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**Households Willingness to Pay for Improved Municipal Solid Waste
Management in Dilla Town, Ethiopia**

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This is to certify that the thesis prepared by Tamru Shemelis, entitled: *Households Willingness to Pay for Improved Municipal Solid Waste Management in Dilla Town, Ethiopia* and submitted in partial fulfillment of the requirements for the Degree of Master of Science in Economics (Resource and Environmental Economics) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Declaration

I hereby declare that this MSc thesis entitled “*Households Willingness to Pay for Improved Municipal Solid Waste Management in Dilla Town, Ethiopia*” was carried out by me for the degree of Master of Science in Economics (Resource and Environmental Economics) under the guidance and supervision of Adane Tuffa (PhD).

For the present thesis, which I am submitting to the University, no degree or diploma or distinction has been conferred on me before, either in this or in any other University. Moreover, I took reasonable care to ensure that the work is original, and, to the best of my knowledge, does not breach copyright law, and has not been taken from other sources except where such work has been cited and acknowledged within the text.

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Date_____

Abstract

This study used a cross-sectional survey of 381 randomly selected respondents to investigate households' willingness to pay (WTP) for improved municipal solid waste management (MSWM) in Dilla town. The survey was conducted using a direct face-to-face interview method. The study employed double-bounded followed by open-ended value elicitation format to estimate households' mean WTP. The probit and tobit models were used to investigate the determinants of households WTP. The findings of the study revealed that there is a serious problem of MSWM in the town. The solid waste generated from the town is poorly managed. As a result, this is creating negative impacts on the environment, human health, and economic activities of residents. About 91.6 percent of the total respondents were willing to pay for improved MSWM. The results of the probit and tobit models revealed that income of households and awareness of respondents about the impacts of poorly managed solid waste on the environment have positive and significant effects on the households WTP response for the initial bids and on the households MWTP respectively. Age of the respondents and satisfaction with the existing system variables have also positive and negative significant effects on the households WTP response for the initial bids respectively. The solid waste generated by households, plan of households and duration variables have positive and significant effects on the households MWTP. The mean WTP values obtained from open-ended and double-bounded value elicitation formats are about ETB 10.7 and ETB 12.36 per month for a household respectively. This study recommended that the mean WTP can be used as a guide for the municipality to determine the socially acceptable fee. The local authorities should work hard on awareness creation for the residents about the impacts of poorly managed solid waste on the environment and human health through mass media and campaign. In order to create a clean, safe, and healthy environment in the town, both the local authorities and residents of the town should cooperate and take the responsibility of SWM.

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Acronyms

AWTP	Average Willingness to Pay
BBC	British Broadcasting Corporation
CE	Choice Experiment
CIWM	Chartered Institution of Wastes Management
CLM	Conditional Logit Model
CM	Choice Modeling
CV	Contingent Valuation
CVM	Contingent Valuation Method
DTAOFED	Dilla Town Administration Office of Finance and Economic Development
DTMO	Dilla Town Municipality Office
ETB	Ethiopian Birr
FDRE	Federal Democratic Republic of Ethiopia
GHS	Ghanaian Cedi
GNP	Gross National Product
IDMC	Internal Displacement Monitoring Centre
ISWA	International Solid Waste Association
JB	Jarque-Bera
LCM	Latent Class Models
LM	Lagrange Multiplier
MEF	Ministry of Environment and Forest

MSE	Micro and Small Enterprises
MSW	Municipal solid waste
MSWM	Municipal Solid Waste Management
MWTP	Maximum Willingness to Pay
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OECD	Organization for Economic Co-operation and Development
RP	Revealed Preference
RPLM	Random Parameter Logit Model
SK	Skewness-Kurtosis
SNNP	Southern Nations, Nationalities, and Peoples
SP	Stated Preference
SUBVP	Seemingly Unrelated Bivariate Probit
SWM	Solid Waste Management
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs
UNEP	United Nations Environment Programme
UN-Habitat	United Nations Human Settlements Programme
USD	United States Dollar
USWM	Urban Solid Waste Management
VIF	Variance Inflation Factor

WRD Waste-Related Diseases

WTA Willingness to Accept

WTP Willingness to Pay

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Waste management is the concern of everyone and a universal growing issue associated directly with the way society produces and consumes. “*Waste management is a basic human need and can also be regarded as a basic human right*” (Wilson et al., 2015, P. 2). Delivering an improved solid waste management service has an importance in terms of making the overall municipal management effective and is usually a pre-condition for other more complicated municipal services (Hoorweg & Bhada-Tata, 2012).

Urbanization and economic development are the principal causes of the generation of municipal solid waste. The amount of solid waste generated increase when economic development and the rate of urbanization is higher (Hoorweg & Bhada-Tata, 2012; Kaza et al., 2018). The amount of urban waste in developing countries is growing rapidly due to increasing living standards and migration of rural population to urban areas. Moreover, municipal solid waste generation rates depend on factors such as income levels, socio-cultural patterns and climatic factors (Wilson et al., 2015).

The world generated 2.01 billion tonnes of municipal solid waste in 2016. The amount of this solid waste is expected to increase to 2.59 billion tonnes by 2030 and 3.40 billion tonnes by 2050. Low-income countries generated 93 million tonnes of municipal waste that is 5 percent of the global waste in 2016 and this number is expected to grow by more than three times by 2050. One hundred and seventy-four million tonnes of waste at a rate of 0.46 kilogram per capita per day was generated in Sub-Saharan Africa region in 2016 and this number is expected to increase to nearly threefold by 2050 (Kaza et al., 2018).

Urban solid waste generation rates and greenhouse gas emissions have a strong correlation (Hoorweg & Bhada-Tata, 2012). The world generated an estimated 1.6 billion tonnes of carbon dioxide equivalent greenhouse gas emissions from solid waste in 2016 and this number is expected to increase to 2.6 billion tonnes of carbon dioxide equivalent by 2050 if there is no improvement in this sector. As a result, solid waste contributes to climate change at the global level (Kaza et al., 2018).

The issue of solid waste is a universal problem that significantly affects public health, the environment and economy (Hoorweg & Bhada-Tata, 2012; Kaza et al., 2018). Air pollution from the burning of waste, contamination of groundwater and surface water by leachate are some of the environmental threats of uncollected solid wastes (Hoorweg & Bhada-Tata, 2012). Unmanaged and improperly managed wastes affect economic development such as through diminishing tourism (Kaza et al., 2018). Accumulation as well as poorly managed wastes often clog drains and cause the stagnation of water, breeding of mosquitoes and create a favourable condition for the propagation of germs, insects, and rats, and thereby causing the creation of dangerous bacterial, viral and parasitic diseases (UN-HABITAT, 2010).

Proper solid waste management contributes to all three pillars of sustainable development such as environmental, economic and social by improving economic efficiency especially in resource extraction and use via waste prevention, reuse, recovery or recycling; by reducing the budget needed for solid waste collection services, by reducing adverse impacts on health and the local as well as general environment; by delivering more attractive and pleasant human settlements and social amenity; and by creating employment opportunities especially for the poor people (Hyman, 2013). For instance, solid waste management (SWM) has an importance in terms of creating employment opportunities in developing countries although workers involved in the sector are exposed to occupational and health risks (UN-HABITAT, 2010). According to Medina (2010; cited in Kaza et al., 2018), about 1 percent of the urban population, or more than 15 million people in the world earn their living informally in the waste sector.

Although urbanization has importance in Ethiopia via creating opportunities for improved energy availability, better road infrastructures, and improved housing conditions, it also created growing challenges in sanitation and waste management systems and thereby serious health problems for people living in urban areas. Because of duplication of effort and unclear roles among various actors or stakeholders, urban solid waste management (USWM) in Ethiopian cities and towns is poorly coordinated as well as difficult to systematically manage. The various sectors working on USWM lacks integration, harmonization, and alignment among themselves. Moreover, the knowledge and attitudes of the urban population to USWM is low (Abera et al., 2015).

Solid waste management (SWM) is a challenging problem in Dilla town. But, the municipality has given no attention to the problem so far. Components of an integrated SWM such as formal and informal recycling, source segregation and composting are not available in the town. There is an area of 10,000 square meters engineered landfill site in the northwestern outskirts located 7 km from the center of the town. However, the landfill site has become a controlled open dumpsite due to lack of equipment and machines such as compactors, bulldozers, loaders, and monitoring staff. Households' awareness about SWM is adequate enough. Even though households have initiated door-to-door solid waste collection in the town and started segregation at the household level, it failed due to lack of efficient primary and secondary collection that discouraged the community's buy-in (UNEP, 2016).

1.2 Statement of the Problem

The amount of solid waste is increasing in Ethiopia due to the rising of the human population, increased economic status, changing consumption patterns, urbanization, and industrialization (UNEP, 2016). The number of people living in urban areas as well as urban areas in Ethiopia is increasing and resulting in a rapidly growing sanitation and SWM problem. However, cities and towns in Ethiopia do not have sufficient waste handling and disposal systems (Abera et al., 2015).

Poorly managed municipal solid waste in Dilla town is a serious problem that creates negative health, environmental and economic impacts on the residents. There is no adequate municipal solid waste management (MSWM) system in the town (World Bank, 2010; UNEP, 2016). The municipal solid waste generated in Dilla town is inappropriately disposed of either in open dumpsite or directly in the environment. As a result, the residents of the town are exposed to health problems and the natural ecosystem is deteriorated in the town. Moreover, the problem has also negative implications on the natural and aesthetic value since the town is considered as commercial and touristic area (World Bank, 2010).

An estimated 70 cubic meters of solid waste per day is generated in Dilla town. The door-to-door collection service is provided by 18 micro and small enterprises (MSE) cooperatives in the town. The MSE cooperatives have sacks and animal-drawn carts, and collect and transport solid wastes using the municipal vehicles. The town generated waste at the rate of 0.25 kilogram per day per capita (kg/day per capita), an estimated 6,861 tonnes of waste per year and 5,853 tonnes of carbon dioxide equivalent greenhouse gas emissions per year from solid waste. The characteristics of waste are organic 64.6 percent, paper 3.7 percent, plastic 2.8 percent, glass 1.2 percent, ferrous metals 1.4 percent, rubber or leather 1.4 percent, wood 3.5 percent, and others 21.4 percent (UNEP, 2016).

Currently, the amount of solid waste generated from Dilla town is increasing due to an increase in the number of residents. An estimated 80 cubic meters of solid waste per day is generated in the town in 2018. The municipality has four vehicles to collect and transport solid waste to the landfill site. The municipality planned to increase the coverage of solid waste collection and removal to 60 percent. However, most of the time the plan of the municipality remains on the

paper and it could not achieve the targeted plan due to mainly financial constraints, shortage of educated manpower and maladministration (DTMO, 2018).

In order to ensure sound MSWM, the first steps are providing a reliable solid waste collection service to all residents and eliminating uncontrolled dumping and open burning (Wilson et al., 2015). Moreover, effective waste collection service is a principal step to reduce pollution and to improve public health and traffic congestion (Kaza et al., 2018). More than 2 billion people in the world and around half of the people living in cities in lower-income countries do not have a solid waste collection service (Wilson et al., 2015). In the case of Dilla town, half of the residents have access to solid waste collection service. An estimated 42.8 percent of the total solid waste generated is collected and transported to the disposal site of the town (UNEP, 2016). The municipality also confirmed that about 40 up to 45 percent of the total solid waste generated is collected and transported to the landfill site (DTMO, 2018). This shows the remaining 57.2 percent of the total solid waste generated is not collected and thus the probability of residents of the town being exposed to health and environmental problems is high.

Urban solid waste management (USWM) is expensive that requires an allocation of adequate municipal budget and on average consumes 20 percent of municipal budgets of cities in low-income countries like Ethiopia. These countries spend less that is about \$35 per tonne, to provide SWM service for people living in urban areas (Kaza et al., 2018). Hence, waste management requires the involvement of different stakeholders with different fields of interest in developing countries. Thus, citizens of these countries should share the responsibility of creating a clean environment in cities or towns with the municipality (Guerrero et al., 2013).

Collecting fees from the residents of a city or town is the feasible option to finance solid waste management service when the municipalities are unable to manage the amount of solid waste generated (Maskey & Singh, 2017). In Dilla town, the local authorities have given no attention to the waste management service although the problem is challenging to the residents. The local authority allocated 115,000 Birr for SWM for the 2014/2015 (2007 Ethiopian Calendar) fiscal year. However, this was not sufficient to offer full SWM services. Hence, an estimated additional 325,000 Birr was required to provide full service (UNEP, 2016). For the 2018/19 (2011 Ethiopian Calendar) fiscal year, the local authority of the town allocated 135,000 Birr per year

which is too low for SWM. Even though the allocated budget has increased relative to the previous years, an additional budget is required to offer full SWM service. Moreover, there is no fee imposed by the municipality on residents of the town for SWM service although the participation of the residents in SWM is vital. This requires the willingness and participation of households to fill the budget gap and thereby provide full SWM service in the town. However, households' willingness to pay (WTP) for such a service is in question until it is proved by research and their WTP depends on a number of demographic, socioeconomic and environmental factors.

Many studies are conducted on the willingness of households to pay for improved SWM in Ethiopia and the rest of the world. These studies also identified the factors that affect households' willingness to pay for SWM service. For instance, factors that significantly affect households' willingness to pay are level of income, education, household size, gender (Bhattarai, 2015; Birara & Kassahun, 2018), awareness of environmental quality (Dagnew et al., 2013; Maskey & Singh, 2017), age, marital status (Alhassan et al., 2017), possession of house and amount of waste generated by households' (Muhdin et al., 2016). Moreover, waste collection service also significantly affects households' willingness to pay (Maskey & Singh, 2017; Birara & Kassahun, 2018).

There is a study conducted by Gezahegn et al. (2018) on the composition and characterization of municipal solid waste in the landfill site of Dilla town. This study identified the different composition of physical waste materials in the upper, middle and lower layer of the town's landfill site. To the best of my knowledge, studies on households' willingness to pay for improved SWM in Dilla town are totally absent so far. Thus, conducting a study on SWM in the town is crucial in order to know the willingness to pay (WTP) of the residents that help to create a clean, safe and healthy environment for the residents of the town. Therefore, this study addressed the following research questions.

- What is the current or existing situation of MSWM service in Dilla town?
- Are the households satisfied with the existing MSMW service of the town?
- Does the poorly managed solid waste affect the quality of the environment, economic activity, and health of households?
- What are the factors that affect households' WTP for improved MSMW service in the town?
- How much are the households willing to pay for improved MSWM service in the town?

1.3 Objectives of the Study

1.3.1 General Objective

The general objective of this study is to investigate households' willingness to pay for improved municipal solid waste management in Dilla town.

1.3.2 Specific Objectives

The specific objectives of this study are to:

- Assess the current or existing situation of MSWM service in Dilla town
- Explore whether the households are satisfied with the current MSWM service of the town
- Assess the impacts of poorly managed solid waste on the environment, economic activity and health of households
- Explore the factors that affect households' WTP for improved MSWM in the town
- Estimate households' mean and total WTP for improved MSWM service in terms of monetary value

1.4 Scope of the Study

The conceptual scope of the study was limited to the willingness of households to pay for improved MSWM in Dilla town. This study does not incorporate or consider other types of solid wastes such as industrial, agricultural and so on. Hence, this study focused on municipal solid waste or urban solid waste only in Dilla town. The geographical scope of the study was delimited to Dilla town, Ethiopia.

1.5 Significance of the Study

Conducting a study on solid waste management has an importance in terms of creating a clean, safe and healthy environment in urban areas and to improve sanitary and public health. The findings of the study will provide a lot of information for the local authority about the characteristics of the residents of the town and their estimated amount of willingness to pay in terms of monetary value for improved solid waste management. Moreover, the local authorities can provide full SWM service by filling the budget gap through taking the WTP of residents of the town. The study can also be a guiding tool for other researchers who are interested to conduct studies on households WTP for improved SWM in other cities or towns of Ethiopia and other developing countries.

The remaining part of the thesis is organized as follows. Chapter two focused on a review of related literature. The methodology of the study was presented in Chapter three. Chapter four was focused on discussions and findings of the study and finally, the last chapter was focused on conclusion and policy implications.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Theoretical Literature

2.1.1 Introduction

Solid wastes refer to non-liquid materials which have no value to the person who is responsible for them. The words such as rubbish, garbage, trash, or refuse are synonyms with solid waste and often used interchangeably (Zhu et al., 2008). “*Solid wastes include municipal garbage, industrial and commercial waste, sewage sludge, wastes resulting from agricultural and animal husbandry operations and other connected activities, demolition wastes and mining residues*” (UN, 1997, p. 69). According to ISWA (2015), the total global waste generation accounts for 7 to 10 billion tonnes per year. Out of the total global waste generated, 36 percent, 21 percent, 11 percent, 5 percent, and 3 percent are categorized as construction and demolition waste; industrial waste; commercial waste; water supply, sewage treatment, waste management, and land remediation; and energy production respectively. The remaining 24 percent or an estimated 2 billion tonnes of the total global waste generated is a municipal solid waste (MSW).

Municipal solid waste (MSW) or urban solid waste is one component of solid waste in which its definition varies between countries and scholars in different professions. MSW incorporates waste generated from households, commerce and trade, office buildings, institutions and small businesses, yard and garden, street sweepings, contents of litter containers, and market cleansing. However, waste generated from municipal sewage networks and treatment, and municipal construction and demolition are excluded from MSW (OECD, 2008). According to Vergara and Tchobanoglous (2012), all solid or semi-solid materials except hazardous wastes and wastewater disposed of by residents and businesses are considered as MSW. MSW assumed to incorporate all community wastes without including wastes generated by municipal services, water, and wastewater treatment plants, industrial processes, and agricultural operations (Tchobanoglous & Kreith, 2002).

All activities and actions required to manage waste from the starting point of waste generation to the final disposal site are referred to as solid waste management (SWM) (Elagroudy et al., 2016). According to the UN (1997), SWM refers to “*supervised handling of waste material from generation at the source through the recovery processes to disposal*” (p. 69). Solid waste has negative impacts on the environment, human health and the economy when the generated waste is poorly managed. But, there are also opportunities derived from proper solid waste management (Hyman, 2013). Solid waste can offer benefits when it is considered as a resource that can be reused, recycled and reconverted to different type of uses (Hyman, 2013). Addressing the problem of poor management of MSW in cities or towns provides co-benefits at the local and global level. At the local level, improving MSWM can generate high economic rates of return via significant environmental, social and public health benefits. At the global level, MSW generates 15 percent of global emissions of methane, a potent greenhouse gas. Hence, improving MSWM can contribute to climate change mitigation via reducing emissions of methane from poorly managed MSW (Lee et al., 2014).

2.1.2 Components of SWM

According to Harvey et al. (2002), solid waste management can be categorized under the following five key components.

i) Generation

Solid waste generation is the stage at which materials of the owner or user become valueless after consumption. However, the generated solid wastes may be important for other purposes even though the first user requires them no longer. According to Kaza et al. (2018), high-income and upper-middle income countries generate 34 percent or 683 million tonnes and 32 percent or 655 million tonnes per year of the world’s total solid waste respectively. Moreover, 29 percent or 586 million tonnes and 5 percent or 93 million tonnes per year of the global total solid waste are generated by lower-middle income and low-income countries respectively.

ii) Storage

This involves activities associated with the management of the generated solid wastes before collection and final disposal. In this stage, different types of solid waste disposal or storage materials such as containers, shallow pits, and communal depots are required to accumulate the generated solid wastes.

iii) Collection

It refers to the ways of collecting solid wastes for transportation to the final disposal site. According to Hoornweg and Bhada-Tata (2012), waste collection refers to the collection of solid wastes through various ways from point of production to the point of treatment or final disposal site. Since SWM is typically an urban service, solid waste collection rates are higher in urban areas than in rural areas. High-income countries collect 100 percent of waste in urban areas and 98 percent of waste in rural areas. Upper-middle-income countries collect 85 percent of waste in urban areas and 45 percent of waste in rural areas. About 71 percent of waste in urban areas and 33 percent of waste in rural areas is collected in lower-middle income countries. Moreover, low-income countries collect about 48 percent of waste in urban areas and 26 percent of waste in rural areas (Kaza et al., 2018). There are several ways of municipal solid waste collection (Hoornweg & Bhada-Tata, 2012).

A) House-to-House (Door-to-Door)

This refers to the collection of solid wastes from the residents by waste collectors. In other words, the waste collectors go to each resident's house to collect solid wastes.

B) Community Bins

In this case, there are community bins that are placed at fixed places where the households or residents bring their solid wastes to the place where the bins are placed.

C) Curbside Pick-Up

Based on the garbage pick-up schedule set by the local authorities, the generator of solid wastes put their garbage directly outside their homes.

D) Self-Delivered

Here, the generators of solid wastes deliver their garbage directly to the disposal sites or transfer stations, or hire third-party operators or the municipality.

E) Contracted or Delegated Service

In this case, businesses hire firms (or municipality with municipal facilities) who arrange collection schedules and charges with customers. Municipalities often license private operators and may designate collection areas to encourage collection efficiencies.

iv) Transportation

This is the stage at which the collected solid wastes are transported to the final disposal site by various modes of transport. The methods of transportation can be chosen depending on the availability and the volume of solid wastes to be transported. The types of transportation can be categorized under three groups; human-powered such as open hand-cart, hand-cart with bins, wheelbarrow and tricycle; animal-powered such as donkey-drawn cart; and motorized such as tractor and trailer, standard truck and tipper-truck.

v) Disposal

This is the final stage of SWM where the transported solid wastes are removed or treated in different ways. Here, there are four ways for the disposal of solid wastes. These methods are burial or landfilling (land application), composting, burning or incineration and recycling.

About 37 percent, 19 percent and 11 percent of solid waste generated around the world are disposed of in landfills, used for recycling and composting purposes, and treated via modern incineration. However, about 33 percent of the global solid waste is still openly dumped. Countries around the world have different solid waste disposal practices. For instance, 93 percent of solid waste is burned or dumped in roads, open lands, or waterways in low-income countries. The remaining 3 percent, 3.7 percent and 0.3 percent of solid waste are disposed of in landfills, used for recycling and composting purposes respectively. In high-income countries, 39 percent, 29 percent and 22 percent of solid waste is disposed of in landfills, used for recycling purposes, and treated via modern incineration respectively (Kaza et al., 2018).

2.1.3 Solid Waste Management in Ethiopia

The issue of waste management in Ethiopia is stated as one of the environmental rights in the country's 1995 constitution and in the solid waste management proclamation No. 513/2007. Article 44 No. 1 of the constitution states that all persons have the right to live in a clean and healthy environment. Moreover, article 92 No. 1 states that "*Government shall endeavour to ensure that all Ethiopians live in a clean and healthy environment*" (FDRE, 1995, p. 33). The solid waste management proclamation No. 513 aims to protect the negative impacts of poor SWM and enhance benefits from SWM by promoting active community participation. It also aims for the preparation of SWM action plans by urban local governments to enable community participation in SWM. The proclamation states that urban administrations should create favourable conditions to promote investment in the provision of SWM services (FDRE, 2007). The country has also ratified multilateral environmental agreements such as the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, the 1998 Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, and the 2001 Stockholm Convention on Persistent Organic Pollutants waste international conventions. The common objective of the three international conventions is protecting human health and the environment from hazardous chemicals and wastes (UNDESA, 2011).

The Basel Convention aims to protect human health and the environment via obligating its parties to properly manage their hazardous as well as other wastes in an environmentally sound manner and reducing the movement of solid waste and hazardous waste between countries. This international convention specifically also aims to prevent developed countries from transferring hazardous waste to less developed countries. The Rotterdam convention aims to protect human health and the environment by promoting shared responsibility and cooperative efforts among parties in the international trade of certain hazardous chemicals. The aim of the Stockholm Convention is protecting human health as well as the environment from highly dangerous, long-lasting chemicals by restricting and ultimately eliminating their production, use, trade, release, and storage (UNDESA, 2011).

SWM in Ethiopia is a sector that requires significant attention. The country has been working to provide adequate solid waste collection and disposal for its citizens. However, the local governments in urban centers of the country face challenges and are unable to manage the generated solid waste due to the rapidly growing of urban population, and the absence of a coordinated national SWM policy and a city-level action plan for integrated waste management policies (UNEP, 2016). Urban solid waste in Ethiopia is managed mainly by open burning and dumping. There is at least one unmanaged landfill in the major cities and towns of the country. Up to 43 percent of the waste generated is collected and disposed of in unmanaged landfills in urban areas of the country. The remaining waste is left in the streets and dumped in open spaces. The waste sector contributes 3 percent of the total greenhouse gas emissions in Ethiopia (MEF, 2015). The landfills are becoming the major source of greenhouse gas emissions because they are not well developed and properly managed. Moreover, many rivers are polluted due to the generation of urban and industrial waste (UNEP, 2016).

2.1.4 Impacts of Poorly Managed Solid Waste in Developing Countries

Properly managed solid waste has positive impacts on the environment, human health, and the economy for both developing and developed countries (ISWA & UNEP, 2002). However, poorly managed solid waste results in serious environmental pollution and this in turn causes serious harmful effects on human health and the environment (Nahman et al., 2018). Moreover, uncontrolled disposal via open dumping and open burning is still the norm in developing countries which leads to substantial public health and environmental risks (Wilson et al., 2015). In general, developing countries have similar trends of SWM in urban areas and the management system is often inefficient and operates at low standards (Aparcana & Hinostroza, 2015).

A) Environmental Impacts

Poor management of solid waste has significant negative impacts on the environment via land use, and pollution with hazardous substances that escape into air, water, and soils (ISWA & UNEP, 2002). For instance, open dumping and burning of solid waste are usual practices in low-income countries (Kaza et al., 2018). As a result, atmospheric pollutants can be generated due to the open burning of solid wastes and the decomposition of high volumes of organic waste in uncontrolled dumpsites (Nahman et al., 2018).

Open burning of solid waste is widely practiced in Africa and results in the generation of dioxins, polycyclic aromatic hydrocarbons and black carbon, which are highly toxic, carcinogenic and powerful short-lived climate pollutants respectively (UNEP, 2015; cited in Nahman et al., 2018).

B) Human Health Impacts

The impact of solid waste on human health are varied and depend on various factors such as the nature of solid waste, method of disposal, duration of exposure, population exposed and availability of mitigation intervention. This impact may cause psychological problem, morbidity, disability, and death. Poorly managed solid waste left near houses, on streets, in markets or in drainage channels can create a favourable condition for the breeding of disease-carrying organisms such as malaria-carrying mosquitos (Hoornweg & Bhada-Tata, 2012). Accumulated solid waste encourages vectors to breed that leads to infectious diseases such as cholera and dengue fever (Wilson et al., 2015). Moreover, the burning of solid waste results in toxins and particulate matter in the air and cause respiratory and neurological diseases (Thompson, 2014; cited in Kaza et al., 2018). Uncollected solid waste blocks drain and cause flooding and subsequent spread of water-borne diseases. For instance, an outbreak of a plague-like disease caused by a major flood in Surat, India, in 1994 caused panic countrywide. As a result, there were over 1000 plague suspected patients with the final death toll of 56 people (UN-HABITAT, 2010). Moreover, 14 people were killed, 43,000 people were affected, and 17,000 people lost their homes in Accra, Ghana in 2011 due to major floods exacerbated by the unorganized collection of plastic bags and other wastes which blocked drains (UNEP/OCHA, 2011).

Poor communities that spring up around dumpsites are vulnerable to direct physical risks due to uncontrolled dumping of solid waste. For instance, 113 people were killed due to solid waste landslide at the Koshe landfill in Addis Ababa, Ethiopia (Haywood, 2017). 16 people were also killed due to solid waste landslide at Hulene landfill in Maputo, Mozambique (Moshenberg, 2018; cited in Nahman et al., 2018). Landslides at Payatas dumpsite in Quezon City, Philippines in July 2000 and at Bandung dumpsite in Indonesia in February 2005 killed 200 persons and at least 40 persons respectively (UN-HABITAT, 2010). Moreover, over 30,000 people injured and 100,000 people sought medical attention due to the 2006 illegal dumping of petrochemical slops from the ship “Probo Koala” at the port in Abidjan, Côte d’Ivoire (BBC, 2010; cited in Nahman et al., 2018). The danger of slides is greater in countries with severe rainfalls like in the case of Manila, Philippines in 2007 when more than 200 people died (UN-HABITAT, 2010).

Workers and waste pickers handling solid waste such as women, children, the elderly, the unemployed and migrants are a vulnerable demographics exposed to occupational health and accident risks related to the content of the materials they are handling, emissions from those materials, and the equipment being used (Cointreau, 2006; Kaza et al., 2018). Even though waste pickers earn a living through sorting and recycling of secondary materials, they are exposed to high occupational risks such as risk from contact with human faecal matter, paper that may have become saturated with toxic materials, bottles with chemical residues, metal containers with residue pesticides and solvents, needles and bandages containing pathogenic organisms from hospitals, and batteries containing heavy metals of waste (Cointreau, 2006).

C) Economic Impacts

Poor management of solid waste has negative impacts on the economy via costs of lost productivity due to disease and the additional healthcare costs of treating it, loss of tourist income due to visual impacts, loss of fish catch due to water pollution due to solid waste dumping and costs of decontaminating water or providing alternative supplies, damaging property and disruption of normal economic activity due to blocking drains and increasing the risk of major flooding (CIWM, 2018) and impact on feeding animals due to consumption of solid wastes (Roman & Hiwot, 2010; Mushonga et al., 2015).

According to Coffey and Coad (2010), up to 1 percent of GNP and 20 to 40 percent of municipal revenues is absorbed by SWM in developing countries. In Southeast Asia, the economic cost of uncollected household waste that is burned, dumped, or discharged to waterways is estimated to be US\$375 per tonne (McKinsey, 2016: cited in Kaza et al., 2018). Due to the outbreak of plague caused by uncollected solid waste that clogged drains in Surat, India in 1994, the city of Surat incurred 516.2 million Indian rupees per day during the plague period and total loss amounting to 12 billion rupees (UN-HABITAT, 2010).

2.1.5 Opportunities of Proper SWM

Proper SWM offers a lot of benefits for human health through alleviating waste-related diseases, and the environment via reducing greenhouse gas emissions, avoiding flood risks and reducing air, water and soil pollutions caused by poor SWM. There are also economic opportunities from proper SWM. Lands allocated for dumpsites or landfill sites especially in developing countries can be put to more productive purposes. Recycling of waste materials can reduce the demand for the extraction of new raw materials for production purposes. Nutrients for agriculture or energy can be obtained from solid waste via composting and anaerobic digestion. A large number of people can get employment opportunities including both low and high value jobs. Moreover, effective SWM offers opportunities for enterprise development and energy generation (Hyman, 2013).

For instance, developing countries have a bigger opportunity to generate renewable energy on a per tonne basis from solid waste since they generate solid wastes which have relatively high organic content. Depending on the waste composition and the technology used for conversion, each tonne of MSW can generate an estimated 150-650 kilowatt hour based on international experience (Elagroudy et al., 2016). The Repi waste to energy plant in Addis Ababa, Ethiopia generates 50 megawatts of electric power per year from the solid waste collected from the city. This plant has its own contribution to environmental protection through emissions reduction and enhancing environmental sanitation, and creates job opportunities for many people (MEF, 2011). The amount of MSW generated in African urban areas has an estimated value of US\$8.0 billion per year, of which US\$7.6 billion worth of valuable resources that is 96 percent is currently lost through the disposal of waste each year to open dumpsites with associated burning (Nahman et

al., 2018). According to Coffey and Coad (2010), up to 6 workers per 1,000 people, that is 2 percent of the national workforce are employed in the SWM sector in developing countries.

2.1.6 Economic Valuation of Environmental Goods and Services

Assigning of money values to non-marketed goods and services is referred to as economic valuation. A good or service has economic value if it has a positive contribution to human wellbeing. However, the positive contribution of a non-marketed good or service to an individual's well-being is determined by whether or not it satisfies his or her preferences (Pearce & Özdemiroglu, 2002). The total economic value of these goods and services can be described as the sum of use values and non-use values (Pearce & Özdemiroglu, 2002; Lee et al., 2010).

Values associated with using up of resources or with the use of an environmental attribute by individuals refer to use values (Lee et al., 2010; Gunatilake, 2003). Use values can be categorized into direct, indirect and option use values. Direct use value refers to the values that involve an observable direct interaction between human being and the environment, including both consumptive that involves the extraction of resources from an ecosystem for consumption purpose and non-consumptive uses which are services provided by ecosystems without extraction such as the provision of recreational opportunities and scenic vistas. Use values derived from ecological functions such as flood control, groundwater recharge, and water filtration are categorized under indirect use values. The option value is the value gained from keeping the option of having a use value or a willingness to pay to have the option of using a service in the future. Non-use values are all remaining values aside from use values including bequest and existence values (Lee et al., 2010; Mendelsohn & Olmstead, 2009).

The techniques of environmental valuation for estimating the economic value of non-marketed goods and services are broadly categorized into two methods such as revealed preference and stated preference. Revealed preference methods are based on the actual or observed behavior of individuals as revealed in the market and classified into travel cost, hedonic property, hedonic wage and averting behavior methods. In the case of revealed preference, proxy markets are needed to value non-marketed goods and services. Stated preference methods depend on the hypothetical or constructed market in which respondents are asked to attach value on the environmental or non-marketed goods and services in carefully structured surveys. These

methods are classified into contingent valuation and choice modeling techniques, such as choice experiments, contingent ranking, paired comparisons and contingent rating (Mendelsohn & Olmstead, 2009; Pearce & Özdemiroglu, 2002; Bolt et al., 2005).

Both revealed preference (RP) and stated preference (SP) methods have their own advantages and disadvantages. Both RP and SP methods can be used to measure use values. Unlike RP, SP methods such as contingent valuation and choice modeling are the most widely used methods and have been used to estimate non-use values. However, RP cannot be used to measure non-use values. SP is the only option when there is no proxy market to value non-marketed goods and services (Pearce & Özdemiroglu, 2002; Hanemann, 1994; Perman et al., 2003). Unlike RP, it is possible to determine the factors that lie behind a given environmental valuation in the case of SP (Pearce & Özdemiroglu, 2002).

According to Johnston et al. (2017), the selection between contingent valuation (CV) and choice modeling (CM) techniques such as choice experiments (CEs) is complex and should be based on respondent perceptions of the change being valued, the decision objective being considered, and the type of information required. When making a decision to choose between CV and CEs, three primary considerations are recommended:

First, will the change to be valued affect specific characteristics of the item or the item as a whole, and what are the information needs of decision makers? Second, do respondents think of (and value) the change in terms of individual attributes, or as a whole? Third, how does the information presentation format affect respondents' understanding of the item to be valued? (Johnston et al., 2017, pp. 333-334)

Among the SP methods, choice modeling techniques may avoid response difficulties that face in case of CV and are preferable as well as applicable when there is a need to value different characteristics or attributes of a good or service (Pearce & Özdemiroglu, 2002). CV method has been used extensively for the valuation of non-marketed goods and services and is preferable to estimate values when an item cannot be easily defined in terms of attributes or characteristics (Johnston et al., 2017).

2.1.6.1 Contingent Valuation Method

The concept of CV seems to have originated in 1947 when Ciriacy-Wantrup proposed asking people to state economic values for items that are not traded in the markets such as public goods through the use of surveys (Jackobsson & Dragun, 1996). Davis conducted the first recorded empirical CV study in 1961 using the idea of surveys to value public goods (Mitchell & Carson, 1989). He used a CV questionnaire to estimate the benefit of outdoor recreation in the Maine woods, US (Davis, 1963).

In order to establish the value of goods and services that are not traded in the markets with no prices, CVM uses survey techniques. This method involves delivering questions for a randomly selected sample of the population whether they are willing to pay or willing to accept for a clearly defined change in the provision of a good or service, or to prevent the change (Bolt et al., 2005). There are three major types of survey administration such as in-person or face-to-face interviews, telephone interviews, and mailed questionnaires. Each type of survey has strengths and weaknesses. Even though the face-to-face survey is more expensive as compared to other surveys, it is recommended by SP practitioners due to the advantages such as higher responses rates, permitting the use of visual aids, and the interviewer can motivate and respond to questions of the respondent (Pearce & Özdemiroglu, 2002; Gunatilake, 2003).

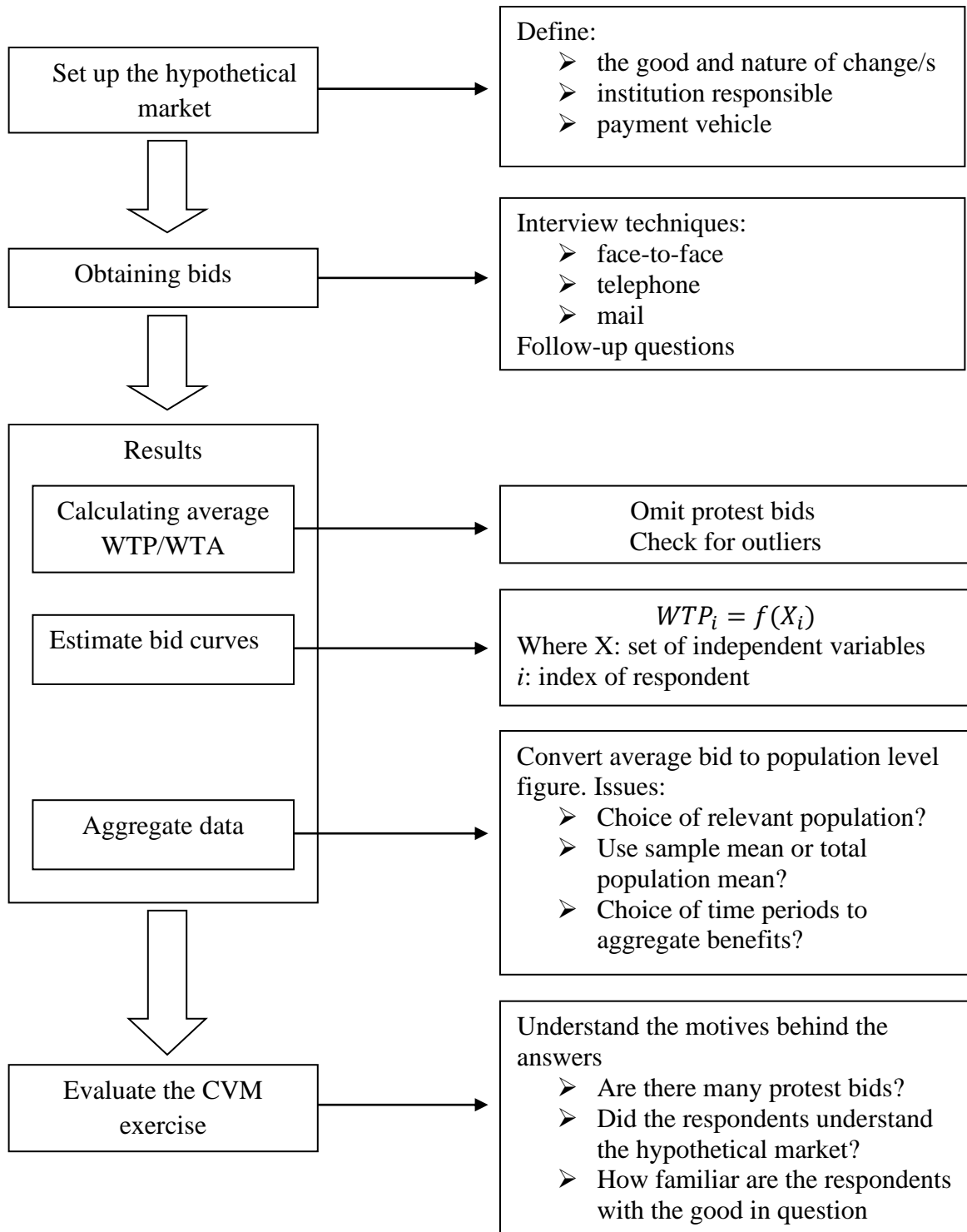
There are four most widely used value elicitation formats in CVM, such as open-ended, bidding game, payment card, and single-bounded or double-bounded dichotomous choice. The open-ended method is the first and earliest method used in which respondents are asked to state their maximum WTP for the good or service that is being valued. In the case of the payment card, respondents are asked to choose the stated WTP amount that is presented on the card with a visual aid. Hence, respondents put a tick on the monetary value that they are willing to pay and put a cross on those amounts that they are not willing to pay. Bidding game is another value elicitation format in which respondents are asked iteratively to state their WTP until a yes answer changes into a no or a no answer changes into a yes answer. In the case of dichotomous or discrete choice format, randomly assigned prices are distributed to each respondent for the non-marketed good or service in question and then each respondent give a yes or no answer for the stated WTP amount in case of single-bounded, and the respondent is asked higher or lower bids

if he or she says yes or no respectively in case of double-bounded (Bolt et al., 2005; Gunatilake, 2003).

According to Carson and Hanemann (2005), surveys conducted using CVM are organized into six sections. The first section deals with an introduction part that explains the general topic and sponsor of the study. The second section presents questions about prior knowledge and attitudes of respondents for the good or service. The third section is about the presentation of the CV scenario such as the objectives of the study, the way of implementing the project or study and paid for, and presentation about the situations if the current study was not implemented. The fourth section presents questions about the respondent's WTP or WTA for the good or service. The fifth section focuses on questions to help ascertain how well respondents understood the scenario. Finally, demographic questions were presented in the sixth section.

There are four main steps for designing a CV study. Setting up the hypothetical market for the non-marketed good or service is the first step in which the valuation scenario should be well defined. The second step is obtaining bids using several survey techniques such as face-to-face interviews, telephone interviews, and mailed questionnaires. The third step is presenting the results of the analysis such as average WTP or WTA and the factors that affect WTP or WTA. Evaluating the CVM exercise is the final step that entails an appraisal of how successful the application of CVM has been (Bolt et al., 2005).

Figure 2.1: Flow Chart of Designing a Contingent Valuation Study



Source: Bolt et al., 2005

Respondents may give biased answers during the CV survey. Different types of potential biases may face during the CV survey (Tietenberg & Lewis, 2012; Hussen, 2004). The first one is strategic bias that arises when respondents provide biased answers in order to influence a particular outcome. Moreover, respondents may not be willing to respond to the survey questions or to state their actual WTP for the proposed project due to strategic reasons such as if there is a free-rider situation. Respondents may understate their true WTP for the non-marketed good or service in question if they think the proposed project will be implemented and wants to benefit from the project by thinking others will pay that is called free-rider problem. The second one is information bias that arises when respondents are forced to value non-marketed goods or services in which they have little or no information as well as experience about the good or service in question. The quantity and quality of information provided to the respondents and the way the questions are constructed affects their WTP for the good or service in question. Starting-point bias is the third bias that arises when the WTP response of the respondents is affected by the way of determining the initial bids. The fourth one is hypothetical bias that arises when the hypothetical market is not carefully designed that leads to the divergence between the hypothetical responses and the actual payment. The inappropriate selection of payment vehicle has also an impact on the response of respondents that forced them to understate or overstate their true WTP. The fifth bias is the gaps between willingness to pay and willingness to accept compensation. Respondents state a higher and lower monetary value in the case of WTA compensation and WTP question for a non-marketed good or service in question.

2.2 Empirical Literature

Dagneu et al. (2013) studied households' willingness to pay for improved urban SWM in Mekelle city, Ethiopia. The study used contingent valuation with a single-bounded format followed by open-ended follow-up questions and a cross-sectional survey of 226 randomly selected households. The study also employed a face-to-face interview to collect data from the respondents. The tobit and probit models were employed by this study to determine the factors that influence households' WTP for improved SWM. Based on the findings of the study, 92 percent of the respondents have positive WTP values for the improvement in SWM. The study also obtained ETB 7.88 and ETB 11.89 mean WTP per household per month using open-ended and close-ended value elicitation formats respectively. The total monthly aggregated WTP of the city based on dichotomous single-bounded and open-ended value elicitation formats were format ETB 532,536 and ETB 430,566 respectively. The result of the Probit model revealed that the level of household income and awareness of environmental quality are positively related to the likelihood of households WTP. Moreover, age of household head was negatively related to the likelihood of households WTP because older people who have freely disposed of their solid waste for many years are less willing to pay for improved SWM. In the case of tobit model, amount of solid waste generated by the household per week, level of education, environmental awareness, type of solid waste service demanded by the household, level of income, marital status and house ownership have positive effects on the households WTP. In addition to this, household perception about the existing SWM was negatively related to households WTP.

Alhassan and Mohammed (2013) studied households' demand for better solid waste disposal services in four communities (Srodæ, Effiduase, Koforidua-ada, and Betom) in the new Juaben municipality, Ghana. The study used a simple random sampling technique to collect data from 200 households using a face-to-face interview. Single-bounded dichotomous choice CVM was employed in this study in order to elicit households WTP. The study also employed the probit model to analyze the determinants of households WTP. Based on the findings of the study, the median WTP was Ghanaian Cedi (GHS) 2.23 (USD 1.13) per household per month and the mean WTP was GHS 3.67 (USD 1.85) per household per month. Moreover, the study revealed that environmental safety concern of the respondent, level of education, length of stay in the current residence and walking time to public dumpster positively and significantly affected households

WTP. Household size was found to be negatively and significantly related to households WTP. This means that smaller household size respondents are more willing to pay than larger household size. Sex of the respondent also negatively and significantly affected households WTP meaning that women are more willing to pay than men. The level of satisfaction of current waste disposal services was negatively and significantly related to households WTP meaning that respondents who are not satisfied with the current waste disposal services have higher WTP than those who are satisfied.

Bhattarai (2015) studied households' WTP for improved SWM in Banepa Municipality, Nepal. The study used a cross-sectional survey of randomly selected 220 households and employed single-bounded dichotomous CVM to elicit WTP. A face-to-face interview was employed in this study to collect the required information from the respondents. According to the results of the study, 51 percent of households were getting solid waste collection service and 83 percent of the total respondents were willing to pay for improved SWM with Nepalese Rupees 166 (USD 1.69) mean WTP per household per month and Nepalese Rupees 160 (USD 1.63) median WTP. The study also used logit model to identify the factors that affect households WTP. The regression result revealed that age of the respondent, household size, level of education and monthly income of households have positive and significant effects on the households WTP for improved SWM. On the other hand, sex of the respondent and present waste collection service negatively and significantly affected WTP for improved SWM.

Muhdin et al. (2016) investigated the determinants of households' WTP for improved SWM in Jimma town, Ethiopia. The study used CVM to elicit WTP from a cross-sectional survey of 200 randomly selected households from four kebeles in the town. The study interviewed the respondents face-to-face to obtain the required information. Descriptive analysis, independent t-tests, correlation, cross-tabulation, and binary logistic regression were employed. The finding of the study revealed that 83.5 percent of the respondents are willing to pay for improved door-to-door waste collection service. The mean WTP of households is ETB 17.26 and level of income, house ownership, solid waste generation and satisfaction with current SWM significantly and positively affected households WTP for improved SWM.

Bhattarai et al. (2017) conducted a study on households' demand for improved SWM in Birendranagar Municipality, Nepal. Single-bounded dichotomous CVM was used to elicit the WTP from the cross-sectional survey of randomly selected 300 households. The study used the logit model to investigate the factors that influence households' WTP for improved SWM. The study found that 91.33 percent of the respondents were interested in the improved SWM service offered. However, 51.67 percent of the respondents were willing to pay for the offered bid amounts with Nepalese Rupees 90.12 mean WTP per household per month. Level of education, present waste collection service and level of income are identified as the factors that positively and significantly affect households' WTP for the improved SWM in the study area. Moreover, the bid amount has a negative and significant effect on households WTP.

Ndunda and Muia (2018) conducted a study on households' WTP for improved SWM to reduce air pollution in Nairobi, Kenya. CVM with face-to-face interviews was used to elicit WTP from the cross-sectional survey of randomly selected 114 households around the Dandora dumpsite areas such as Dandora, Babadogo, Kariobangi North and Korogocho. The study employed a double-bounded model to investigate the determinants of households' WTP for improved SWM in Dandora dumpsite. The findings of the study revealed that majority of the respondents (78.95 percent) were willing to pay for improved SWM with average WTP Kenyan Shilling 237 per month (USD 2.8). The results from the double-bounded model revealed that level of education, household size and level of income positively and significantly affected WTP of households. Moreover, the gender of the household head had a negative and significant effect on WTP for improved SWM meaning that male-headed households are less willing to pay than female-headed households.

Eshetie et al. (2017) conducted a study on households' preferences and WTP for improved SWM interventions using a choice experiment approach in Debre Tabor town, Northwest Ethiopia. The study used a multi-stage stratified random sampling design to obtain data from 220 households. The standard conditional logit model (CLM), random parameter logit model (RPLM) and latent class models (LCM) were employed in this study. The results of the standard CLM and RPLM revealed that the mode of transportation and method of solid waste disposal had a positive relationship with households WTP. Whereas, the service delivery institute and sorting of solid waste attributes had a negative relationship with households WTP. According to the results of

RPLM and LCM, preferences for all attributes such as solid waste collection system, mode of transportation, method of solid waste disposal service, delivery institute and sorting of solid waste were heterogenous among households. Based on the implicit price, mode of transportation was the principal attribute followed by solid waste disposal method, and service delivery institute and sorting of solid waste were the least important attributes. The study also found that respondents with a higher level of income, a higher level of education and female-headed households preferred the upswing SWM interventions.

Alhassan et al. (2017) examined households' WTP for improved SWM service in the Tamale metropolitan area in the northern region of Ghana. The study employed CVM to identify households WTP from the 120 respondents' selected using three-stage sampling. The open-ended and iterative or bidding games value elicitation formats were used to elicit respondents' WTP. A direct face-to-face interview was employed in this study to conduct a survey. The study also used an ordered probit model to investigate the determinants of households WTP for improved SWM service in the study area. According to the outputs of the study, about 76.7 percent of the respondents were willing to pay from Ghanaian Cedi (GHS) 2 to GHS 25 per month for the improved SWM service. The findings also revealed that households' WTP were positively and significantly determined by the gender, age, marital status, income and education of the household head.

Maskey and Singh (2017) studied households' WTP for improved waste collection service in Gorkha municipality of Nepal. The study employed CVM to elicit households' WTP from 401 households selected using a stratified sampling method from all 15 wards of Gorkha municipality of Nepal. The survey for this study was conducted using face-to-face interview method and an open-ended value elicitation format was used to elicit maximum WTP. The factors that affect households WTP and factors influencing the maximum WTP of households for improved waste collection service were analyzed by logit and tobit regression model respectively. The outcomes of the study revealed that 61 percent of the respondents were willing to pay for improved solid waste collection service with Nepalese Rupee 73.38 (0.72 USD) mean WTP per month. The logit regression results showed that monthly household income, education of household head, environmental awareness and waste collection service positively and significantly affected households' WTP for the improved waste collection service. Income,

environmental awareness, and waste collection service were found to be the significant factors that affect households WTP positively in the case of tobit regression results.

Birara and Kassahun (2018) conducted a study on urban households' demand for improved SWM service in Bahir Dar city, Ethiopia. Double-bounded CVM followed by the open-ended question was used by this study to elicit the households' WTP for improved SWM services. The study also employed face-to-face interviews, key informant interview and focus group discussion to collect data from 350 households selected using multi-stage random sampling technique. Ordered probit model was employed to analyze determinants of households' WTP for improved SWM services. Based on the findings of the study, 86.3 percent of the respondents were willing to pay for improved SWM services with 13 ETB mean WTP per month. In addition to this, the model result revealed that education level of household head, monthly aggregate income, access to SWM service, disease outbreak, number of children and quantity of waste generated per week positively and significantly affected households' WTP. However, sex of the household head had a negative and significant effect on households' WTP meaning that female-headed households are more willing to pay than male-headed households.

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

In the case of Dilla town, Gezahegn et al. (2018) conducted a study on the composition and characterization of MSW in landfill site of the town. The study used a purposive sampling technique to collect nine samples of solid waste from three stratified layers such as upper, middle and bottom layers. 5 kilo samples were collected from each layer to analyze the composition and characterization of solid waste in the landfill site. The study employed laboratory methods based on ASTM standard to measure the proximate analysis of samples. The findings of the study revealed that waste materials physical composition in the upper layer were cringe 4 percent, demolish waste 41 percent, paper 3 percent, soil 4 percent, plastic 7 percent, stone 4 percent, glass 3 percent, shoes 6 percent, textile 1 percent, bone 6 percent, ash 7 percent, and other 14 percent. In the middle layer, waste materials physical composition were paper 5 percent, charcoal 3 percent, textile 3 percent, glass 6 percent, wood 8 percent, plastic 6 percent, bone 9 percent, soil 29 percent, stone 5 percent, and other 24 percent. The bottom layer contains decomposed waste 33 percent, textile 9 percent, bone 10 percent, plastic 7 percent, shoes 5 percent and other 30 percent. The proximate analysis result of the study revealed that moisture, ash and fixed carbon content were increased with increasing the depth of the landfill site. The study also recommended that a large proportion of the generated solid wastes from the town can be compostable and recyclable, and can generate energy.

CHAPTER THREE

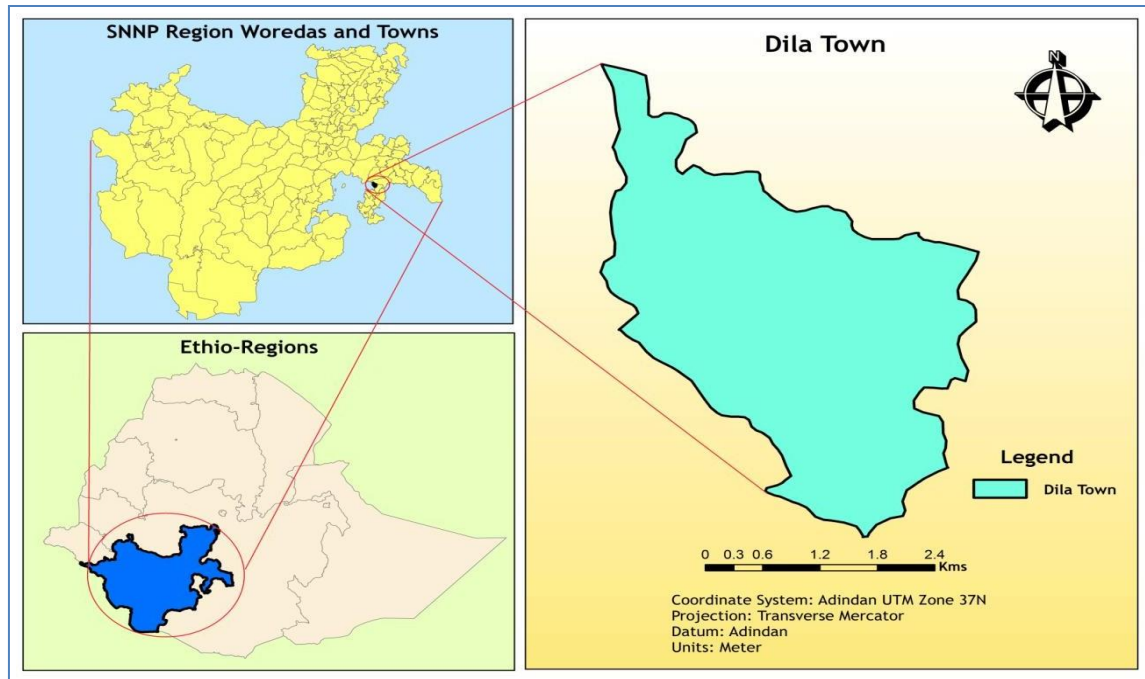
METHODOLOGY

3.1 Description of the Study Area

Dilla town is located in southern Ethiopia on the main road from Addis Ababa, Ethiopia to Nairobi, Kenya, and is the administrative center of Gedeo Zone in the Southern Nations, Nationalities, and Peoples (SNNP) Region. Dilla town is located 365 Kilometers from Addis Ababa, the capital city of Ethiopia and 90 kilometers from Hawassa, the capital city of the SNNP Region. The town has an area of 2,741.27 hectares that accounts for about 0.75 percent of the total area of the zone. The town is found in Kolla agro-ecological zone with an altitude ranging from 1500 - 2000 meters above sea level, an average annual rainfall ranging from 1400 - 1600 millimeters (mm) and the mean annual temperature ranging from 20.1 - 22.5 degree Celsius (°C). The town is bounded by Legedara River in the north, Chichu River in the south, Gola peasant association in the east and Oromia Region in the southwest (DTAOFED, 2018). Geographically, the town is located at 6° 20' to 6° 24" N latitude and 38° 17' to 38° 20" E longitude (World Bank, 2010).

According to DTAOFED (2017/18), the projected total population of the town in 2017/18 is 99,977, of which 52,521 are males and 47,457 are females. The projected number of households living in the town in 2017/18 is 22,217, and the average family size per household is 4.5. Currently, the town has three sub-cities namely Sesa, Bedecha and Harowelabu, and has nine kebeles. The Sesa, Bedecha, and Harowelabu sub-cities of the town have 29,487, 23,308 and 47,182 total population respectively.

Figure 3.1: Map of the Study Area



3.2 Sampling Techniques and Survey Administration

This study used a stratified random sampling technique to collect data from the households of Dilla town. Since it is difficult to collect data from all households of the town, the study randomly selected a sample of households from the three sub-cities of the town. Thus, the sample size for this study is calculated using a simplified formula for proportions that was introduced by Yamane (1967). This formula assumed a 95 percent confidence level and 5 percent level of precision, and is given in equation 1 below. Based on this formula, this study conducted a survey on 400 randomly selected households in order to collect the required data.

$$n = \frac{N}{1 + N(e)^2} \quad (1)$$

Where n is the sample size, N is the total number of households in Dilla town since the study is conducted at the household level and e is the level of precision.

The total 400 sample households were distributed among the three sub-cities based on the population or household number share of each sub-city from the total population or household number of the town. Due to the inaccessibility of data for the number of households in each sub-city, the household number of each sub-city was calculated by dividing the total population of each sub-city by the average family size of the town that is 4.5. Sample households from each sub-city were taken by considering the share of each sub-city from the total population or total household number of the town. Therefore, in order to take representative sample households from the total household, this study took 118 households, 93 households and 189 households from Sesa, Bedecha, and Harowelabu sub-cities respectively.

Table 3.1: Sample Selection from Total Households of Dilla Town

Sub-city	Population	Household Number	Percentage (%) of Total Household (P)	Selected Sample Size = (400 × P/100 %)
Sesa	29,487	6,553	29.5	118
Bedecha	23,308	5,179	23.3	93
Harowelabu	47,182	10,485	47.2	189
Total	99,997	22,217	100	400

The survey for this study was conducted from March 10 to April 12, 2019, using a direct face-to-face interview method. This method is selected from other survey techniques due to its capacity to generate the highest quality WTP data (Alberini and Cooper, 2000). Although the face-to-face interview is very expensive, it ensures a high response rate and effective information provision (Perman et al., 2003). In order to collect the required information from the respondents, three Master of Science in Resource and Environmental Economics students including the researcher participated as enumerators. Since the enumerators are familiar with the nature of the study, data with high quality was expected to be collected.

This study also conducted a pilot survey from 25 randomly selected households living in the three sub-cities of Dilla town. Based on the population or household number of each sub-city, 9 households, 7 households, and 14 households were randomly selected from Sesa, Bedecha, and Harowelabu sub-cities respectively. The pilot survey was conducted in order to determine five initial bids or starting point prices using open-ended questions, to determine the payment vehicle for the CV scenario, and to revise the final questionnaire before the main survey is conducted. Based on the results of the survey, the five initial bids are ETB 5.5, ETB 8, ETB 12.25, ETB 15.5 and ETB 20. Out of the 25 respondents, 84 percent (21) of the total respondents were willing to pay for improved USWM. Moreover, 85.71 percent (18) of the willing households' chosen to pay the MSWM service fee with water bill separately without adding on the bill.

Finally, the actual or main survey was conducted by dividing the randomly selected respondents from each sub-city into five groups based on the starting point prices. All respondents from each sub-city have an equal chance to get the five initial bids. A total of 80 questionnaires for every five initial bids were distributed for the three sub-cities.

Table 3.2: Questionnaire Distribution Based on Initial Bids

Sub-city	Selected Sample Size	Distributed Questionnaire Based on Initial Bids				
		ETB 5.5	ETB 8	ETB 12.25	ETB 15.5	ETB 20
Sesa	118	24	23	23	24	24
Bedecha	93	19	19	19	18	18
Harowelabu	189	37	38	38	38	38
Total	400	80	80	80	80	80

3.3 Questionnaire Design and Valuation Techniques

The design of the questionnaire for this study followed the recommendation of Carson and Hanemann (2005). The questionnaire has six sections. The first section is an introductory part that identifies the sponsor and the general topic of the study. The second section incorporates questions related to the prior knowledge of respondents about improved SWM and their attitudes towards the service. The third section informed the respondents about the main aim of the study, the way of implementing the proposed scenario and the impacts of the existing poorly managed solid waste if the study will not be implemented. In the fourth section, respondents were asked about their maximum WTP for improved USMW. The fifth section focused on to help ascertain how well respondents understood the scenario. Finally, the respondents were asked about socioeconomic and demographic questions in the sixth section.

Even though the majority of the people in the Gedeo zone are Gedeo and speaks Gedeofa, residents of Dilla town are a heterogeneous society in terms of their ethnicity. As a result, the residents usually use the Amharic language to communicate with each other and thus, can speak Amharic, the working language of the SNNP Region and the federal government of Ethiopia. Hence, the respondents were interviewed by the enumerators using the Amharic language in order to obtain better information.

This study employed CVM that uses survey techniques in order to elicit households WTP for improved USWM in Dilla town. The discrete choice elicitation format with follow-up questions or double-bounded dichotomous choice elicitation format followed by open-ended elicitation format was employed in order to elicit WTP of households for improved USWM in Dilla town. The double-bounded dichotomous choice elicitation format was first proposed and implemented by Carson, Hanemann, and Mitchell (1986). According to Freeman III et al. (2014), the single-bounded discrete choice format has at least three advantages relative to open-ended value elicitation formats. First, it places respondents in a relatively familiar social context that is take-it or leave-it option like in the case of a real market transaction. Second, it is simple for respondents to make a decision. Third, it is incentive compatible in at least some circumstances. However, this method provides little information from each respondent. The double-bounded dichotomous choice format is better than the single-bounded dichotomous choice format in terms

of increasing efficiency in three ways (Haab & McConnell, 2002). First, it provides more information about respondents' WTP. Second, a "yes" followed by a "no" and a "no" followed by a "yes" response of the respondents for the sequential offer bids provides clear bound on WTP. Third, for the "no-no" and "yes-yes" combinations, there is also efficiency gain from the further WTP questions even though the responses do not provide a clear bound on the WTP of a respondent.

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

According to Hanemann et al. (1991), the likelihood of the four outcomes are π^{yy} , π^{nn} , π^{yn} and π^{ny} . Suppose B_i^1 , B_i^{2u} and B_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.

$$\begin{aligned}
 \pi^{yy}(B_i^1, B_i^{2u}) &= Prob\{B_i^1 \leq max\ WTP\ and\ B_i^{2u} \leq max\ WTP\} \\
 &= Prob\{B_i^1 \leq max\ WTP | B_i^{2u} \leq max\ WTP\} \\
 &= Prob\{B_i^{2u} \leq max\ WTP\} \\
 &= 1 - G(B_i^{2u}; \theta)
 \end{aligned} \tag{2}$$

$$\begin{aligned}
 \pi^{nn}(B_i^1, B_i^{2l}) &= Prob\{B_i^1 > max\ WTP\ and\ B_i^{2l} > max\ WTP\} \\
 &= G(B_i^{2l}; \theta)
 \end{aligned} \tag{3}$$

$$\begin{aligned}
\pi^{yn}(B_i^1, B_i^{2u}) &= Prob\{B_i^1 \leq \max WTP \leq B_i^{2u}\} \\
&= G(B_i^{2u}; \theta) - G(B_i^1; \theta)
\end{aligned} \tag{4}$$

$$\begin{aligned}
\pi^{ny}(B_i^1, B_i^{2l}) &= Prob\{B_i^1 \geq \max WTP \geq B_i^{2l}\} \\
&= G(B_i^1; \theta) - G(B_i^{2l}; \theta)
\end{aligned} \tag{5}$$

Where $G(\cdot)$ represents cumulative distribution function (cdf) and θ represents the parameters of this distribution. Therefore, the log-likelihood function for the set of responses given a sample of N respondents (400 in this case) can be formulated as follows.

$$\begin{aligned}
Ln L^s(\theta) &= \sum_{i=1}^N \{d_i^{yy} \ln \pi^{yy}(B_i^1, B_i^{2u}) + d_i^{nn} \ln \pi^{nn}(B_i^1, B_i^{2l}) + d_i^{yn} \ln \pi^{yn}(B_i^1, B_i^{2u}) \\
&\quad + d_i^{ny} \ln \pi^{ny}(B_i^1, B_i^{2l})\}
\end{aligned} \tag{6}$$

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 $d_i^{yy} = 0$ if the response is otherwise. $d_i^{nn} = 1$ if the respondent says “no” to the first and second lower bid, and $d_i^{nn} = 0$ if the response is 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 doubled-bounded model is the solution to the first-order condition:

$$\frac{\partial Ln L^s(\hat{\theta})}{\partial \theta} = 0 \tag{7}$$

3.4 CV Scenario

A hypothetical market scenario was described to the respondents in order to help them to elicit their WTP for improved USWM in Dilla town. The impacts of poorly managed solid waste and the importance of improved SWM was described to the respondents before the interview. The scenario can be expressed as follows: In order to provide regular USWM service by the Dilla town municipality, adequate human power and vehicles are required. However, the municipality cannot cover the full cost of providing the service. Therefore, this requires the participation of residents of the town by paying money to the municipality. If the municipality provides regular improved USMW service in the town, are you willing to pay for the service by considering your household monthly income and expenditures? Here, each respondent receives one randomly selected initial bid from the five initial bids or starting point prices. If the individual responds “yes” to the initial bid, he or she was asked the second higher bid greater than the initial bid by half. If the respondent says “no” to the initial bid, he or she was asked the second lower bid less than the initial bid by half. If the respondent answered the second round question by saying either “yes” or “no”, he or she was asked to state his or her maximum WTP per month for the service. However, the respondent was asked his or her reason if he or she is not willing to pay for improved USWM service.

The choice of a proper payment vehicle for CV studies is very crucial in order to obtain realistic WTP values from respondents. Payment vehicles provide the way of collecting money from the good or service demanders for a given proposed project. However, inappropriate choice of payment vehicle may lead to payment vehicle biases and an increase in the number of protest responses (Morrison et al., 2000). Payment vehicles can generally be classified into two categories such as voluntary payments and coercive payments. Voluntary payment vehicles include donations and gifts. Income tax, value-added or sales tax, trust funds, entry charges, property taxes, water bills, and utility bills are categorized under coercive payment vehicles. In the case of voluntary payment vehicles, respondents may act strategically and overstate their WTP values or may agree to pay the offered bids in order to secure the good or service in question. However, they will pay less than the stated WTP value in reality after the new proposed good or service is already delivered to them (Carson, 1997; OECD, 2018). Moreover, respondents may be less willing to pay for a given new proposed good or service because they

consider the free-riding problem in which some people will not be willing to pay while receiving the benefits (OECD, 2018).

Three considerations should be taken into account during the choice of payment vehicles. The first one is the suitability of the payment to the elicitation of use and non-use values. The credibility of the payment vehicle is the second one. The third one is the acceptability of the payment vehicle. Coercive payment vehicles are more credible than voluntary payment vehicles since it is mandatory for everyone to pay the agreed WTP values (Green & Tunstall, 1999). Therefore, this study employed coercive payment vehicles in order to inform the respondents about the way of collecting the money that they are willing to pay and to minimize payment vehicle bias. Hence, the types of coercive payment vehicles such as water bill and electric bill were offered as a choice for respondents during the pilot survey. Paying the MSWM fee with water or electric bill by adding on the monthly water or electric bill respectively, and paying the MSWM fee with water or electric bill separately without adding on the bills were delivered as payment method options to them during the survey. About 85.71 percent of the willing respondents agree to pay the MSWM fee when they pay their monthly water bill. They do not agree on the addition of the fee on their monthly water bill or electric bill. In order to save their time and to minimize the bureaucracy they face during payment, they prefer to pay the fee with their monthly water bill separately. However, another type of coercive payment vehicles such as taxes may create negative thinking in the respondents if they do not have trust on the government, and are not sure whether the collected money is spent on the new proposed project or on any other projects (Green & Tunstall, 1999; OECD, 2018).

3.5 Data Analysis

The computation of descriptive statistics was used in this study in order to determine the measure of dispersion and central tendency of the collected data. The determinants of households WTP for improved USWM were analyzed by employing probit and tobit regression models. Moreover, the study used the seemingly unrelated bivariate probit model to estimate the average WTP. The regression of the three models was conducted using STATA version 14.2.

3.5.1 The Probit Model

Binary choice models such as logit and probit models are often derived from an underlying latent variable model. The major difference between the two models lies mainly on the assumption of the distribution of the error terms. The logit model has a standard logistic distribution of error terms, while the probit model has a normal distribution of error terms (Verbeek, 2004; Wooldridge, 2012). Many economists use probit model due to its attraction of being motivated by a latent normal random variable and extends naturally to tobit models (Cameron & Trivedi, 2005). The probit model solves three limitations of logit model such as the logit model cannot represent random taste variation, it exhibits restrictive substitution patterns and it cannot be used with panel data when unobserved factors are correlated over time for each decision-maker (Train, 2003). This model was used by this study in order to identify the determinants of households WTP response for the initial bids for improved USWM in Dilla town.

The probit model is based on the assumption that there exists an underlying latent or unobservable variable y^* . Moreover, the error term is assumed to be normally and independently distributed with zero mean and constant variance of one, and is independent of explanatory variables (Wooldridge, 2012; Cameron & Trivedi, 2005). According to Verbeek (2004), the probit model can be specified as follows.

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

$$y_i = 1 \quad \text{if } y_i^* \geq B_i^1$$

$$y_i = 0 \quad \text{if } y_i^* < B_i^1$$

where y_i^* is unobserved actual WTP of households for improved USWM service in Dilla town; y_i is actual WTP of households for the service that takes binary responses; B_i^1 represents initial bid offered arbitrarily to respondent i ; x_i is the vector of independent variables which affect households WTP; β is a vector of coefficients and ε_i is error term that assumed to follow a standard normal distribution.

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

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

In order to estimate mean WTP from the double-bounded dichotomous value elicitation format, this study employed a bivariate probit model. According to Greene (2003), the bivariate probit model is a natural extension of the probit model. The system of equations can be estimated as seemingly unrelated bivariate probit (SUBVP) mode if the error terms in the bivariate probit model follow normal distributions (Haab & McConnell, 2002). Hence, this study used SUBVP model in order to estimate mean WTP. The general specification of the bivariate probit model for this study can be described as follows (Green, 2003).

$$y_1^* = x_1' \beta_1 + \varepsilon_1, \quad y_1 = 1 \quad \text{if } y_1^* \geq B_i^1, 0 \text{ otherwise} \quad (10)$$

$$y_2^* = x_2' \beta_2 + \varepsilon_2, \quad y_2 = 1 \quad \text{if } y_2^* \geq B_i^2, 0 \text{ otherwise} \quad (11)$$

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

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

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

Where y_1^* and y_2^* are i^{th} respondent's unobserved true WTP to the initial and follow-up bids respectively; y_1 and y_2 are actual WTP of respondents that takes binary responses for the initial and follow-up bids offered respectively; B_i^1 and B_i^2 are the initial and follow-up bids offered for respondent i respectively; x_1 and x_2 are vectors of the initial and follow-up bids offered to the respondents respectively; β_1 and β_2 are vectors of coefficients of the initial and follow-up bids offered; ε_1 and ε_2 are error terms assumed to follow normal distributions with mean zero and variance one for the first and second equations of the bivariate probit model; ρ is the correlation coefficient that denotes the covariance between the error terms.

3.5.2 The Tobit Model

The tobit model or censored regression model was first proposed by James Tobin in 1958. All negative values in this model are mapped to zeros (Verbeek, 2004). This model is an extension of a probit model that expresses the observed response y_i in terms of an underlying latent or unobserved variable y_i^* that satisfy the classical linear model assumptions (Gujarati, 2003; Wooldridge, 2012). This model was used in order to analyze the factors that affect households' maximum willingness to pay (MWTP) obtained from the respondents using open-ended value elicitation format. The standard tobit model can be formulated as follows.

$$y_i^* = x_i' \beta + \varepsilon_i, \quad i = 1, 2, \dots, N, \quad (13)$$

$$y_i = y_i^* \quad \text{if } y_i^* > 0$$

$$y_i = 0 \quad \text{if } y_i^* \leq 0,$$

where y_i^* is the unobserved MWTP of a household for improved USWM service; y_i is the dependent variable that is actual MWTP of a household for improved USWM service; x_i is the vector of explanatory variables which affect households maximum WTP; β is a vector of parameters and ε_i is disturbance term and, assumed to be normally and independently distributed with zero mean and constant variance σ^2 and is independent of x_i (Verbeek, 2004). The maximum likelihood method was used for this study to estimate the tobit model. The log-likelihood function of the tobit model can be written as follows.

$$\begin{aligned}
\log L_1(\beta, \sigma^2) &= \sum_{i \in I_0} \log P\{y_i = 0\} + \sum_{i \in I_1} [\log f(y_i | y_i > 0) + \log P\{y_i > 0\}] \\
&= \sum_{i \in I_0} \log P\{y_i = 0\} + \sum_{i \in I_1} \log f(y_i)
\end{aligned} \tag{14}$$

Where $f(\cdot)$ is a generic notation for the density function. The last equality follows from the definition of a conditional density. I_0 and I_1 are index sets and defined as the sets of those indices corresponding to the zero and the positive observations respectively. Here, $I_0 = \{i = 1, 2, \dots, N: y_i = 0\}$. The following function can be obtained using the appropriate expressions for the normal distribution. The maximum likelihood estimates can be obtained via maximizing the function with respect to β and σ^2 (Verbeek, 2004).

$$\log L_1(\beta, \sigma^2) = \sum_{i \in I_0} \log \left[1 - \Phi \left(\frac{x_i' \beta}{\sigma} \right) \right] + \sum_{i \in I_1} \log \left[\frac{1}{\sqrt{2\pi\sigma^2}} \exp \left\{ -\frac{1}{2} \frac{(y_i - x_i' \beta)^2}{\sigma^2} \right\} \right] \tag{15}$$

Where $\Phi(\cdot)$ is the standard normal cumulative distribution function (cdf)

3.5.3 Variables Selection for the Probit and Tobit Models

The dependent variable for the econometric models used in this study is households WTP in general. Specifically, the dependent variables used for the probit and tobit models are households WTP response for the initial bids and households MWTP for improved USWM respectively. WTP refers to the maximum amount of money that an individual would be willing to pay rather than do without an increase in some good such as an environmental amenity. The amount of money that the individual would be willing to pay makes him or her indifferent between paying for and having the improvement and forgoing the improvement while keeping the money to spend on other things (Freeman III et al., 2014).

The selection of explanatory variables for the probit and tobit models is based on significant variables used in other studies conducted on households WTP for improved SWM. The description of the explanatory variables used in this study is presented below in Table 3.3.

Table 3.3: Description of Explanatory Variables

Variable	Description	Unit of Measurement
Income	Total average monthly income of the household	Ethiopian Birr (ETB)
Household size	Total number of members of the household currently living in the house	Number of individuals
Solid waste generation	Amount of solid waste generated by the household	Solid waste in sacks (50 kilograms) per week
Awareness	Awareness of the respondent about the impacts of poorly managed solid waste on the environment	1 = Aware (Yes), 0 = Not aware (No)
Satisfaction	Household satisfaction from the existing solid waste collection service	1 = Satisfied (Yes), 0 = Not satisfied (No)
Education	Total number of years attained by the household head on education	Years
Age	Age of the household head	Years
Gender	Gender of the household head	1 = Male, 0 = Female
House ownership	The ownership of the house the household lives in	1 = Owned, 0 = Rented
Marital status	The marital status of the household head such as married, unmarried, divorced and widowed	1 = Married, 0 = Otherwise
Household's Plan	The plan of a household to live permanently or temporarily in the town	1 = Permanently, 0 = Temporarily
Duration	Period of time the household lived in the town	Years
Cost	Cost incurred by households who are affected by waste-related diseases	1 = Yes, 0 = No

i) Income

This variable refers to the average monthly income of a household per month in Ethiopian Birr (ETB). Many studies found that income is positively and significantly related to households WTP for improved SWM (Bhattarai, 2015; Bhattarai et al., 2017; Dagneu et al., 2013; Muhdin et al., 2016; Ndunda & Muia, 2018; Birara & Kassahun, 2018; Maskey & Singh, 2017; Alhassan et al., 2017; Bamlaku et al., 2019). Hence, income is one of the major determinants of households WTP and is expected to positively affect households WTP for improved USWM in Dilla town.

ii) Household Size

Household size refers to the total number of people currently living in the house. When the number of individuals in a household increases, the amount of solid waste generated will rise and thus the household head will be more willing to pay for improved SWM service (Bhattarai, 2015; Birara & Kassahun, 2018; Ndunda & Muia, 2018). Therefore, household size is expected to positively affect households WTP in this study.

iii) Solid Waste Generation

This variable refers to the amount of solid waste generated by a household in sacks (50 kilograms) per week. Households will be more willing to pay for improved SWM as the amount of solid waste generated increases. Thus, amount of solid waste generated is positively and significantly related to households WTP for improved SWM (Dagneu et al., 2013; Muhdin et al., 2016; Birara & Kassahun, 2018; Bamlaku et al., 2019). Therefore, the solid waste generation variable is expected to positively affect households WTP in this study.

iv) Awareness

Awareness of households about the impacts of poorly managed solid waste on the environment has a significant effect on the respondents' WTP for improved USWM service. Hence, households' awareness about the impacts of solid waste is expected to positively affect their WTP for improved USWM service in Dilla town as found by other studies in different study areas (Dagneu et al., 2013; Maskey & Singh, 2017).

v) Satisfaction

This variable refers to the satisfaction of households from the existing solid waste collection service. Households are more willing to pay for improved SWM if they are not satisfied with the existing solid waste collection service (Alhassan & Mohammed, 2013; Muhdin et al., 2016). Hence, this study expects the positive relationship between dissatisfaction with the current SWM and households WTP for improved USWM in Dilla town.

vi) Education

This variable refers to the total number of years the household head attained on formal education. The impacts of solid waste on the environment, human health and the economy can be better understood by educated people. Thus, the level of education of a household head is expected to positively affect households WTP for improved SWM as found by other similar studies (Bhattarai, 2015; Bhattarai et al., 2017; Dagneu et al., 2013; Ndunda & Muia, 2018; Alhassan & Mohammed, 2013; Birara & Kassahun, 2018; Maskey & Singh, 2017; Alhassan et al., 2017; Bamlaku et al., 2019).

vii) Age

The age of the household head in number of years is another determinant of households WTP for improved SWM. So far, studies conducted on households WTP for improved SWM found both positive and negative effects of age of the household head on his or her WTP (Bhattarai, 2015; Alhassan et al., 2017; Dagneu et al., 2013; Bamlaku et al., 2019). Hence, this study expects the age of the household head to negatively affect the household WTP for improved SWM because as the household head gets older, his or her productive capacity and income will diminish over time.

viii) Gender

This variable refers to the sex or gender of the household head. In most societies, women are responsible for the management of household sanitation and food preparation (UN, 2006). Therefore, this study expects the negative relationship between sex of a household head and the household WTP for improved USWM and thus, female-headed households are more willing to

pay for improved SWM as found by other similar studies (Bhattarai, 2015; Ndunda & Muia, 2018; Alhassan & Mohammed, 2013; Eshetie et al., 2017; Birara & Kassahun, 2018).

ix) House Ownership

A household feels free to live and give attention to the cleanness of the house as well as the surrounding compound when the house is owned by the household. Hence, the household will be more willing to pay for better SWM as compared to a household that lives in a rented house (Dagneu et al., 2013; Muhdin et al., 2016). This study expects the positive relationship between house ownership and WTP variables. Thus, those people who owned their own house will be more willing to pay for improved SWM than people who live in a rented house.

x) Marriage

This variable refers to the marital status of the household head categorized under married and other than married such as unmarried, divorced and widowed. Married households generate more amount of solid waste and thus, are more willing to pay for improved SWM as compared to those household heads who are unmarried, divorced or widowed (Dagneu et al., 2013; Alhassan et al., 2017). Therefore, this study expects the positive relationship between marital status and WTP of households.

xi) Households Plan

Households may have a plan to move from their current residence to other places or urban areas due to many reasons. For instance, inter-communal conflict is one reason that forces households to move to another place. Internal displacement in Ethiopia is increasing in recent years due to the inter-communal conflict in several parts of the country. Displacement of people in the country has significant negative effects on the lives and livelihoods of millions of people. There are 3.19 million internally displaced people who are in need of humanitarian assistance in the country (UNOCHA, 2019). Due to the outbreak of inter-communal conflict, more than a million people are displaced along the border in West Guji, Oromia Region and Gedeo, SNNP Region (IDMC, 2018). Since Dilla town is the administrative center of Gedeo zone, residents of the town may have a plan to move to other places. Therefore, this study expects that households who planned

to live permanently in the town will be more willing to pay than those who planned to live temporarily in the town and to leave the town.

xii) Duration

This variable refers to the number of years that a household lived in Dilla town. Households who lived a longer time period will be more willing to pay for improved USWM (Alhassan & Mohammed, 2013). Therefore, this study expects the positive relationship between the duration of households stayed in the town and their WTP for improved USWM.

xiii) Cost

This variable refers to the medical cost incurred by households who are affected by waste-related diseases. Households who are affected by waste-related diseases may incur a cost in order to get medical treatment from health stations. Hence, households who are affected by waste-related diseases will be more willing to pay for improved USWM in order to minimize medical cost due to WRD.

3.6 Mean and Aggregate WTP Estimation

Two options such as the mean and the median can be used to calculate the average willingness to pay (AWTP) across respondents (Perman et al., 2003). So far, there is no consensus on the choice between the mean and the median as the better and appropriate measure of welfare. The median is less affected by a few very high WTP responses which are known as outliers. The mean WTP is the theoretically correct measure and is relevant in the case of cost-benefit analysis. Whereas, the median is important in the case of public choice or the economic analysis of political decisions due to its more weight on the majority (Pearce & Özdemiroglu, 2002; OECD, 2006). Therefore, this study used mean WTP to estimate AWTP of respondents from the responses of both open-ended and double-bounded value elicitation formats since the proposed project is related to cost-benefit analysis.

The median and especially the mean WTP are significantly affected by the treatment of outliers and protest responses. There are two ways of treating outliers in CVM and one of the two ways can be used to solve the problem (Gunatilake, 2003). In the first way, the selection of outliers is determined by the analyst or the researcher by putting a criterion on the share of WTP of respondents from their income (Freeman III, 1993). The decision is deleting all MWTP values of respondents greater than 'x' percent of their income where the x percent is determined by the researcher. In the second way, high valuations are reduced to some maximum plausible amount. This study used the first way of treating outliers. Protest responses are usually excluded from the calculation or estimation of mean WTP (Perman et al., 2003). However, the exclusion of all protest responses results in bias for the estimation of WTP. So far, there is no standard definition of protest responses (Frey & Pirscher, 2019). Moreover, there is no established procedure for classifying protest responses as protest zero bids to exclude them from the WTP estimation (Meyerhoff & Liebe, 2006). This study treated protest zero bid as protest responses of respondents. However, all protest zero bids were not excluded from the estimation of mean WTP. The real protest zero bids were distinguished based on the debriefing questions asked for respondents. The debriefing questions were delivered for respondents to state their reasons for willing and unwilling to pay for improved USWM.

The mean WTP obtained from open-ended value elicitation format is the sum of each respondent's maximum willingness to pay (MWTP) divided by the total sample size.

$$Mean\ WTP = \frac{\sum_{i=1}^n MWTP_i}{n} \quad (15)$$

Where n is the total sample size and $MWTP_i$ is the maximum willingness to pay (MWTP) of respondent i obtained from the open-ended value elicitation format.

According to Haab and McConnell (2002), the mean WTP value from double-bounded discrete choice value elicitation format can be calculated based on the following formula where β_0 and β_1 represents the regression constants and regression coefficients of the two equations of the seemingly unrelated bivariate probit (SUBP) model respectively.

$$\text{Mean WTP} = -\frac{\beta_0}{\beta_1} \quad (16)$$

After the estimation of mean WTP value, the next step is converting mean WTP to the total population level. This step is an aggregation of WTP by multiplying the mean WTP by the relevant total population (Perman et al., 2003). The relevant total population for this study is the total number of households living in Dilla town. Hence, the total or aggregate WTP is mean WTP multiplied by the total number of households (N).

$$\text{Total WTP} = \text{Mean WTP} \times N \quad (17)$$

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Descriptive Analysis

4.1.1 Demographic and Socioeconomic Characteristics of Respondents

During the survey, a total of 400 questionnaires were distributed for the randomly selected respondents. Every 80 questionnaires contain five initial bids. Out of the total 400 distributed questionnaires, 381 questionnaires were successfully completed. 74 questionnaires for each ETB 5.5 and ETB 8 initial bids were successfully completed. For each ETB 12.25 and ETB 15.5 initial bids, 78 questionnaires were successfully collected. 77 questionnaires for ETB 20 initial bid were successfully completed. Finally, a total of 19 questionnaires were not successfully completed and are excluded from the analysis part of this study.

The survey results revealed that 67.19 percent (256) and 32.81 percent (125) of the total respondents were male and female respectively. The average age of respondents is 46.57 year with a minimum of 27 years and a maximum of 68 years. The marital status of the respondents revealed that 91.34 percent (348) are married. The remaining 5.51 percent (21), 1.84 percent (7) and 1.31 percent (5) of the total respondents were single, divorced and widowed respectively. The average family size of the respondents is 4.85 per household with a minimum of 1 and a maximum of 8. The occupation of respondents revealed that 30.97 percent (118), 5.25 percent (20), 49.34 percent (188), 1.05 percent (4), 12.34 percent (47) and 1.05 percent (4) are governmental and non-governmental employee, private employee, businessperson, unemployed, self-employed and retired people respectively. The average level of education of respondents is 10.43 years with a minimum of 5 years and a maximum of 19 years. The study results also revealed that the average monthly income of respondents is ETB 3320.3 with a minimum of ETB 1100 and the maximum of ETB 10470. The house ownership status of the respondents revealed that 70.34 percent (268) have their own house and the remaining 29.66 percent (113) do not have their own house or live in rented houses. Moreover, the study results revealed that the average duration or number of years that households lived in the town is 39.23 years with a minimum of 3 years and a maximum of 64 years. Households who want to live permanently in the town

constitute 87.14 percent (332). The remaining 12.86 percent (49) of the total respondents planned to live temporarily in the town. Here, respondents were asked to state their own reason that forced them to leave the town. Out of the 49 respondents who planned to live temporarily in the town, 18.36 percent (9) and 61.22 percent (30) of the respondents selected “the town is not comfortable for life” and “searching for better livelihoods in another place” reasons respectively. The remaining 20.41 percent (10) of the respondents planned to live temporarily in the town due to the inter-communal conflict in the town and surrounding area of the town. The general information of households’ demographic and socioeconomic characteristics is presented below.

Table 4.1: Summary of Categorical Variables

Variable	Category	Observation (Percentage)
Gender	Male	256 (67.19)
	Female	125 (32.81)
Marital Status	Unmarried	21 (5.51)
	Married	348 (91.34)
	Divorced	7 (1.84)
	Widowed	5 (1.31)
Occupation	Government & Non-government employee	118 (30.97)
	Private employee	20 (5.25)
	Businessperson	188 (49.34)
	Unemployed	4 (1.05)
	Self-employed	47 (12.34)
	Retired	4 (1.05)
House Ownership Status	Owned	268 (70.34)
	Rented	113 (29.66)
Households Plan	To live permanently	332 (87.14)
	To live temporarily	49 (12.86)

Source: Survey Result

Table 4.2: Summary of Continuous Variables

Variable	Mean	Standard Deviation	Minimum	Maximum
Age	46.56693	8.057286	27	68
Household Size	4.855643	1.4501	1	8
Level of Education	10.42782	2.953706	5	19
Income	3320.297	1465.819	1100	10470
Duration	39.22572	15.62678	3	64

Source: Survey Result

4.1.2 Households Response for Current Situation of MSWM in Dilla Town

The average solid waste generated per week by households is 22.05 kilograms with a minimum of 10 kilograms and a maximum of 50 kilograms. Majority of the respondents that is about 40.16 percent (153) and 26.78 percent (102) of the total respondents practiced open burning of solid waste around their houses or in the village and open dumping on an open space or on the street respectively. Direct dumping on approved public land or community bins, direct dumping on their own land and throwing into nearby the river are practiced by 11.02 percent (42), 16.53 percent (63) and 5.51 percent (21) of the total respondent respectively. None of the respondents used the generated solid waste for the purpose of making compost. Methods of disposal of solid waste practiced by the respondents were presented below. Like in the case of the towns or cities of other developing countries, this result shows that open burning and open dumping of solid waste on an open space or on the street are widely practiced by households in Dilla town. This result is consistent with the report of the World Bank (Kaza et al. 2018).

Table 4.3: Households Response for Methods of Disposal of Solid Waste

Methods of Disposal of Solid Waste	Observation	Percentage
Direct dumping in approved public land or community bins	42	11.02
Direct dumping on your own land	63	16.53
Throw it on an open space or on the street	102	26.78
Throw it into the nearby river	21	5.51
Burning around the house or in the village	153	40.16
Making compost	0	0
Total	381	100

Source: Survey Result

The findings of the study revealed that 29.92 percent (114) of the total respondents received solid waste collection or disposal service from the municipality of the town. All respondents who received the service also said there is no regular solid waste collection service in the town. Moreover, about 11.55 percent (44) of the respondents are satisfied with the current solid waste collection service provided in the town.

Table 4.4: Households Response for Satisfaction with the Current SWM Service

Response	Observation	Percentage
Yes	44	11.55
No	337	88.45
Total	381	100

Source: Survey Result

Households were also asked to state the current SWM problem in Dilla town as very serious, serious, not serious and do not know. The finding revealed that 63.78 percent (243), 32.55 percent (124), and 3.67 percent (14) of the total respondents stated the current or existing SWM problem as very serious, serious and not serious respectively. In general, this result revealed that solid waste generated from the town is not properly managed.

Table 4.5: Households Response for Current SWM Problem in the Town

Response	Observation	Percentage
Very Serious	243	63.78
Serious	124	32.55
Not Serious	14	3.67
Do not know	0	0
Total	381	100

Source: Survey Result

Respondents were also asked about who is the responsible body for MSWM in Dilla town. The results of the survey revealed that 46.46 percent (177) and 12.07 percent (46) of the total respondents said the local authorities and households' are responsible for the MSWM in the town respectively. The remaining 41.47 percent (158) of the total respondents said both the local authorities as well as households are responsible for MSWM in the town.

Table 4.6: Households Response for “Who is responsible for MSWM in Dilla Town?”

Responsible Body	Observation	Percentage
Local Authorities	176	46.2
Households	46	12.07
Both	159	41.73
Total	381	100

Source: Survey Result

4.1.3 Households Response for Impacts of Poorly Managed Solid Waste

Out of the total 381 respondents, 54.86 percent (209) have awareness about the negative impacts of poorly managed solid waste on the environment such as water and air pollutions due to open burning and uncontrolled dumping of solid waste. About 48.3 percent (184) of the respondents are affected by waste-related diseases due to the negative impact of poorly managed solid waste on human health.

Table 4.7: Households Environmental Awareness and Affected by Waste-Related Diseases

Response	Environmental Awareness	Affected By Waste Related Diseases
	Observation (Percentage)	Observation (Percentage)
Yes	209 (54.86)	184 (48.3)
No	172 (45.14)	197 (51.7)
Total	381(100)	381 (100)

Source: Survey Result

Respondents who are affected by waste-related diseases (WRD) were asked to state the type of diseases from the given lists. The finding revealed that about 100 percent (184) and 25.54 percent (47) of the respondents are affected by common cold and asthma diseases due to the bad odor of the poorly treated generated solid waste in the town respectively. Moreover, 36.41 percent (67) and 26.08 percent (48) of the respondents are affected by typhoid fever and diarrhea diseases respectively. Due to the poorly managed solid waste in the town that creates a conducive environment for the breeding of mosquitoes, 32.06 percent (59) of the respondents are exposed to malaria disease. Out of 184 respondents who are affected by WRD, households' daily life of 98.37 percent (181) and are affected by WRD via making the members unable to engage in productive works, school or elsewhere due to sickness. Moreover, about 86.95 percent (160) of the respondents incurred a cost to their household members in order to get medical treatment from health stations. Here, the total percentage of responses of households affected by WRD is greater than 100 since they selected more than one disease from the given alternatives.

Table 4.8: Response of Households Affected by Waste-Related Diseases

Disease	Observation	Percentage
Common cold	184	100
Asthma	47	25.54
Typhoid fever	67	36.41
Malaria	59	32.06
Diarrhea	48	26.08

Source: Survey Result

4.1.4 Households WTP Response for Improved MSWM in Dilla Town

Based on the finding of the study, about 91.6 percent of the total respondents were willing to pay for improved USWM in Dilla town. However, the remaining 8.4 percent of the respondents were not willing to pay for the proposed project. Depending on the responses of respondents, reasons for their willing or not willing to pay for improved USWM (debriefing questions) were asked in order to know whether they clearly understood the scenario or not. Out of the total 349 respondents who are willing to pay, 61.32 percent of them said “the new proposed USWM service will make the town suitable for life” from the given list of options delivered to them. Moreover, 43.27 percent and 87.1 percent of the willing respondents selected “the negative impacts of poorly managed solid waste will be minimized”, and “a clean, safe and healthy environment will be created in the town” choices respectively. Here, the total percentage of responses of the willing respondents exceeds 100 percent because many of them selected more than one reason from the given choices. The 32 unwilling respondents were also chosen their reasons from the given list of alternatives. As a result, 21.87 percent (7) and 12.5 percent (4) of the unwilling respondents selected “satisfied with the existing system” and “Do not trust the new proposed system reasons respectively. Moreover, the remaining 46.87 percent (15) and 18.75 percent (6) of the unwilling respondents chosen “I cannot afford” and “It is government’s responsibility to provide USWM service for free” from the given list of reasons respectively.

Table 4.9: Households WTP Response for Improved MSWM

Response	Observation	Percentage
Yes	349	91.6
No	32	8.4
Total	381	100

Source: Survey Result

The WTP responses of households for the double-bounded value elicitation format is presented below in Table 4.10. The results revealed that the number of “yes-yes” responses for the initial and follow-up bids decreases as the value of initial bids increases. Since the values of the follow-up bids are dependent on the value of the initial bids, the number of “yes-yes” responses decreases as the initial bids increase. For instance, the number of “yes-yes” responses decline from 50 to the minimum value 0 as the initial bids increase from ETB 5.5 to ETB 20. Whereas, the number of “no-no” responses for the initial and follow-up bids increases as the value of initial bids increases since the value of the follow-up bids depends on the value of initial bids. The number of “no-no” responses increases from 4 to 52 as the value of initial bids increases. Moreover, the number of “yes-no” and “no-yes” responses may increase or decrease depending on the response for the initial bids.

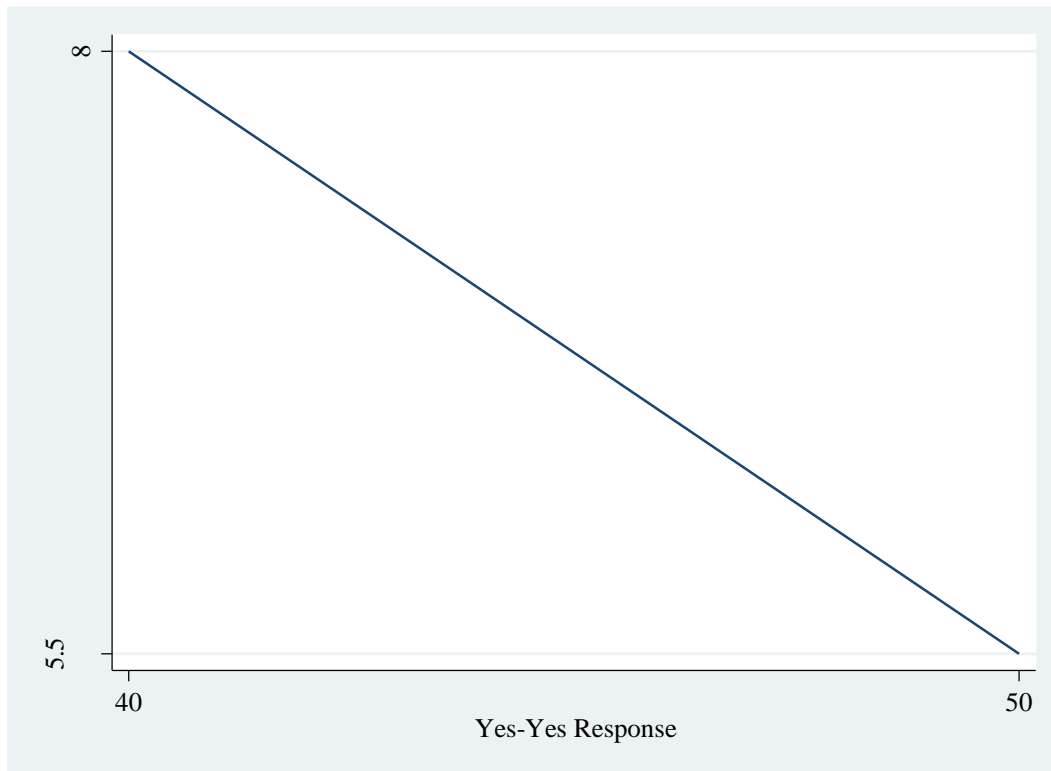
The number or percentage of the four responses for each initial as well as follow-up bid was computed out of the successfully collected questionnaires. For instance, out of the 74 successfully completed questionnaire for the ETB 5.5 initial bid and the follow-up bids (5 ± 2.75), 50 respondents (67.57 percent), 18 respondents (24.32 percent), 2 respondents (2.7 percent), and 4 respondents (5.41 percent) gave “yes-yes”, “yes-no”, “no-yes” and “no-no” responses. Out of the total 381 respondents, “yes-yes”, “yes-no”, “no-yes” and “no-no” responses constitute 23.62 percent, 27.56 percent, 35.17 percent, and 13.65 percent respectively. After the double-bounded value elicitation format, respondents were asked to state their maximum WTP. Out of the respondents who have positive WTP, the result of the open-ended elicitation format revealed that the minimum WTP is ETB 5 and the maximum WTP is ETB 25.

Table 4.10: Households WTP Response for the Initial and Follow-up Bids

Initial Bids in ETB	Follow-up Bids in ETB	Responses							
		Yes-Yes	Yes-Yes (%)	Yes-No	Yes-No (%)	No-Yes	No-Yes (%)	No-No	No-No (%)
5.5	5 ± 2.75	50	67.57	18	24.32	2	2.7	4	5.41
8	8 ± 4	40	54.05	25	33.78	4	5.41	5	6.76
12.25	12.25 ± 6.125	0	0	36	46.15	32	41.03	10	12.82
15.5	15.5 ± 7.75	0	0	14	17.95	51	65.38	13	16.67
20	20 ± 10	0	0	12	15.58	44	57.14	21	27.27
Total		90	23.62	105	27.56	133	35.17	53	13.65

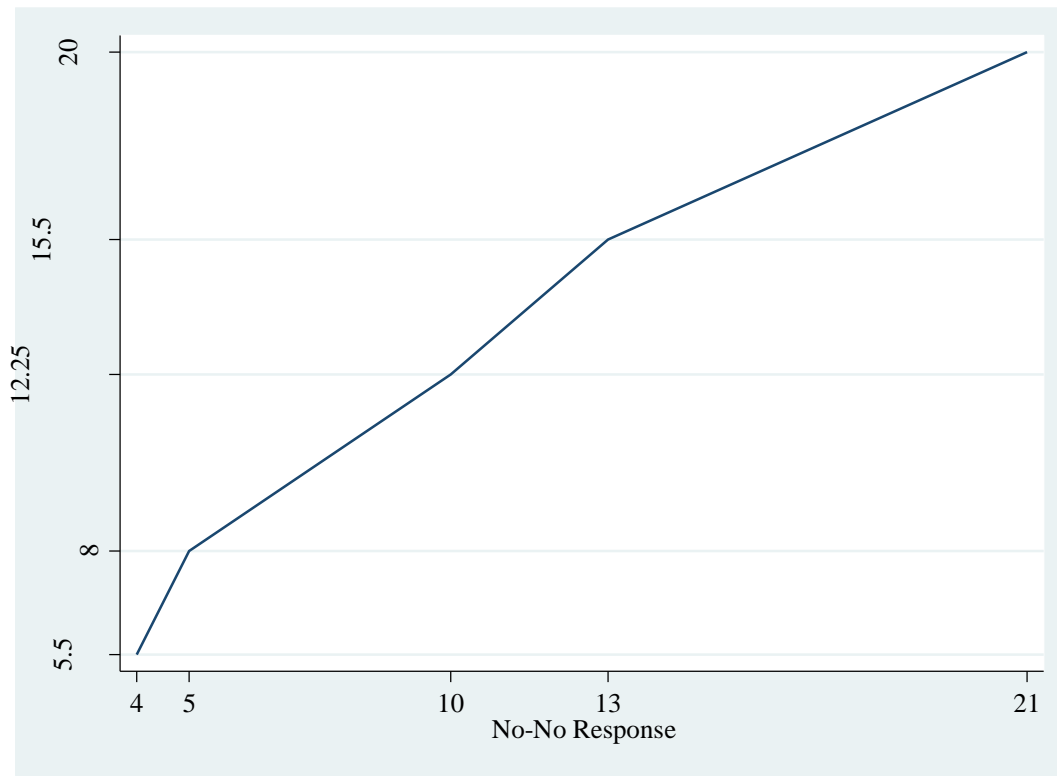
Source: Survey Result

Figure 4.1: The Relationship between Initial Bids and Yes-Yes Response of Respondents



Source: Survey Result

Figure 4.2: The Relationship between Initial Bids and No-No Response of Respondents



Source: Survey Result

4.2 Econometric Analysis

4.2.1 Specification Tests for the Probit and Tobit Models

The issues of heteroscedasticity and non-normality are the two common problems which arise in microeconomic data. Maximum likelihood estimators will be inconsistent if there are problems of heteroscedasticity and non-normality in both probit and tobit models (Greene, 2003; Verbeek, 2004; Cameron & Trivedi, 2005). The Lagrange multiplier (LM) test can be used to test whether there is constant variance (homoscedasticity) or no constant variance (heteroscedasticity) of the error terms. There are different types of LM tests. This study used the Breusch-Pagan and Harvey-Godfrey LM tests for the probit and tobit models respectively.

The first step of the two LM tests is estimating the probit as well as the tobit models and obtaining the residuals. The second step is running an auxiliary regression. In this step, a regression of the square of residuals on the explanatory variables is used for the Breusch-Pagan LM test. A regression of the natural logarithm of residuals square on the explanatory variables is used for the Harvey-Godfrey LM test. The third step is computing the LM statistic that is the number of observations multiplied by R-squared. The final step is comparing the LM statistic with the chi-square critical value at $(k-1)$ degree of freedom (df), where k is the number of parameters. Then, the variance of the error term is constant (homoscedasticity) if the LM statistic is less than the chi-square critical value (χ^2_{k-1}). If the reverse is true, there is a heteroscedasticity problem. The cost variable is excluded from the regression of the probit model because it creates the heteroscedasticity problem. The square of household size variable for the probit model and the natural logarithm of income for both the probit and tobit models were used in order to detect the problem of heteroscedasticity. As it can be observed from Table 4.11 and 4.12, there is no heteroscedasticity problem for both the probit and tobit models since the LM statistics are less than the chi-square critical value. Hence, the maximum likelihood estimators of the two models are consistent.

This study employed Skewness-Kurtosis (SK) and Jarque-Bera (JB) tests for normality of error terms. Residuals are normally distributed if $\text{prob} > \text{chi-square}$ and chi-square results of the SK test and JB test are greater than 0.05 respectively. The results of the two tests for both the probit and tobit models revealed that the assumption of normality of the residuals is fulfilled since the $\text{prob} > \text{chi-square}$ result of the SK test and chi-square result of the JB test are greater than 0.05. Hence, the maximum likelihood estimators of the two models are consistent. Moreover, graphical methods can be used for showing the normality of error terms. A histogram plot is one of the graphical methods that can be used to show the normality of error terms. Hence, residuals are normally distributed if the histogram plot shows a bell-shaped curve. As it can be observed from appendix 8 and 18, the histogram plots revealed bell-shaped curves and thus, the normality of residuals for the two models.

The correlation between explanatory variables is tested using the variance inflation factor (VIF) and correlation matrix. As it can be observed from appendix 3 and 13, the results revealed that there is no multicollinearity problem or no correlation between explanatory variables for both the probit and tobit models since VIF values for each explanatory variable are less than ten.

Table 4.11: Multicollinearity, Heteroscedasticity and Normality Tests for the Probit Model

Test	Test Result	Decision
VIF	VIF for each explanatory variable < 10	No multicollinearity or no correlation between explanatory variables
LM Test	$\begin{aligned} \text{LM Statistic} &= N \times R\text{-squared} \\ &= 381 \times 0.0532 \\ &= 20.2692 \end{aligned}$ <hr/> Chi-Square Critical ($X^2_{.05}$) at (K-1) df, df = 13 $= 22.362$	Constant variance (Homoscedasticity) of residuals since LM Stat < $X^2_{.05}$
JB Test	Chi-Square $= 0.7466$ <hr/> Prob>chi2	Residuals are normally distributed since Chi-Square > 0.05
SK Test	$= 0.6656$	Residuals are normally distributed since (Prob>chi2) > 0.05

Source: Regression Result

Table 4.12: Multicollinearity, Heteroscedasticity and Normality Tests for the Tobit Model

Test	Test Result	Decision
VIF	VIF for each explanatory variable < 10	No multicollinearity or no correlation between explanatory variables
LM Test	$\begin{aligned} \text{LM Statistic} &= N \times R\text{-squared} \\ &= 381 \times 0.0567 \\ &= 21.6027 \end{aligned}$ <hr/> Chi-Square Critical ($X^2_{.05}$) at (K-1) df, df = 13 $= 22.362$	Constant variance (Homoscedasticity) of residuals since LM Stat < $X^2_{.05}$
JB Test	$\begin{aligned} \text{Chi-Square} &= 0.1776 \end{aligned}$	Residuals are normally distributed since Chi-Square > 0.05
SK Test	$\begin{aligned} \text{Prob}>\text{chi2} &= 0.1699 \end{aligned}$	Residuals are normally distributed since (Prob>chi2) > 0.05

Source: Regression Result

4.2.2 Probit Model Estimation Result

The probit model describes the relationship between households WTP response for the initial bids and the explanatory variables employed in the model. The average marginal effects were used in order to interpret the coefficients of each significant explanatory variable. The results of the regression revealed that the income of households positively and significantly affects households WTP response for the initial bids at one percent level of significance. This positive relationship is consistent with the expected sign and the findings of other studies found in the literature (Bhattarai, 2015; Bhattarai et al., 2017; Dagnew et al., 2013; Muhdin et al., 2016; Ndunda & Muia, 2018; Birara & Kassahun, 2018; Maskey & Singh, 2017; Alhassan et al., 2017). Households who have a higher level of monthly income are more willing to pay and have a higher probability of accepting the initial bids. Other things remain constant, a one percent increase in the monthly income of households leads to about a 0.47 percent increase in the probability of accepting the initial bids and vice versa.

The awareness of respondents about the impact of poorly managed solid waste on the environment was found to be positively and significantly affect households WTP response for the initial bids at one percent level of significance. This result is consistent with the expected sign and the findings of other studies found in the literature (Dagneu et al., 2013; Maskey & Singh, 2017). This shows those respondents who have awareness about the impact of poorly managed solid waste on the environment have a higher probability of accepting the initial bids and were more willing to pay for improved USWM in Dilla town and vice versa. Other things remain constant, respondents who have awareness have a 33.21 percent higher probability of accepting the initial bids as compared to those respondents who do not have awareness.

The satisfaction with the existing system was found to be negatively and significantly related to households WTP response for the initial bids at five percent level of significance. This result is consistent with the expected sign and the findings of other studies found in the literature (Alhassan & Mohammed, 2013; Muhdin et al., 2016). As a result, households who are not satisfied with the existing system were more willing to pay for the improved USWM and vice versa. Other things remain constant, households who are not satisfied with the existing system have about a 19.8 percent higher probability of accepting the initial bids and vice versa.

The age of the respondents has also a positive and significant effect on the households WTP response for the initial bids at one percent level of significance. This result is not consistent with the expected sign. But, it is consistent with the findings of some studies found in the literature (Bhattarai, 2015; Alhassan et al., 2017). Since the average age of the respondents is 46.57 year and the age of the majority of respondents is found in the working-age population that is between 15 and 64 ages, the positive relationship regression result is consistent with the survey data. Other things remain constant, the probability of accepting the initial bids increase by 1.34 percent as the age of respondents increase by one year and vice versa.

Table 4.13: Probit Model Regression Result

Dependent Variable: Households WTP Response for the Initial Bids			
Explanatory Variable	Coefficient	P> z 	Average Marginal Effects
Ln income	2.012403	0.000***	0.4785364
Household Size	0.3424519	0.387	0.0814329
Household Size ²	-0.0373929	0.316	-0.0088918
SW Generation	0.0056312	0.698	0.0013391
Awareness	1.179138	0.000***	0.3321634
Satisfaction	-0.8036292	0.032**	-0.1979246
Education	-0.0590566	0.223	-0.0140433
Age	0.056455	0.000***	0.0134246
Gender	0.2226881	0.218	0.0528707
House ownership	0.0488525	0.841	0.0116689
Marital status	0.2056004	0.681	0.0494957
Households Plan	0.0893138	0.82	0.0213534
Duration	0.0070816	0.383	0.001684
Constant	-20.34315	0.000	
Number of Observation	381		
LR chi2(13)	203.43		
Prob > chi2	0.0000		
Pseudo R2	0.3853		
Log likelihood	-162.27005		

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

4.2.3 Tobit Model Estimation Result

The tobit model shows the relationship between the MWTP of respondents and the explanatory variables used in the model. Average marginal effects were used in order to interpret the coefficients of each significant explanatory variable. As it can be observed from Table 4.14, column A, B, and C represents average marginal effects on the probability of being censored, average marginal effects for the censored sample and average marginal effects for the truncated sample or for willing observations who have positive WTP respectively. The results of the tobit regression revealed that income of the respondents positively and significantly affected their MWTP at one percent level of significance. This result is consistent with the expected sign and findings of other studies found in the literature (Bhattarai, 2015; Bhattarai et al., 2017; Dagneu et al., 2013; Muhdin et al., 2016; Ndunda & Muia, 2018; Birara & Kassahun, 2018; Maskey & Singh, 2017; Alhassan et al., 2017). Other things remain constant, a one percent increase in respondent's monthly income leads to an increase in the probability of a household's WTP for improved USWM by 0.069 percent and vice versa. Moreover, households WTP increases by about ETB 6.5 for all observation and ETB 6.27 for willing observation when the income of the households increases by one percent and vice versa.

The solid waste generation variable has a positive and significant effect on households MWTP for improved USWM. This result is consistent with the expected sign and the findings of other studies found in the literature (Dagneu et al., 2013; Muhdin et al., 2016; Birara & Kassahun, 2018). Hence, households who generated more quantity of solid waste were more willing to pay for improved USWM. Other things remain constant, a kilogram increase in solid waste generated by households leads to a 0.17 percent increase in the probability of households WTP for improved USWM. Moreover, keeping other things constant, the WTP of households increase by about ETB 0.16 for all observation and about ETB 0.15 for the willing observations when the amount of solid waste generated by households increases by one kilogram and vice versa.

The awareness of respondents about the impact of poorly managed solid waste on the environment is another significant variable that significantly and positively affects the MWTP of households for improved USWM. This finding is consistent with the expected sign of this variable and the findings of other studies found in the literature (Dagneu et al., 2013; Maskey & Singh, 2017). Households who have awareness about the impact of poorly managed solid waste on the environment were more willing to for improved USWM than those who do not have awareness. Keeping other things constant, households who have awareness have a 0.87 percent higher probability of WTP for improved USWM. Besides, respondents who have awareness were more willing to pay about ETB 0.85 for all observation and about ETB 0.83 for willing observation than those respondents who do not have awareness.

The households' plan variable was found to be positively and significantly related to households MWTP for improved USWM. This finding was consistent with the expected sign. As a result, households who planned to live permanently in the town were more willing to pay for improved USWM. Other things remain constant, households who planned to live permanently in Dilla town have about a 4.5 percent higher probability of WTP than those households who planned to live temporarily in the town. Moreover, respondents who planned to live permanently were more willing to pay about ETB 3.03 for all observation and ETB 2.87 for willing observations that those respondents who planned to live temporarily.

The duration variable has also a positive and significant effect on the MWTP of households. This result is consistent with the expected sign as well as the findings of Alhassan and Mohammed (2013). As a result, households who live a longer time period in Dilla town were more willing to pay for improved USWM. *Ceteris Paribus*, the probability of households WTP for improved USWM increases by about 0.036 percent when households increase their duration in the town by one year and vice versa. Moreover, households MWTP increases by ETB 0.034 for the censored sample and about ETB 0.033 for the truncated sample when the duration of households in the town increases by one year.

Table 4.14: Tobit Model Regression Result

Dependent Variable: MWTP					
Explanatory Variable	Coefficient	P> t 	Marginal Effects		
			A¹	B²	C³
Ln income	6.672838	0.000***	0.069575	6.493346	6.272882
Household Size	0.072234	0.763	0.0007532	0.0702909	0.0679044
SW Generation	0.1653404	0.000***	0.0017239	0.1608929	0.1554302
Awareness	0.8723479	0.057*	0.0086921	0.8510134	0.8227466
Satisfaction	-0.1563426	0.793	-0.0016497	-0.152126	-0.1468722
Education	0.0692479	0.479	0.000722	0.0673852	0.0650973
Age	-0.0169237	0.586	-0.0001765	-0.0164684	-0.0159093
Gender	-0.1488936	0.695	-0.0015295	-0.1449761	-0.1401084
House ownership	0.1003291	0.843	0.0010422	0.0976596	0.0943368
Marital status	0.402954	0.579	0.00438	0.3918472	0.3778442
Households Plan	3.12741	0.000***	0.0449521	3.031671	2.872238
Duration	0.0347844	0.035**	0.0003627	0.0338487	0.0326995
Cost	0.4639837	0.179	0.0047299	0.4518368	0.436708
Constant	-52.56748	0.000			
Number of Observation	381		32 left-censored observations at MWTP <= 0		
LR chi2(13)	330.26		349 uncensored observations		
Prob > chi2	0.0000		0 right-censored observations		
Pseudo R2	0.1497				
Log likelihood	-938.14538				

***, **, 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

This study computed or estimated mean WTP from the responses of respondents obtained from both open-ended and double-bounded value elicitation formats. Since the treatment of protest responses has a significant effect on mean WTP, the respondents' response for the debriefing questions was used in order to identify the protest zero bids. As a result, respondents who do not trust the new proposed system and said "It is the government's responsibility to provide USWM service for free" are excluded from the computation of mean WTP. There are respondents who have positive WTP response and are satisfied with the existing system. There are also respondents who have zero WTP response and are satisfied with the existing system. Those respondents who are satisfied and have positive WTP needs better improvement in USWM in Dilla town. However, respondents who are satisfied and have zero WTP for improved USWM in the town are excluded from the computation of mean WTP. Responses of respondents who said "I cannot afford" are included in mean WTP computation and are considered as real or valid zero bids. The treatment of outliers has also a significant effect on mean WTP. The MWTP values of respondents greater than five percent of their income are considered as outliers in this study as other studies mentioned (Alemu, 2000; Dagneu et al., 2012). However, all MWTP of respondents is less than five percent (even 15 percent and above) of their income. Hence, there are no MWTP responses of respondents which are considered as outliers.

In general, 21.87 percent (7), 12.5 percent (4) and 18.75 percent (6) of the total 32 respondents who have zero WTP said "Satisfied with the existing system" , "Do not trust the new proposed system and "It is the government's responsibility to provide USWM service for free" respectively. The remaining 46.87 percent (15) of the unwilling respondents said: "I cannot afford". Hence, 364 respondents out of a total of 381 respondents are included in mean WTP computation or estimation.

As it can be observed from Table 4.15 below, the coefficients of the initial and follow-up bids are negative as well as statistically significant at one percent level of significance. This shows the negative relationship between the initial bids with initial bids response and follow-up bids with follow-up bids response. The rho is statistically significant as well as different from zero that shows the greater efficiency of the result of SUBP model.

Table 4.15: Seemingly Unrelated Bivariate Probit Model Estimation Result

Dependent Variable: Initial Bids Response			
Explanatory Variable	Coefficient	Z	P> z
Initial Bid	-0.2215023	-13.29	0.000***
Constant	2.905063	14.1	0.000***
Dependent Variable: Follow-up Bids Response			
Follow-up Bid	-0.2586671	-15.46	0.000***
Constant	3.006506	15.79	0.000***
Athrho	0.9900327	9.98	0.000***
Rho			
Number of observation	364		
Wald chi2(2)	360.16		
Prob > chi2	0.0000		
Log pseudo likelihood	-341.15518		
Wald test of rho=0: chi2(1)	99.6655		
Prob > chi2	0.0000		

*** represents the level of significance at one percent

The mean WTP obtained from open-ended value elicitation format⁴ was about ETB 10.7 per month for a household. The seemingly unrelated bivariate probit (SUBP) model estimation result was used to compute the mean WTP obtained from double-bounded value elicitation format⁵. The delta method using Stata's nlcom (non-linear combinations of estimators) command was used to estimate mean WTP from the initial and follow-up bids response. The 95 percent confidence interval shows the lower and upper bounds. The results revealed that the mean WTP obtained from the initial bids response was ETB 13.11 with the lower bound ETB 12.4 and the upper bound ETB 13.82. The mean WTP obtained from the follow-up bids response was ETB 11.62 with the lower bound ETB 11.1 and the upper bound ETB 12.14. The mean WTP obtained from double-bounded format is greater than the open-ended format.

Table 4.16: Mean WTP Estimation Result from Double-Bounded Value Elicitation Format

	Coefficient	Z	P> z 	95% Confidence Interval	
Mean WTP from Initial Bids Response	13.11527	36.32	0.000***	12.40756	13.82298
Mean WTP from Follow-up Bids Response	11.62307	43.84	0.000***	11.10344	12.1427

*** represents the level of significance at one percent

The total WTP of households is the total amount of money that will be used for providing improved USWM in Dilla town. The mean WTP multiplied by the total number of households who have valid responses is the total WTP. Based on the 17 number of households who have invalid or protest responses, about 991 households out of the total household number in Dilla town were expected to have protest responses. Here, households who are excluded from mean WTP calculation are excluded from the total WTP.

⁴ Is the sum of MWTP of respondents divided by the number of respondents who have valid responses (364).

⁵ According to Haab and McConnell (2002), Mean WTP = $-\frac{\beta_0}{\beta_1}$, where β_0 and β_1 represents the constants and coefficients of the initial as well as the follow-up bids respectively.

Table4.17: Total WTP of Households

Total Household Number	Households Who have protest responses⁶	Households who have valid responses⁷	Mean WTP per month in ETB⁸	Total WTP per month in ETB⁹
22,217	991	21,226	10.7	227,118.2
22,217	991	21,226	12.36	262,353.36

Source: Own Computation

⁶ Since the number of households who have protest responses out of 381 respondents is 17 (4.46 percent), the total household number that is 22,217 times 0.0446 gives the number of households who are expected to have protest responses (991 households) from the total household number.

⁷ The difference between total household number (22,217) and households who have protest responses (991) is the number of households who have valid responses (21,226).

⁸ ETB 10.7 is the mean WTP obtained from open-ended value elicitation format. ETB 12.36 is the mean WTP obtained from double-bounded format and is calculated by taking the average of the mean WTP obtained from the initial and follow-up bids responses.

⁹ Total WTP is the mean WTP multiplied by the total number of households who have valid responses (21,226).

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The main objective of this study is to investigate households WTP for improved USWM in Dilla town. The study used CVM in order to estimate households WTP using double-bounded followed by open-ended value elicitation formats. Seemingly unrelated bivariate probit model and the maximum WTP responses from open-ended question were used to estimate households Mean WTP. The sample households were selected from the three sub-cities of Dilla town using a stratified random sampling technique. Based on the household or population share of each sub-city from the total household or population number of the town, the study selected 118 households, 93 households and 189 households from Sesa, Bedecha, and Harowelabu sub-cities respectively. Out of the total 400 sample households, 381 households successfully completed the face-to-face interview. The study also conducted a pilot survey on the 25 randomly selected households from each sub-city of the town. The randomly selected households were selected based on the population or household share of each sub-city from the total population or household number of the town. The main aims of the pilot survey were to determine the initial bids such as ETB 5.5, ETB 8, ETB 12.25, ETB 15.5 and ETB 20, and the payment vehicle.

The findings of the study revealed that the generated solid waste from the town is poorly managed. There is a serious problem of SWM in the town. There is no regular solid waste collection service in the town. About 63.78 percent, 32.55 percent, and 3.67 percent of the total respondents stated the current or existing SWM problem as very serious, serious and not serious respectively. About 29.92 percent of the total respondents received solid waste collection or disposal service from the municipality of the town. The poor management of solid waste in the town creates negative impacts on human health and the environment. About 54.86 percent of the respondents have awareness about the negative impacts of poorly managed solid waste on the environment such as water and air pollutions due to open burning and uncontrolled dumping of solid waste. Moreover, 48.3 percent of the respondents are affected by waste-related diseases due to the negative impact of poorly managed solid waste on human health.

The study also employed probit and tobit models in order to investigate the determinants of households WTP for improved USWM. The result of the probit regression revealed that income of households, awareness of respondents about the impact of poorly managed solid waste on the environment and age of the respondents have positive and significant effects on the households WTP response for the initial bids. The satisfaction with the existing system has a negative and significant relationship with the WTP response of respondents for the initial bids. The tobit model was used to estimate the relationship between the explanatory variables used in the study and households MWTP. The result of the regression revealed that income of the respondents, solid waste generated by households, awareness of respondents about the impact of poorly managed solid waste on the environment, plan of households, and duration have positive and significant effects on the households MWTP for improved USWM.

The majority of the respondents were willing to pay for improved USWM in Dilla town. About 91.6 percent of the total respondents were willing to pay for improved USWM in Dilla town. The mean WTP values obtained from open-ended and double-bounded value elicitation formats are about ETB 10.7 and ETB 12.36 per month for a household respectively. The total WTP for improved USWM obtained from open-ended and double-bounded value elicitation formats are about ETB 227,118.2 and ETB 262,353.36 respectively. This shows the municipality of Dilla town can solve the problem of shortage of budget for providing USWM by imposing MSWM fee on the residents.

5.2 Recommendation

This study derived the following recommendations from the findings of the study. The local authorities should work hard on awareness creation for the residents of the town about the impacts of poorly managed solid waste on the environment and human health through mass media and campaign. Particularly, awareness creation about the impacts of open dumping and open burning on the environment and human health should be delivered to the residents since the majority of the residents practiced open burning and open dumping of solid waste on an open space or on the street. In order to create a clean, safe, and healthy environment in the town, both the local authorities or the municipality and residents of the town should cooperate and take the responsibility of SWM. The residents of the town should contribute to the SWM by supplying their labour.

The municipality of the town should invest or create a conducive environment for private investment on the disposal of solid waste generated from the town. For instance, composting and recycling of the generated solid waste have a significant role in changing the generated solid waste into a good opportunity. The solid waste generated from the town can be used for generating renewable energy. The unemployed people in the town can get employment opportunities from solid waste-related projects.

It is not mandatory to charge the mean WTP obtained from this study as a MSWM fee on the households. The mean WTP of this study can be used as a guide for the municipality in order to determine the socially acceptable fee. In order to avoid the free-rider problem, the municipality of the town should charge the MSWM fee on every household who lives in the town.

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APPENDICES

Appendix 1: Probit Model Regression Result

```

Iteration 0:   log likelihood = -263.98277
Iteration 1:   log likelihood = -165.80839
Iteration 2:   log likelihood = -162.31137
Iteration 3:   log likelihood = -162.27005
Iteration 4:   log likelihood = -162.27005
    
```

```

Probit regression           Number of obs   =       381
                           LR chi2(13)         =       203.43
                           Prob > chi2         =       0.0000
Log likelihood = -162.27005 Pseudo R2          =       0.3853
    
```

initialbidresponse	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
lnincome	2.012403	.3959017	5.08	0.000	1.23645 2.788356
householdsize	.3424519	.3958065	0.87	0.387	-.4333146 1.118218
householdsize2	-.0373929	.0372735	-1.00	0.316	-.1104476 .0356617
swgeneration	.0056312	.014504	0.39	0.698	-.0227961 .0340585
1.awareness	1.179138	.216616	5.44	0.000	.754578 1.603697
1.satisfaction	-.8036292	.3741289	-2.15	0.032	-1.536908 -.07035
education	-.0590566	.0484126	-1.22	0.223	-.1539436 .0358304
age	.056455	.0152365	3.71	0.000	.0265919 .086318
1.gender	.2226881	.1808974	1.23	0.218	-.1318643 .5772405
1.houseownership	.0488525	.2438989	0.20	0.841	-.4291805 .5268856
1.maritalstataus	.2056004	.5001116	0.41	0.681	-.7746004 1.185801
1.householdsplan	.0893138	.3922141	0.23	0.820	-.6794118 .8580393
duration	.0070816	.0081252	0.87	0.383	-.0088435 .0230066
_cons	-20.34315	3.270858	-6.22	0.000	-26.75392 -13.93239

Appendix 4: Correlation Matrix for the Probit Model

	initialbid-e	lnincome	households-e	swgeneration	awareness	satisfaction	education	age	gender	houseowner-p	maritalsta-s	households-n	duration
initialbid-e	1.0000												
lnincome	0.4435	1.0000											
households-e	0.2942	0.1078	1.0000										
swgeneration	0.3000	0.2121	0.6991	1.0000									
awareness	0.4963	0.4798	0.0407	0.1270	1.0000								
satisfaction	-0.3207	-0.2904	-0.3439	-0.3089	-0.2663	1.0000							
education	0.2751	0.6620	-0.2547	-0.0924	0.6179	-0.1276	1.0000						
age	0.3344	0.0280	0.7030	0.4543	0.0488	-0.2673	-0.2047	1.0000					
gender	-0.0226	-0.0739	-0.2974	-0.2341	0.0064	0.1475	0.0369	-0.0758	1.0000				
houseowner-p	0.2395	0.0267	0.6138	0.5087	0.1038	-0.2328	-0.2117	0.4949	-0.2457	1.0000			
maritalsta-s	0.2033	0.1286	0.5363	0.3422	0.0769	-0.2683	-0.1009	0.2942	-0.1754	0.3721	1.0000		
households-n	0.1267	-0.1439	0.4652	0.3541	-0.0334	-0.2291	-0.2659	0.3954	-0.1850	0.5058	0.2998	1.0000	
duration	0.2453	-0.0548	0.5755	0.5124	0.0182	-0.2557	-0.2716	0.5546	-0.1840	0.5621	0.3196	0.6576	1.0000
		duration											
duration		1.0000											

Appendix 5: Auxiliary Regression for the Probit model

Source	SS	df	MS	Number of obs	=	381
Model	.856977915	13	.065921378	F(13, 367)	=	1.59
Residual	15.2616769	367	.041584951	Prob > F	=	0.0869
				R-squared	=	0.0532
				Adj R-squared	=	0.0196
Total	16.1186548	380	.042417513	Root MSE	=	.20392

errorterm2	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
lnincome	-.0732228	.0454592	-1.61	0.108	-.1626159 .0161704
householdsize	-.0185189	.0456171	-0.41	0.685	-.1082225 .0711847
householdsize2	.0005878	.0044631	0.13	0.895	-.0081887 .0093644
swgeneration	.0016388	.0019643	0.83	0.405	-.002224 .0055015
1.awareness	-.0397656	.0287758	-1.38	0.168	-.0963517 .0168205
1.satisfaction	-.1091245	.0373483	-2.92	0.004	-.1825681 -.0356809
education	.0028405	.0062405	0.46	0.649	-.0094312 .0151122
age	.0012829	.0020424	0.63	0.530	-.0027334 .0052992
1.gender	.0055725	.0241046	0.23	0.817	-.041828 .0529729
1.houseownership	.0156406	.0320315	0.49	0.626	-.0473478 .0786289
1.maritalstataus	.0663182	.0586117	1.13	0.259	-.0489387 .1815751
1.householdspan	-.0043876	.0444636	-0.10	0.921	-.091823 .0830478
duration	.000335	.0010609	0.32	0.752	-.0017513 .0024213
_cons	.627392	.3377928	1.86	0.064	-.0368602 1.291644

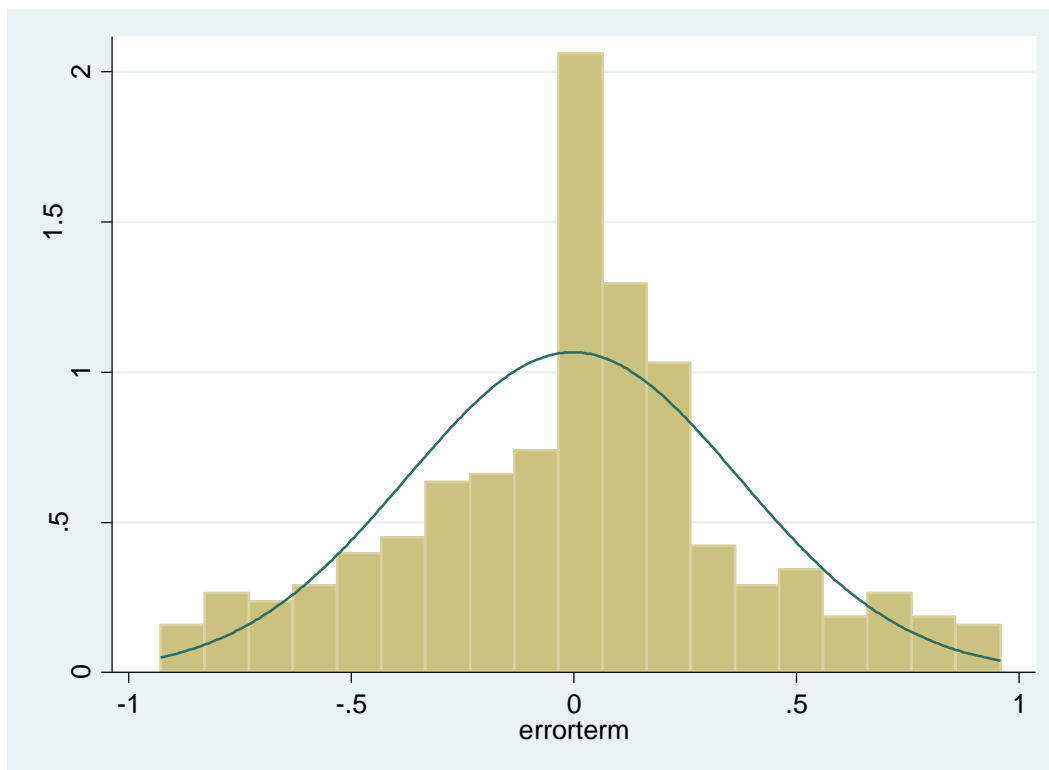
Appendix 6: Jarque-Bera Test for the Probit Model

```
. jb errorterm
Jarque-Bera normality test:  .5846 Chi(2)  .7466
Jarque-Bera test for Ho: normality:
```

Appendix 7: Skewness and Kurtosis Test for the Probit Model

Skewness/Kurtosis tests for Normality					
Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	joint Prob>chi2
errorterm	381	0.7179	0.4102	0.81	0.6656

Appendix 8: Histogram for the Probit Model



Appendix 9: Tobit Model Regression Result

```

Tobit regression                               Number of obs   =       381
                                                LR chi2(13)    =       330.26
                                                Prob > chi2    =       0.0000
Log likelihood = -938.14538                    Pseudo R2      =       0.1497
    
```

mwtp	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
lnincome	6.672838	.7172203	9.30	0.000	5.262474	8.083203
householdsize	.072234	.2395364	0.30	0.763	-.3987979	.5432658
swgeneration	.1653404	.0306172	5.40	0.000	.1051338	.225547
1.awareness	.8723479	.4571453	1.91	0.057	-.0265968	1.771293
1.satisfaction	-.1563426	.5947727	-0.26	0.793	-1.325922	1.013237
education	.0692479	.0976804	0.71	0.479	-.1228339	.2613297
age	-.0169237	.0310797	-0.54	0.586	-.0780399	.0441925
1.gender	-.1488936	.3792587	-0.39	0.695	-.8946798	.5968926
1.houseownership	.1003291	.5064337	0.20	0.843	-.895538	1.096196
1.maritalstataus	.402954	.7263059	0.55	0.579	-1.025277	1.831185
1.householdsplan	3.12741	.6990746	4.47	0.000	1.752728	4.502092
duration	.0347844	.01647	2.11	0.035	.0023972	.0671716
1.cost	.4639837	.3449228	1.35	0.179	-.2142832	1.142251
_cons	-52.56748	5.247934	-10.02	0.000	-62.88718	-42.24778
/sigma	3.181293	.1235694			2.938302	3.424283

```

32 left-censored observations at mwtp <= 0
349 uncensored observations
0 right-censored observations
    
```


Appendix 14: Correlation Matrix for the Tobit Model

	mwtp	lnincome	househ~e	swgene~n	aware~s	satisf~n	educat~n	age	gender	houseo~p	marita~s	househ~n
mwtp	1.0000											
lnincome	0.5929	1.0000										
households~e	0.4149	0.1078	1.0000									
swgeneration	0.5276	0.2121	0.6991	1.0000								
awareness	0.3926	0.4798	0.0407	0.1270	1.0000							
satisfaction	-0.3549	-0.2904	-0.3439	-0.3089	-0.2663	1.0000						
education	0.3137	0.6620	-0.2547	-0.0924	0.6179	-0.1276	1.0000					
age	0.2694	0.0280	0.7030	0.4543	0.0488	-0.2673	-0.2047	1.0000				
gender	-0.1841	-0.0739	-0.2974	-0.2341	0.0064	0.1475	0.0369	-0.0758	1.0000			
houseowner~p	0.3276	0.0267	0.6138	0.5087	0.1038	-0.2328	-0.2117	0.4949	-0.2457	1.0000		
maritalsta~s	0.2837	0.1286	0.5363	0.3422	0.0769	-0.2683	-0.1009	0.2942	-0.1754	0.3721	1.0000	
households~n	0.2910	-0.1439	0.4652	0.3541	-0.0334	-0.2291	-0.2659	0.3954	-0.1850	0.5058	0.2998	1.0000
duration	0.3492	-0.0548	0.5755	0.5124	0.0182	-0.2557	-0.2716	0.5546	-0.1840	0.5621	0.3196	0.6576
cost	0.1018	0.1137	-0.0804	-0.0384	0.1628	-0.0079	0.0965	-0.0613	-0.0624	-0.0995	-0.0594	-0.0067

	duration	cost
duration	1.0000	
cost	-0.0184	1.0000

Appendix 15: Auxiliary Regression for the Tobit Model

Source	SS	df	MS	Number of obs	=	381
Model	151.856115	13	11.6812396	F(13, 367)	=	1.70
Residual	2526.81059	367	6.88504247	Prob > F	=	0.0596
				R-squared	=	0.0567
				Adj R-squared	=	0.0233
Total	2678.6667	380	7.0491229	Root MSE	=	2.6239

lnerrorterm2	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
lnincome	.3992512	.5861888	0.68	0.496	-.7534591 1.551961
householdsize	-.0601451	.1962377	-0.31	0.759	-.4460365 .3257462
swgeneration	-.002127	.025148	-0.08	0.933	-.0515793 .0473253
1.awareness	-.3363966	.3752624	-0.90	0.371	-1.074331 .4015379
1.satisfaction	.1808975	.4805169	0.38	0.707	-.7640144 1.12581
education	.0249922	.0800818	0.31	0.755	-.1324847 .182469
age	-.0047492	.0255143	-0.19	0.852	-.0549218 .0454234
1.gender	.0913008	.3115968	0.29	0.770	-.5214384 .70404
1.houseownership	-.1192217	.4144418	-0.29	0.774	-.9342003 .6957569
1.maritalstataus	-.214379	.5837448	-0.37	0.714	-1.362283 .9335253
1.householdspan	-1.097443	.5632141	-1.95	0.052	-2.204975 .0100885
duration	-.0032275	.0134646	-0.24	0.811	-.029705 .02325
1.cost	-.1491247	.2827844	-0.53	0.598	-.7052059 .4069565
_cons	-.7380632	4.274311	-0.17	0.863	-9.143277 7.667151

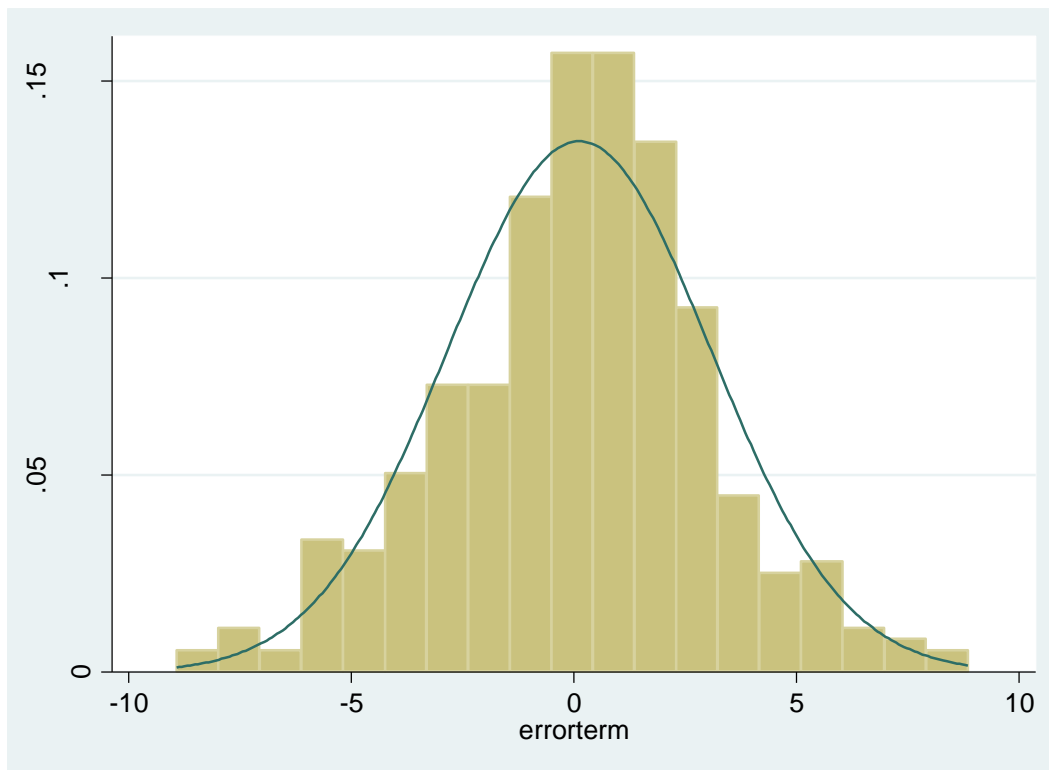
Appendix 16: Jarque-Bera Test for the Tobit Model

```
. jb errorterm
Jarque-Bera normality test:  3.456 Chi(2)  .1776
Jarque-Bera test for Ho: normality:
```

Appendix 17: Skewness and Kurtosis Test for the Tobit Model

Skewness/Kurtosis tests for Normality					
Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	joint Prob>chi2
errorterm	381	0.2195	0.1546	3.54	0.1699

Appendix 18: Histogram for the Tobit Model



Appendix 19: Seemingly Unrelated Bivariate Probit Model Regression Result

Fitting comparison equation 1:

```
Iteration 0: log pseudolikelihood = -251.37621
Iteration 1: log pseudolikelihood = -163.47613
Iteration 2: log pseudolikelihood = -163.03932
Iteration 3: log pseudolikelihood = -163.03886
Iteration 4: log pseudolikelihood = -163.03886
```

Fitting comparison equation 2:

```
Iteration 0: log pseudolikelihood = -242.98956
Iteration 1: log pseudolikelihood = -182.58917
Iteration 2: log pseudolikelihood = -180.71945
Iteration 3: log pseudolikelihood = -180.71176
Iteration 4: log pseudolikelihood = -180.71176
```

Comparison: log pseudolikelihood = -343.75062

Fitting full model:

```
Iteration 0: log pseudolikelihood = -343.75062
Iteration 1: log pseudolikelihood = -342.02472
Iteration 2: log pseudolikelihood = -341.43029
Iteration 3: log pseudolikelihood = -341.30152
Iteration 4: log pseudolikelihood = -341.20097
Iteration 5: log pseudolikelihood = -341.16878
Iteration 6: log pseudolikelihood = -341.15583
Iteration 7: log pseudolikelihood = -341.15519
Iteration 8: log pseudolikelihood = -341.15518
```

```
Seemingly unrelated bivariate probit          Number of obs   =          364
Log pseudolikelihood = -341.15518           Wald chi2(2)    =          360.16
                                           Prob > chi2     =           0.0000
```

	Coef.	Robust Std. Err.	z	P> z	[95% Conf. Interval]	
initialbidresponse						
initialbid	-.2215023	.0166639	-13.29	0.000	-.254163	-.1888417
_cons	2.905063	.2059918	14.10	0.000	2.501326	3.308799
followupbidresponse						
followupbid	-.2586671	.0167333	-15.46	0.000	-.2914637	-.2258704
_cons	3.006506	.1904086	15.79	0.000	2.633312	3.3797
/athrho	2.6483	.2652741	9.98	0.000	2.128373	3.168228
rho	.9900327	.0052618			.9720592	.9964651

Wald test of rho=0: chi2(1) = 99.6655

Prob > chi2 = 0.0000

Appendix 20: Mean WTP Estimation Result from Initial Bids Response

	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
WTP	13.11527	.3610853	36.32	0.000	12.40756	13.82298

Appendix 21: Mean WTP Estimation Result from Follow-up Bids Response

	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
WTP	11.62307	.2651217	43.84	0.000	11.10344	12.1427

Appendix 22: Questionnaire

Households' Willingness to Pay (WTP) for Improved Municipal Solid Waste Management (MSWM) in Dilla Town, Ethiopia

Name of the Household Head:

Name of the Interviewer:

Date of Interview:

Section One: Background to the Survey

Dear respondent, my name is Tamru Shemelis. I am second year MSc in Resource and Environmental Economics student at Addis Ababa University. Currently, I am conducting a study on households WTP for MSWM in Dilla town, Ethiopia. The ultimate aim of this study is to provide regular MSWM service for the residents of the town and to create a clean, safe and healthy environment in the town. Dear respondent, you are randomly selected to give information for the given questions below.

Section Two: Questions on Current Situation of MSWM

- 1) How many sacks (50 kilograms) of solid waste are generated in your household per week?
- 2) How do you dispose of your solid waste?
 - A) Direct dumping in approved public land or community bins
 - B) Direct dumping on your own land
 - C) Throw it on an open space or on the street
 - D) Throw it into the nearby river
 - E) Burning around the house or in the village
 - F) Making compost
 - G) Any other (specify)

.....

3) Is your household getting the service of solid waste collection or disposal?

- A) Yes
- B) No

If “Yes” go to question 4

If “No”, go to question 10

4) Which collection service do you use?

- A) Public (Dilla town municipality)
- B) Private
- C) Other (specify).....

5) Do you have regular solid waste collection service in your area?

- A) Yes
- B) No

If “Yes” go to question 6

If “No”, go to question 8

6) Do you use the service?

- A) Yes
- B) No

7) How often do you use the collection service?

- A) Once in a week
- B) Twice in a month
- C) Other (specify).....

8) Do you pay for the collection service?

- A) Yes
- B) No

If “Yes” go to question 9

If “No”, go to question 10

9) How much do you pay for the service per month? ETB

10) Are you satisfied with the current solid waste collection service in the town?

- A) Yes
- B) No

11) How do you see the current solid waste problem in the town?

- A) Very serious B) Serious C) Not serious D) Do not know

12) Who do you think is responsible to properly manage MSW in Dilla town?

- A) Local authorities B) Households C) Both

Impacts of Solid Waste on the Environment, Human Health, and Economy

13) Do you think that the MSW is creating environmental problems such as water pollution and air pollution due to open burning and uncontrolled dumping of solid waste?

- A) Yes B) No

14) Do you think that the MSW is damaging members of the household’s health?

- A) Yes B) No

If “Yes” go to question 15

15) Have your household members suffered any one of the following diseases due to MSW? Tick the type of disease.

	Diseases	Tick(✓)
i.	Common cold	
ii.	Asthma	
iii.	Typhoid fever	
iv.	Malaria	
v.	Diarrhea	
vi.	Cholera	

Other diseases (specify).....

16) Does the MSW 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

17) Have you incurred a cost to your household members in order to get medical treatment from health stations?

A) Yes

B) No

18) How many days on average a household member becomes unable to engage in his or her own work per month during illness?

Section Three: Contingent Valuation (CV) Scenario

Suppose it is decided to provide improved municipal or urban solid waste management (USWM) service especially solid waste collection service for the residents of Dilla town. The ultimate objective of this study is to create a clean, safe and healthy environment in Dilla town. This requires the participation of residents of the town in addition to Dilla town municipality and other concerned bodies. If attention is not given to the management of solid waste generated from the town, poorly managed solid waste will create negative impacts on the environment, human health and the economy.

The generated solid waste from all households will be collected twice a week by a cart driven persons who will be employed by Dilla town municipality. The collected solid waste generated from all villages of the town will be transported and disposed of by the municipality vehicles to the landfill site of the town. Hence, this will help residents to have a clean, safe and healthy environment in Dilla town. However, this activity requires an adequate budget in order to implement the proposed study and to finance costs related to USWM in Dilla town. The municipality of the town faces a shortage of budget and is unable to provide full USWM service to the residents. For instance, the municipality has allocated 135,000 Birr for 2011 E.C (2018/19) fiscal year. But, this budget is insufficient to provide satisfactory USWM. Therefore, this requires the participation of households living in Dilla town via sharing the cost of providing USWM service with the municipality.

Dear respondents, this kind of service will be delivered in a sufficient way if you agree to share the costs related to USWM service with the municipality, and if you are willing to pay the assigned monetary values per month for this service on a regular basis. Hence, every household will pay the same MSWM service fee per month with water bill separately. The MSWM service fee will not be added on your monthly water bill. But, you will pay the fee when you pay your monthly water bill.

Section Four: Questions on WTP for Improved USWM

19) Are you willing to pay some amount of money as a MSWM fee in order to participate in USWM?

A) Yes

B) No

If “Yes”, go to question 20 and 24

If “No”, go to question 25

20) Are you willing to pay.....ETB per month?

A) Yes

B) No

If “Yes”, go to question 21

If “No”, go to question 22

21) Are you willing to pay.....ETB per month?

A) Yes

B) No

Either “Yes” or “No”, go to question 23

22) Are you willing to pay.....ETB?

A) Yes

B) No

Either “Yes” or “No”, go to question 23

23) What is your maximum willingness to pay (MWTP)? ETB

Section Five: Debriefing Questions

- 24) Why are you willing to pay for an improved USWM service?
 - A) The new proposed USWM service will make the town suitable for life
 - B) The negative impacts of poorly managed solid waste will be minimized or vanished
 - C) A Clean, safe and healthy environment will be created in the town
 - D) Any other reason (specify).....
.....
- 25) Why are you not willing to pay anything for an improved USWM service?
 - A) Satisfied with the existing system
 - B) Do not trust the new proposed system
 - C) I cannot afford
 - D) It is the government’s responsibility to provide USWM service for free
 - E) Other (specify).....

Section Six: Demographic and Socioeconomic Questions

- 26) Gender
 - A) Male
 - B) Female
- 27) Age.....years
- 28) Marital Status
 - A) Unmarried
 - B) Married
 - C) Divorced
 - D) Widowed
- 29) Household size.....
- 30) Occupation
 - A) Government and Non-government employee
 - B) Private employee
 - C) Businessperson
 - D) Unemployed
 - E) Self-employed
 - F) Retired
 - G) Others (specify).....

31) Educational Level.....years

32) Average income per month.....ETB

33) House ownership status

A) Owned

B) Rented

34) How long have you lived in the town? Years

35) How do you plan to live in the town?

A) Permanently

B) Temporarily

If “Temporarily”, go to question 35

36) If you plan to live temporarily in the town, what is your reason that forces your household to leave the town?

A) The town is not comfortable for life

B) Searching for better livelihoods in another place

C) Inter-communal conflict

D) Any other (specify).....

Thank you very much for your cooperation as well as contribution to this survey