017). As a result, this research anticipates a positive correlation between marital status and household WTP. It accepts the values of 1 (married) and 0 (not married).

Education of Respondent (Educ): This variable refers to the level of formal education received by the household head. People who are more educated are more aware of the negative effects of poor solid waste management on the environment and are more prepared to pay for solid trash collection services. As in other similar studies in the literature, a household head's level of education is projected to have a favorable impact on a household's WTP for enhanced SWM (Alhassan et al., 2017; Banga et al., 2011). It accepts the values 1 for primary and above and 0 for everything else.

Household Plan (HHpresidence): For a variety of reasons, households may have a plan to relocate from their existing residence to another location or urban region. Intercommunal strife, for example, is one of the factors that causes households to relocate. Internal displacement has increased in Ethiopia in recent years as a result of intercommunal strife in several sections of the nation. Displacement in the county has a huge detrimental impact on people's lives and livelihoods (UNOCHA, 2019). This study anticipates that households planning to reside permanently in the town will be more willing to pay than those planning to live temporarily in the town, as in previous studies (Tamru, 2019). As a result, 1 denotes permanent and 0 denotes transitory.

Household size (HHsize) refers to the total number of adults and children currently residing in the home and receiving food from the same source. When the number of people in a family grows, the amount of solid waste produced grows, and the household head is more prepared to pay for SWC service (Tesfa, 2019; Bhattarai, 2015). As a result, in this study, household size is projected to have a favorable impact on household WTP. The number of people was counted.

3.5.4. Mean and Aggregate WTP Estimation

One of the primary goals of developing an empirical WTP model based on CV survey responses is to determine the central measure, or mean and median, of the willingness to pay distribution (Hanemann, 1984). The average willingness to pay (AWTP) across respondents can be calculated using two methods: the mean and the median (Perman et al., 2003). There is currently no agreement on which is the better and more appropriate measure of welfare: the mean or the median. A few extremely high WTP responses, known as outliers, have a smaller impact on the median. The theoretically proper measure

is the mean WTP, which is relevant in cost-benefit analysis. The median, on the other hand, is essential in public choice or economic analysis of political decisions since it gives the majority more weight (D. Pearce & Ozdemiroglu, 2002). Because the proposed project is related to cost-benefit analysis, this study used mean WTP to estimate AWTP of respondents from the responses of both open-ended and double-bounded value elicitation formats.

The way outliers and protest responses are handled has a big impact on the median and especially the mean WTP. In CVM, there are two techniques to deal with outliers, and either one can be utilized to tackle the problem (Gunatilake, 2003). In the first approach, the researcher selects outliers by using a criterion based on the respondents' proportion of WTP as a percentage of their total income (Freeman et al., 2014). The decision is to delete all MWTP values of respondents who earn more than 'x' percent of their income, as determined by the researcher. High valuations are decreased to some maximum conceivable amount in the second method. The first method of addressing outliers was utilized in this study, with a 'x' value of 5% of the household income. In most cases, protest responses are not included in the calculation or estimation of mean WTP (Perman et al., 2003).

There is no standard method for identifying protest responses as protest zero bids in order to exclude them from WTP calculations (Meyerhoff & Liebe, 2006). Respondents' protest zero bids were classified as protest answers in this study. All protest zero bids, on the other hand, were not excluded from the calculation of mean WTP. The true protest zero bids were identified based on the responses of the families to the debriefing questions, which prompted them to explain why they were unwilling to pay for SWC service. The sum of each respondent's maximum willingness to pay (MWTP) divided by the total sample size yields the mean WTP acquired from an open-ended value elicitation format.

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

Where MWTPi is the maximum willingness to pay of respondent i as determined by the open-ended value elicitation format, and n is the overall sample size. The 'doubleb' command designed by (Lopez-Feldman, 2012) is used to calculate the mean WTP from

the double bounded discrete value elicitation format. Because the 'doubleb' command estimates directly, $\hat{\beta}$ the WTP formula is just $\widetilde{z}'\widehat{\beta}$. when no control variables are present, WTP is simply the constant. The WTP was calculated using the average values for the explanatory variables after the covariates were included. Following the estimation of the mean WTP value, the following step is to convert the mean WTP to the level of the entire population. This phase involves aggregating WTP by multiplying the mean WTP by the total population in question (Perman et al., 2003). The total number of households in Burayu town is the relevant total population for this investigation. As a result, the total or aggregate WTP is calculated by multiplying the mean WTP by the total number of households (N).

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

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Descriptive Analysis

Based on the first bids, the 330 questionnaires used in the survey were delivered to randomly selected respondents. Three hundred and twenty three of the 330 questionnaires issued were successfully completed. Seven questions were not successfully completed and were therefore omitted from the analysis section, resulting in a response rate of 97.8%.

4.1.1. Demographic and Socioeconomic Characteristics of Respondents

According to the survey results, 313 (96.90%) and 10 (3.10%) of the total respondents were male and female, respectively. The respondent's educational attainment revealed that 23 (7.12%), 140 (43.34%), 154 (47.6%), and 6 (1.86%) have primary, secondary, above secondary, and no education, respectively. According to the respondents' occupations, 245 (75.85%), 8 (2.49%), 66 (20.43%), and 4 (1.24%) are self-employed, jobless, civil servants, and traders, respectively. According to the marital status of the respondents, 284 (87.93%) of them are married. The remaining 30 (9.29%), 1 (0.31%), and 8 (2.48%) people are single, widowed, and divorced, respectively. According to the respondents' housing ownership status, 271 (83.90 percent) have their own home and 52 (16.10 percent) have rented from others (Table 3).

According to the study, 316 (97.83 percent) of the respondents planned to reside in the town permanently, while 7 (2.17 percent) planned to live there temporarily. Those who said they wouldn't be staying in town for a long time were asked to explain why they had to go. 5 (1.54 percent), 1 (0.3 percent), and 1 (0.3 percent) of the 7 respondents who planned to live temporarily in the town chose "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 3).

Table 3: Respondent's Characteristics: Summary of Categorical Variables

Variables	No.	Percent
Sex		
Male	313	96.90
Female	10	3.10
Educational Attainment		
Primary	23	7.12
Secondary	140	43.34
Above secondary	154	47.68
No education	6	1.86
Occupation		
Self-employed	245	75.85
Unemployed	8	2.48
Civil servant	66	20.43
Trader	4	1.24
Marital Status		
Married	284	87.93
Single	30	9.29
Widowed	1	0.31
Divorced	8	2.48
House Ownership		
Own	271	83.90
Rented	52	16.10
Plan to Reside Permanently		
Yes	316	97.83
No	7	2.17

Source: Own Survey

The average age of the respondents is 37.28 years, with a minimum of 24 years and a maximum of 65 years, according to the survey results in Table 4. In addition, the survey found that the average number of years a household has lived in the region (town) is 5.69

years, with a minimum of two years and a maximum of 22 years. The household's average total monthly income is 6,275.54 ETB, with a low and high of 400 ETB and 15,000 ETB, respectively. With a minimum of zero and a maximum of six individuals, the average household size is 2.23.

Table 4: Respondents Characteristics: Summary of Continuous Variables

Variables	Mean	Std. Dev.	Min	Max.
Age	37.28	5.45	24	65
Household Size	2.23	1.23	0	6
Time Spent in the Area	5.69	2.99	2	22
Total Monthly income	6,275.54	2,956.32	400	15,000

***Source**: Own Survey*

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

Table 5 demonstrates that a substantial percentage of respondents (291 or 90.09 percent) believe that females are responsible for solid waste management in the home. Children and males, respectively, are the responsible persons in the family for solid waste management, according to a modest number of respondents: 24 (7.43 percent) and 8 (2.48 percent). The majority of the respondents, 288 (89.16 percent), a small 32 (9.91 percent), and one (0.31 percent), rated the current state of solid waste management as terrible, extremely bad, and good, respectively (Table 5).

Table 5: Households response to questions about SWM and evaluation of current SWM in the town [n=323]

Responsible person for SWM in the household	**No**	**Percent**
Females	291	90.09
Males	8	2.48
Children	24	7.43
Evaluation of current situation of SWM		
Bad	288	89.16
Very bad	32	9.91
Good	1	0.31
I can't judge	1	0.31
I don't know	1	0.31

Source: Own Survey

Households generate an average of 0.26 kilograms of solid trash per capita each day, with a minimum of 0.1 and a maximum of one kilogram. This figure is based on the World Bank's 2012 global review of solid waste management report, which found that developed countries produce about half of the world's waste, while Africa (0.65) and South Asia (0.45) produce the least. Table 7 demonstrates that the majority of the total respondents, around 140 (61.3 percent) and 78 (24.15 percent), respectively, threw in an open place or on the street and disposed in a nearby river. About 57 (17.65%), 38 (11.76%), and 6 (1.86%) of the total respondents use open air burning and solid waste collectors, respectively. Because many of the respondents employed multiple methods of trash disposal, the total percentage of responses for the method of disposal is larger than 100 percent. In addition, respondents were asked who is in charge of solid waste management in the town. According to the survey's findings, 243 (75.23 percent) and 47 (14.55 percent) of the total respondents claimed the municipality and households, respectively, are responsible for the town's solid waste management.

The remaining 33 (10.22%) of the total respondents responded that solid waste management in the town is shared between the municipality and the households (Table 6).

Table 6: Households response for methods of disposal and responsible body for SWM in the town

Method of Disposal	**No.**	**Percent of Responses**
Open air burning	38	11.76
Solid waste collectors take it	6	1.86
Throw in an open space (on the street)	140	43.34
Dispose in nearby river	78	24.15
Throw into drainage	58	17.95
Others	3	0.09
Total	**323**	**100.0**
Responsible Body for SWM		
Households	47	14.55
Municipality	243	75.23
Municipality & Household	33	10.22
Total	**323**	**100.0**

Source: Own Survey

Only 30 (9.29%) of the total respondents received solid waste collection service from the municipality or a private service provider in the town, according to table 7. 4 (1.23%) and 26 (8.05%) of the respondents who received solid waste service received it once a week and occasionally, respectively. Furthermore, around 28 (8.66%) of respondents are dissatisfied with the current solid waste collection service offered to them in the town, while just 2 (0.6%) are satisfied (Table 7).

Table 7: Response of households who get SWC service and their satisfaction

SWCS Service in the Town (n=323)	No	Percent
Yes	30	9.29
No	293	90.71
Frequency of Service per week (n=206)		
Once	4	1.23
Irregular	26	8.05
Satisfaction with the SWCS Service (n=30)		
Yes	2	0.6
No	28	8.66

Source: Own Survey

4.1.3. Households Response for Impacts of Unsound Solid Waste Management

When asked about the environmental consequences of improper solid waste disposal, 308 people (95.35 percent) said they were aware of the consequences in their community. Respondents were also questioned whether they believe that improper garbage disposal has an impact on the health of household members. As a result, nearly all of them 320 (99.07 percent) of households believe that improper solid waste disposal is harmful to family members' health (Table 9).

Table 8: Response of households' awareness on impacts of unsound SWM on environment (n=323)

Environmental Awareness	No.	Percent
Yes	308	95.35
No	13	4.65
Health Concern Among Members		
Yes	320	99.07
No	3	0.93

Source: Own Survey

4.1.4. Households Willingness to Pay for solid waste collection service in Burayu Town

According to the study's findings, about 310 (95.98 percent) of the total respondents were willing to pay for the town's solid waste collection service. The remaining 13 (4.02%) respondents, on the other hand, were unwilling to pay for the planned project. The respondents were asked why they were willing to pay for solid waste collection service or not, in order to determine whether they fully comprehended the circumstance. The unwilling 13 respondents were further questioned about why they were unwilling to pay for the proposed system from a list of options. Accordingly, four (1.23 percent) of the hesitant respondents chose "lack of income" and "we don't have faith in the proposed initiative" from the supplied options, respectively. Furthermore, the other three hesitant respondents (0.92 percent) and two (0.62 percent) chose "it is the government's responsibility" and "happy with the existing service," respectively (Table 10).

Table 9: Households' willingness to pay for Solid waste collection service

Willingness to pay	**No**	**Percent**
Yes	310	95.98
No	13	4.02
Total	**323**	**100**

Source: Own Survey

The WTP responses of households for the double-bounded value elicitation format are shown in Table 11. Furthermore, as shown in the table below, the proportion of "yes-yes" replying patterns for the initial bid plus is bigger than the proportion of "yes-yes" answering patterns for the initial bid negative. This demonstrates the respondents' desire to make their environment more appealing or clear. "Yes-no" and "no-yes" responses imply that respondents' willingness to pay is somewhere between the initial bid amount and the raised and decreased bid amounts, respectively. As a result, this result can be taken as evidence of the CVM replies' internal validity, verifying the choice of an efficient bid design (Banga et al., 2011). (Table 11).

Table 10: Respondents' willingness to pay response for the initial and follow-up bids

Initial bid*	**WTP****				
	Yes-Yes	Yes-No	No-Yes	No-No	Total
50	175(56.45)	133(42.90)	2 (0.64)	_____	310

** Values in parenthesis are percentages

Source: Own Survey

4.2. Econometric Analysis

4.2.1. Specification Tests for the Probit and Tobit Models

In econometric analysis, data exploration is a crucial first step. As a result, the correlation matrix constructed using the data demonstrates that there is no multicollinearity problem because the mean variance inflation factor (VIF) for both the probit and Tobit models is 1.31, which is less than 10. (see appendix 4 & 10). For the probit model, the robust standard error was utilized to account for the problem of heteroscedasticity of error terms. The 'linktest' for joint model specification was employed, and the pr7m]/obability of hatsq was found to be 0.317 and 0.443, respectively, which is equivalent to 31.7 percent and 44.3 percent for the probit and Tobit models, and it is good for model specification mistake (see appendix 3 & 9).

4.2.2. Probit Model Estimation Results

The probit model was used to show the link between the explanatory factors and households' willingness to pay for solid waste collection service. The coefficients of each significant variable were interpreted using the average marginal effects. Environmental awareness (Awarenv), amount of solid waste generated (Amountswg), sex, health effect on households (Heffect), currently married (Cmarr), education, and households' intention to live in the area (HHpresidence) are found to have no significant impact on households' willingness to pay for solid waste collection.

The model's findings reveal that household income has a positive and substantial impact on households' willingness to pay for solid waste collection service at the 1% level of significance. This link is in line with the expected sign as well as the findings of other

studies in the literature (Dagnew et al., 2013; Banga et al., 2011; Tamru, 2019; Alhassan; et al., 2017). Households with greater incomes are more prepared to pay for the upgrade and are more likely to accept the improved SWC service. Keeping all other variables fixed, a 1% increase or decrease in a household's total monthly income results in a 4.96 percent increase or decrease in the likelihood of accepting the improvement.

At a 1% level of significance, the existing state of solid waste management was found to be positively and significantly related to households' willingness to pay decision for the service. This result contradicts the expected sign and the findings of previous studies in the literature (Dagnew et al., 2013; Ayenew et al., 2019). This is because people who believe the existing state of waste management is worse are more likely to be dissatisfied with the current state of solid waste collection service and are more prepare'd to pay for and accept the solution given to them. When all other factors are similar, households who regard the current state of solid waste management as poor have a 5.92 percent higher likelihood of being willing to pay for an improvement than households who perceive the current state as good.

When compared to older household heads, younger age household heads have a positive and substantial readiness to pay for improved SWC service at a one percent level of significance. This could be because households with children seek a better quality of life and are more worried about solid trash collection. Younger household heads are more likely to pay for SWC services and have a higher likelihood of WTP (0.17 percent higher). This result matches the expected sign as well as the findings of other studies in the literature (Endalew & Tassie, 2018; Selamawit et al., 2019).

At a 1% level of relevance, home ownership affects people's willingness to spend for improvements in a favorable and meaningful way. Households who own their homes had a higher likelihood of being willing to pay for the SWC service than those who live in rented homes, as expected. With all other variables held equal, persons who live in their own home have a 7.92 percent higher chance of accepting an improvement in solid waste collection service than those who live in rented housing. This results is also in line with the findings of previous studies published in the literature (Dagnew et al., 2013; Banga et

al., 2011). This could be due to a security component of willingness to pay, where homeowners know they will be staying in their houses for a long time, or if they decide to sell, better waste management in the neighborhood will boost the value of their home.

At a 1% level of significance, the length of time spent in the neighborhood has an inverse and substantial effect on willingness to pay for solid waste collection service. Keeping all other variables constant, households who have only resided in the area for a short time are more prepared to pay and have a 0.19 percent higher chance of WTP for solid waste collection service than those who have lived in the area for a longer time. This result differs from the expected sign, although it is in line with the findings of other research in the literature (Tamru, 2019).

When household size is taken into account, the relationship between WTP and household size is quadratic, and it has a negative impact on the likelihood of wanting to pay for solid waste collection service. It's worth noting that the impact varies depending on the size of the family. That is, the impact is often positive for large family sizes compared to medium and small family sizes.

Table 11: Probit Model Regression Result

Dependent Variable: Households' WTP for solid waste collection 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	323		
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. Tobit Model Estimation Result

The Tobit model displays the relationship between respondents' maximum willingness to pay (MWTP) and the model's explanatory factors. The coefficients of significant factors were interpreted using average marginal effects. The next sections describe the

significant relationships between explanatory variables and respondents' MWTP.

At a 1% level of significance, the model's results demonstrate that income is positively and significantly connected to the respondent's maximal willingness to pay. In other words, a 1% increase in monthly total income correlates to a 0.09 percent rise in the likelihood of wanting to pay the maximum cost for the town's solid waste collection service. Furthermore, when families' income improves by 1%, their maximum willingness to pay increases by 19.36 ETB for all observations and 15.42 ETB for willing observations. This result is in line with the expected sign and findings from previous research published in the literature (Banga et al., 2011; Tamru, 2019; Bhattarai, 2015; Alhassan; et al., 2017).

At a 1% level of significance, being a female household head has a negative and significant impact on willingness to pay the maximum amount. Other things being equal, females are 7.29 percent less likely than males to be willing to pay the full sum. Females are also less likely to spend 16.15 ETB for all observation and 12.86 ETB for voluntary observation than their male counterparts. This result differs from the expected sign, although it is consistent with the findings of previous research in the literature (Bhattarai, 2015; Alhassan et al., 2017; Endalew & Tassie, 2018).

At a 5% level of significance, the length of residence has a negative and significant effect on the willingness to pay the maximum sum. Households who have been in the neighborhood for a longer time are less inclined to pay the maximum amount than those who have lived there for a shorter time. Keeping all other factors equal, households who have lived in the same place for a longer period of time are 0.17 percent less likely to be willing to pay the maximum cost for better service. Furthermore, respondents who resided in the area for a longer period of time are prepared to pay roughly 13.05 ETB less for all observation and 10.22 ETB less for willing observation than respondents who were in the area for a shorter period of time. This result is in line with the expected sign as well as the findings of other studies in the literature (Tamru, 2019).

Table 12: 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	0.023**	-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	323	13 left-censored observations at MWTP<=0
Wald chi2(14)	65.40	323 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

4.2.4. Mean WTP Estimation Result and Aggregate WTP

Out of 13 respondents with a zero willingness to pay valuation, 7 were considered protest responses to the valuation question based on their response to the debriefing question. Respondents who stated "I don't believe in the proposed project" or "It is the

government's obligation to provide the service" were classified as protest zeros (invalid responses) and were excluded from the mean willingness to pay valuation. Respondents who indicated "I can't pay because I don't have enough money" or "I'm content with the current service" are included in the mean WTP calculation and are deemed real or legitimate zero bids. "I don't have faith in the planned project" and "It is the government's job to provide the service for free," respectively, said 1.24 percent (4) and 0.93 percent (3) of the total 13 respondents with zero WTP. "I cannot afford" and "I'm content with the existing service," respectively, said the remaining 1.24 percent (4) and 0.62 percent (2) of the hesitant respondents. "I cannot afford" and "I'm content with the existing service," respectively, said the remaining 1.24 percent (4) and 0.62 percent (2) of the hesitant respondents. There are a total of seven invalid responses from protest zero. As a result, the mean WTP calculation is based on 316 responders out of 323 total sample observations.

The mean WTP produced via an open-ended value elicitation format for a household was around 59.7 ETB per month pay for an average 7.28 sack per month of solid waste production for a household as shown in Table 13, with the 95 percent confidence interval showing 55.6 ETB and 63.8 ETB lower and upper bounds, respectively.

Table 13: 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 mean WTP produced from double-bounded value elicitation format was computed using the ‘doubleb' command estimation result in table 14 below. The delta approach, which included all covariates, was used to estimate mean WTP from the initial and follow-up bid responses using Stata's nlcom (non-linear combinations of estimators) command. The lower and upper boundaries are shown in the 95 percent confidence interval. The results revealed that the mean WTP obtained from the double bound response was 65.3 ETB per month pay for an average 7.28 sack per month of solid waste production of a household with the lower bound ETB 54.8 and the upper bound 76.2

ETB. Thus, the mean WTP obtained from double-bounded format is greater than the open-ended format.

***Table 14**: Mean WTP Estimation Result from Double-Bounded Value Elicitation Format*

	Coefficient	Z	P>|z |	[95% conf. interval]	
Mean WTP	65.26169	21.50	0.000***	54.79189	76.23149

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

The total WTP of households is the total amount of money that will be spent in Burayu town to provide SWC service. The total WTP is calculated by multiplying the mean WTP by the number of homes with valid replies. As a result, out of the total number of households in the town, 2,412 were projected to have invalid responses. Households that were removed from calculating the mean WTP were also excluded from calculating the total WTP.

The total WTP each month from the open-ended format is about 1,913,862.6 ETB and is calculated by multiplying the total number of households with valid responses (32,058) by the mean maximum WTP (59.7 ETB). The total monthly WTP received from the double-bounded value elicitation format is about 2,093,387.4 ETB, and is determined by multiplying the mean WTP obtained from the double-bounded responses (65.3 ETB) by the total number of households with valid responses. As a result, households in Burayu town's actual willingness to pay may fall somewhere between these two figures.

Table 15: 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			
34,470	747[a]	33,723 [c]	59.70	2,013,263.10[d]
34,470	747[b]	33,723 [c]	65.26	2,200,762.90[e]

Source: Own calculation

[a]There are 7 (2.12 percent) protest zeros out of a total of 323 observations. The number of

households predicted to have protest responses are 7 times 106.71 gives the total number of households expected to have protest responses (747).

[c]The difference between the total number of households (34,470) and the number of households with incorrect responses (747).

[d]Total WTP calculated as the average of open-ended format WTP.

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

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1. Conclusion

Waste is an unavoidable result of a society's consumption and production activities; as a result, appropriate waste management is becoming a critical problem in cities all over the world, particularly in developing countries with severe financial and technical constraints. Solid waste, particularly insufficient collection and incorrect disposal, is a serious challenge for many quickly growing cities in developing countries due to a lack of appropriate planning, weak governance, resource restrictions, and incompetent management.

The goal of this study is to look into households' WTP in order to improve home SWC in Burayu. CVM was utilized to estimate households' WTP utilizing double-bounded and open-ended value elicitation formats in the study. A stratified random sampling procedure was used to choose the sample houses from the town's two Kebeles. The study chose 171 and 152 households from Burayu Gafarsa and Gafarsa Guje, respectively, based on their household or population share of the overall household or population number of the town. The face-to-face interview was successfully completed by 323 households out of a total of 330 sample houses.

The study's findings revealed that the town's generated solid waste is inadequately handled, and that the town's SWC service is limited to specified regions. Furthermore, the town's solid waste management condition is currently dire. Poor solid waste management in the town had a significant influence on human health and the environment, resulting in water and air pollution from waste dumped in open spaces, into the surrounding river, and unregulated dumping. As a result, a large percentage of the town's citizens (95%) were willing to pay for SWC service. Furthermore, higher monthly household income, the age of younger household heads, household heads who believed the current environmental situation was the worst, household heads who owned a house, shorter duration of residence in the area, and smaller household sizes all predicted positive willingness to pay for improved SWC service.

Open-ended and double-bounded value elicitation formats yielded mean WTP values of 59.7 ETB and 65.3 ETB per month for a household, respectively. The total WTP for improved SWM services calculated using open-ended and double-bounded value elicitation formats is approximately 1,913,862.6 ETB and 2,093,387.4 ETB, respectively. Furthermore, total monthly income of the respondents, male household heads, and shorter time of residency all positively predicted the maximum WTP for SWC services.

5.2. Recommendation

Based on the research findings and conclusions, the researcher has proposed the following recommendations as solution steps that all stakeholders should adopt to tackle the study area's solid waste collecting con`cerns.

- The town's municipality works hard to provide regular residential solid trash collection services in order to improve the current status of solid waste management in a sustainable manner.
- To produce a clean, safe, and healthy environment in the town, the local authorities or municipality, as well as the town's concerned entities, should plan, implement, and monitor a context-specific SWC project.
- The municipality of the town should invest in or create an environment that encourages private investment in the disposal of solid waste generated in the town for composting and recycling.
- The town's health departments should make a concerted effort to raise public awareness about the negative effects of inappropriate solid waste disposal on the environment and human health.
- Because the majority of residents practice, throw in an open space (on the street), and dispose in a nearby river & drainage, the town's environmental protection and climate change bureau must work on it to improve the adverse effects on the environment's quality.
- There is a lot that needs to be done on the household level to keep those who are the source and sufferer of solid trash accountable for good waste management.
- The city administration's solid waste management rules and regulations shall be followed. Individuals and households who do not follow the guidelines should

face legal consequences.

- Increase the number of Micro and Small Scale Enterprises in all kebeles for a proper collection of waste from households.
- Since the financial constraint is one of the main problems, the participation of household important to pay for solid waste collection service in the city.
- The city administration should provide the proper primary collection equipment like hand push carts for the Micro and small scale enterprises.

- The municipality might use the study's mean WTP as a guide when determining an economically viable fee.
- Conduct a comprehensive social and environmental impact evaluation of the dumping site, which is conveniently placed in the heart of the city.

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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	aaa-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	0.960	SD dependent var	0.197
Pseudo r-squared	0.147	Number of obs	323
Chi-square	78.411	Prob > chi2	0.000
Akaike crit. (AIC)	120.995	Bayesian crit. (BIC)	209.162

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

Appendix 2: Average Marginal Effects for Probit

Average marginal effects Number of obs = 323

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 3: Linktest for Probit

Number of obs = 323
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 4: 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 5: 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 6: Average Marginal Effects on the Probability of Being Censored

Average marginal effects Number of obs = 323

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 7: Average Marginal Effects for the Censored Sample

Average marginal effects Number of obs = 323

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 8: Average Marginal Effects for the Truncated Sample

Average marginal effects Number of obs = 323

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 9: Linktest for the Tobit Model

Tobit regression — Number of obs = 323

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	48.9001.818				45.327 52.474	

Appendix 10: 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 11: 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]))

	Coefficient	Z	P>|z |	[95% conf. interval]	
Mean WTP	65.26169	21.50	0.000***	54.79189	76.23149

Appendix 112: 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 Solid waste collection service in Burayu 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. Burayu 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 Burayu 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 Solid waste collection service (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 SWC service?

    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 SWC service?

    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 SWC service?

    A. Yes B. No

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

19. Would you be willing to pay _____ ETB per month for SWC service?

    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 SWC service?
    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 SWC 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 D. Unemployed B. Trader E. Others _____ C. Self-employed
27. Marital status A. married D. Divorced B. Single 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._____

Thank you for your cooperation!