COLLEGE OF AGRICULTURE AND NATURAL RESOURCE

DEPARTMENT OF NATURAL RESOURCE MANAGEMENT

ASSESSMENT OF SOLID WASTE DISPOSAL PRACTICES AND ITS MANAGEMENT SYSTEM IN WOLKITE TOWN GURAGE ZONE, CENTRAL ETHIOPIA

SENIOR RESEARCH PROJECT

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Abbreviations and Acronyms:

3Rs	Reduce, Reuse, Recycle
EPA	Environmental Protection Agency (U.S.)
ERIA	Economic Research Institute for Asia
FDRE	Federal Democratic Republic of Ethiopia
FEPA	Federal Environmental Protection Authority (Ethiopia)
MSW	Municipal Solid Waste
MUDC	Ministry of Urban Development and Construction (Ethiopia
NGO	Non-Governmental Organization
RCRA	Resource Conservation and Recovery Act (U.S.)
SPSS	Statistical Package for the Social Sciences
SWM	Solid Waste Management
TEQ	Toxic Equivalency
UN-Habitat	United Nations Human Settlements Programme
UNISA	University of South Africa
WHO	World Health Organization

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Abstract

This study assesses solid waste disposal practices and management systems in Wolkite Town, Ethiopia, and highlighting the environmental, health, and socioeconomic impacts of improper waste management. The research employed a mixed-methods approach, combining household surveys, interviews, and for household surveys to gather data from 98 randomly selected households. Findings reveal that commercial activities (39%), households (29%), agriculture (10%) and municipal (22%) are the primary sources of solid waste, with organic waste constituting the largest proportion (58%) and other (42%) different types of wastes. Open dumping (45%), incineration (25%) and used to both methods (30%) are the dominant disposal methods, leading to severe environmental degradation, including soil and water contamination, air pollution, and ecological damage. Health risks such as malaria, respiratory diseases, and gastrointestinal infections are prevalent due to poor waste management practices. The study identifies systemic challenges, including inadequate infrastructure, financial constraints, and low public awareness, which hinder effective waste management. The study Recommends include implementing the 3Rs (Reduce, Reuse, Recycle), establishing controlled landfill sites, enhancing community education, and fostering stakeholder collaboration to develop sustainable waste management solutions. The findings also the urgent need for coordinated efforts to mitigate the adverse effects of solid waste and promote environmental and public health in Wolkite Town.

Keywords: *Solid waste management, environmental impacts, health risks, disposal practices, sustainable solutions*

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the Study

Almost all human activities generate waste materials that are often discarded because they are considered useless. These wastes are normally solid, and the word waste suggests that the material is useless and unwanted (Tchobanoglous and Kreith, 2002). Human activities create a large variety of wastes and by-products which accumulate over a period of time and become toxic to the naturally growing plants, animals and man. All components of environment such as air, water, and soil are exposed the accumulated toxic pollutants (Ambasht, 2005).

Current global MSW generation levels are approximately 1.3 billion tons per year, and are expected to increase to approximately 2.2 billion tons per year by 2025. This represents a significant increase in per capita waste generation rates, from 1.2 to 1.42 kg per person per day in the next fifteen years. Waste generation in sub-Saharan Africa is approximately 62 million tons per year and in the Middle East and North Africa is about 63 million tons per year (Daniel, 2012). Waste generation rates will more than double over the next twenty years in lower income countries (Daniel, 2012). Globally, solid waste management costs will increase from today annual $205.4 billion to about $375.5 billion in 2025. Cost increases will be most severe in low income countries (more than 5-fold increases) and lower-middle income countries (more than 4-fold increases). High-income countries produce the most waste per capita; while low income countries produce the least solid waste per capita (Daniel, 2012).

Poorly managed waste has an enormous impact on health, local and global environment, and economy; improperly managed waste usually results in down-stream costs higher than what it would have cost to manage the waste properly in the first place (Daniel, 2012). In lower-income countries, as well as poorer parts of middle-income nations such as Ethiopia, an estimated of 30 to 50% solid waste produced in urban areas is left uncollected. Some viral and other infectious diseases are associated with waste and also serve as habitat formation for breeding insects and

mosquitoes. In general, clean and healthy living conditions in cities and city s cannot be achieved without reliable and regular waste collection and adequate disposal systems (MUDC, 2012).

1.2 Statement of problems

Household waste and other waste streams need to be removed from the human environment to avoid nuisance and public health problems. Solid waste management is becoming a major public health and environmental concern in urban areas of many developing countries. In lower-income countries, as well as poorer parts of middle-income nations such as Ethiopia, an estimated 30 to 50% of solid waste produced in urban areas remains uncollected, leading to significant environmental pollution and deteriorating health for humans, animals, and ecosystems (MUDC, 2012).

Solid waste management continues to receive low priority in developing countries, resulting in persistent environmental, social, and health challenges. Improper solid waste management causes environmental harm, including air, soil, and water pollution, greenhouse gas emissions from landfills, and social issues such as rising waste management costs for safe, long term disposal solutions. It also creates health and safety risks, such as disease transmission by insects and rodents, and illnesses linked to pollution (Imad, 2011).

In most urban centers of developing countries, the fate of waste materials is not well documented because systematic recording and assessment of waste collection and transportation by municipalities or private enterprises are lacking. Robust data to evaluate waste management performance or understand current and future impacts of waste remain scarce (Schultheis, 2012). In the study area improper disposal and management of waste continue to harm human, animal, and environmental health by polluting water, soil, and air, and act as a driver of disease risks. Residents living near dumping sites are frequently complaining about these issues.

This study aims to assess solid waste disposal practices and management in Wolkite Town. To achieve this, sample households are selected to collect data, which has used to propose improvements to solid waste management (SWM) and formulate actionable recommendations. In developing countries, including Ethiopia, gaps persist due to the absence of updated, clear data on solid waste status, disposal systems, and their environmental, social, economic, and

health impacts. Addressing these gaps were required systematic recording, assessment, and future-oriented strategies to mitigate risks and enhance sustainability.

1.3 Objectives

1.3.1 General objective

- To assess solid waste disposal practices and its management system in Wolkite Town.

1.3.2 Specific objectives

1. To identify sources and disposal practices of solid waste in the area,
2. To assess impacts of solid waste in the study area, and
3. To assess solid waste management system of the study area.

1.4 Research question

The research was answer the following questions

1. What are the common solid wastes and source of these wastes in the study area?
2. What are the main solid waste disposal practices in the study area?
3. Does solid waste have impacts in the study area and what are the impacts?
4. Who is responsible to manage solid waste in the study area?

1.5 Significant of the study

This study generated novel and reliable information on the subject of solid waste disposal practices and their management systems, as well as the environmental, health-related, social, and economic impacts of solid waste in Wolkite Town. The information generated assisted concerned bodies in their managerial activities to achieve better waste disposal practices and management by providing knowledge about the impacts and management of waste and by serving as guidance (alongside other regulations and guiding documents) for waste management.

This improved the health of the environment and communities and addressed social and economic issues related to solid waste management. In addition, the results of the study served as a baseline to estimate future health and environmental problems related to improper waste disposal and management. Also, the results of this study contributed to the development of scientific knowledge.

1.6 Scope of the study

This study focuses on solid waste disposal practices and its management system in Wolkite Town Gurage Zone, Central Ethiopia. It examines the unique solid waste impacts in the study area, involving local residents to gather quantitative data on their experiences and perceptions regarding solid waste impacts and sustainable practices. This approach aims to provide a comprehensive understanding of the common impacts within Wolkite Town.

1.7 Study Limitation

Like any research endeavor, this study faced several challenges that may affect its execution and outcomes. Key limitations include a lack of sufficient documented data, concerns regarding the reliability of the information gathered, and the reluctance of some respondents to share comprehensive details. Additionally, time constraints and limited financial resources posed significant challenges in conducting the research effectively. These factors may influence the depth and accuracy of the findings.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Definition of Terms and Concepts

2.1.1 Waste

According to WHO (1982) cited in Purohit (2007), waste is defined as every substance or object arising from human or animal activities that has to be discarded as useless or unwanted. It further elaborates that the above definition encompasses an extremely heterogeneous mass of wastes, which may originate from peoples home, and from commercial or industrial activities.

Wastes are the rubbish or materials that are not needed and are economically unusable without further processing. It may be in liquid, gas or solid form and originate from a wide range of human operations, such as industry, commerce, transport, agriculture, medicine, and domestic activities (Purohit, 2007).

Waste can be classified in many different ways such as according to its origin (for example, domestic, industrial, commercial, clinical, construction, nuclear and agricultural) or its properties (for example, inert, toxic, and flammable). Without suitable treatment such waste becomes a source of contamination of the environment at large, leading to air, water and soil pollution (Purohit, 2007). Urban solid wastes consist of household wastes, construction and demolition debris, sanitation residues, industrial and hospital wastes. Broadly, it can be divided into three categories namely household, hospital and industrial wastes (Jagbir, 2005).

Based on their chemical natures wastes categorized as inorganic wastes those generated by metallurgical and chemical industries and coal mines, organic wastes those from agricultural products, slaughterhouses, sewage and mixed wastes those discharged from industries dealing with textiles, dyes, gases, plastic, wool, leather, petroleum, etc. (Purohit, 2007).

Waste can be classified in to solid, liquid and gaseous based on their physical state. Solid wastes are any discarded solid material such as papers, plastic products, vegetable leaves, bottles etc. which can be burnt, thermally decomposed, an aerobically digested to get methane and other combustible gases or biologically converted to a variety of products. Liquid wastes are any

discharged liquid waste materials generated from different factories such as sewage which are the most troublesome because of the presence of non-retractable chemicals and their further return to gases. Gaseous wastes are wastes produced from different factories in the form of gas or smoke such as carbon dioxide, sulfur dioxide, methane etc. (Purohit, 2007).

2.1.2 Solid Waste

Resource conservation and recovery (RCRA) of U.S. has defined solid waste as 'any garbage, refuse, sludge from waste treatment plants, on air pollution control facility and other discarded materials including solid, liquid, semi-solid, or contained gaseous material, resulting from industrial, commercial, mining and agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage.' Solid wastes are all the wastes arising from human and animal activities that are discarded as useless or unwanted and are neither liquid discharges nor atmospheric emissions (Jagbir, 2005).

The term solid waste is all- inclusive, encompassing the heterogeneous mass of throwaway from the urban community as well as the more homogeneous accumulation of agricultural, industrial, and mineral wastes (Takele, 2004) Solid wastes may be classified on the basis of their source of generation and composition. The following two tables display solid waste classification based on their source of generation and composition respectively.

Table 2.1: Classification of solid waste based on their source of generation (Source: (Jagbir, 2005)

No	Source	Type of wastes
1	Municipal	Street sweeping, sewage treatment plant wastes, wastes from other institutions.
2	Domestic	Garbage, rubbish, occasional large wastes from homes
3	Commercial	From stores and offices
4	Industrial	From manufacturing plant
5	Mining	From coal mining, strip mining, etc.
6	Agricultural	Agric and horticultural wastes

Table 2.2: Classification of solid waste based on their composition (Source: (Jagbir, 2005)

No	Type	Description
1	Garbage	Decomposable wastes from food, slaughter houses, canning and freezing industries.
2	Rubbish	Either combustible or non-combustible e.g. paper, wood, cloth, robber, leather and garden wastes are of former type and metals, glasses, ceramics, stones, dirt, machinery and some chemicals are the latter.
3	Ashes	Residues such as cinders and fly-ash of the combustion of the solid, fuels for heating and cooking or incineration of solid wastes by municipal, industrial and apartment houses.
4	Large	Waste demolition and construction rubbles (pipe, bricks, plastics, automobiles, furniture, trees, tire, refrigerators and other appliances)
5	Dead animals	Household pets, birds, rodents, zoo animals, pathological wastes from hospitals.
6	Process solids	Screenings, settled solids, sludge, etc.
7	Industrial	Chemicals, paints, sand, scraps, explosives, and other wastes
8	Mining wastes	Tailings, slag chips, culms pipe at coal mines, etc.
9	Agricultural	Farm animal manure, crop residues etc.

Besides, the classification of waste can also be done on the basis of their processing potential and environmental considerations. On the basis of processing potential can be divided as follows:

Compostable wastes: are those wastes on which the microorganisms can feed and reduce the amount with the help of biological process. Such wastes can act as good nutrient fertilizers for vegetative cover without disturbing the balance of the ecosystem network.

Combustible wastes: includes those wastes, which can be burnt down or inflamed in order to properly dispose them off although the residues remains of very smaller percentage is left behind and can be mixed with the soil. Inert wastes: are those wastes, which does not react with any chemical composition and hence retain their present nature of composition even if they are dumped into the soil or set a blazed (Jagbir, 2005).

Classification on the basis of environmental considerations can provide us with the following majority types of wastes. Biodegradable wastes: includes those wastes, which reduce biologically, whether in a natural or an artificial process. Non-biodegradable wastes: comprise of those wastes, which require artificial means of processing to reduce its amount and are not perishable.

Hazardous wastes: includes wastes, which are harmful for the existence of kind and all livings in some or other way, affecting the proper functioning of the ecosystem (Jagbir, 2005). Hazardous wastes are legally defined in the Resource Conservation and Recovery Act as: a solid or combination of solid wastes, which, because of its quantity or concentration; or physical, chemical, or infectious characteristics may cause, or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed (Purohit, 2007).

2.2 Impacts of Solid Waste and Their Improper Management

The amount of waste produced by human activities is increasing in most parts of the world accompanied by problems of disposal particularly in those developing countries waste disposal facilities are minimal. In the world solid waste disposal is done through landfill. Suitable locations for landfill are becoming increasingly difficult to find and disposal of waste by this method has potential environmental problems, such as leaching of toxins into groundwater and generation of methane gas which contribute to greenhouse effect (Purohit, -2007).

The increasing volume and complexity of waste poses serious risks to human health and the environment. These risks are most obvious in situations where waste collection and treatment is insufficient or even absent but can also occur in situations where collection and treatment methods are already established (Prasad, 2011). Every year, an estimated 11.2 billion tons of solid waste are collected worldwide and decay of the organic proportion of solid waste is contributing to about 5 per cent of global Greenhouse Gas emissions (Prasad, 2011).

Inadequate collection, transport or improper disposal of household waste can have adverse environmental impacts, such as air pollution, potential health hazards from accumulation of polluted water, which provide breeding grounds for mosquitoes and attract flies, vermin, and injuries from infected sharps, loss of productive land due to the presence of non-biodegradable

items, contamination of soil, ground and surface waters by leach ate with resultant environmental effects or health hazards (FEPA, 2004).

Most individual items of waste, particularly wastes from homes and offices, are not themselves a direct threat for the public health. It is the way these wastes are or not handled, stored, collected, and disposed that can pose risks to public health (MUDC, 2012). Poor waste management practices particularly the widespread dumping of wastes in water bodies and uncontrolled dump sites, aggravates the problems of generally low sanitation levels across the African continent (Patrick and *et.al*; 2009).Uncontrolled dumpsites have been linked to many harmful health effects such as skin and eye infections, respiratory problems, and vector-borne diseases like diarrhea, dysentery, typhoid, hepatitis, cholera, malaria and yellow fever. Rodents and other stray animals have also been known to spread a variety of diseases including plague and flea-born fever (Prasad, 2011).

2.3 Concepts of Solid Waste Management

Waste management is currently one of the key areas of public policy. Population growth in cities usually results in corresponding increase in waste generation. Basically solid waste generation has always been related to the economic status of a country and the lifestyle of its population. This in turn also affects the management style of the waste generated. Over the years, modern waste management has shifted from conventional and single-choice reliance on landfills to a more flexible waste hierarchy concept, also known as 3R (reduce, reuse, recycle) policies (Hezri, 2010).

Solid waste management is a collective activity involving generation, segregation, collection, storage, transportation, re-processing, recycling, incineration, monitoring and disposal of various types of waste materials. Sustainable waste management involves managing waste in an environmentally sound, socially satisfactory and a techno-economically viable manner (Vadiwala and Vaghani, 2004).

The term solid waste management usually relates to materials produced by human activity and is generally under taken to reduce the effect of wastes on human and environment health. Waste management practices are different in developed and developing countries, in urban and rural and residential and industrial producers (Clark, 2002). The methods of solid waste management

cannot be uniform across regions and sectors because individual waste management methods cannot deal with all potential waste materials in a sustainable manner. This is because conditions vary and therefore procedures must also vary accordingly to ensure that these conditions can be successfully met. Waste management systems must remain flexible in light of changing economic, environmental and social conditions. Due to this in most cases, waste management is carried out by a number of processes, many of which are closely interrelated; therefore it is logical to design holistic waste management systems, rather than alternative and competing options (McDougall, 2001).

There are a number of concepts about waste management which is varying in their usage and between countries or region. Some of the most widely used concepts includes: **''Waste Hierarchy''** which refers to **''3R''**i.e. reduce; reuse and recycle those classify waste management strategies according to their desirability in terms of waste minimization (Clark, 2002).

As waste generation rates have risen, processing costs increased, and available landfill space decreased, the three R`s have become a central tenet in sustainable waste management efforts (El-Haggar, 2007) and it were proposed with priority on source minimization, intermediate treatment then final disposal and enlighten the waste generators to practice 3R's as a substantial measure to reduce, reuse and recycle the generated solid waste there all day. Waste minimization can be achieved in an efficient way by focusing primarily on the first of the 3Rs, "reduce," followed by "reuse" and then "recycle" and finally "energy recovery". Things which cannot be used by any means have to be disposed of appropriately (Vadiwala and Vaghani, 2004).

Three R's is an approach that promotes the efficient use of resources and the avoidance of risks to humans and environment from waste disposal, harmonizing both environmental and economic concerns through efforts to reduce, reuse, and recycle materials and wastes. It is mostly applied to consumer goods, and to consumer behavior (Prasad, 2011). In generally, solid waste management has a wide range of technological options and these are as follow in their order of appropriateness for the management.

2.3.1 Waste Prevention

The concept of waste prevention, involves redesigning products or changing societal patterns of consumption, use, and waste generation to prevent the creation of waste and minimize the toxicity of waste that is produced (USEPA, 1995). Common examples of this include using a reusable coffee mug instead of a disposable one, reducing product packaging, and buying durable products which can be repaired rather than replaced.

2.3.2 Waste Reduction (Minimization)

Waste reduction is defined as all the activities and efforts of individuals and/or groups of individuals undertaken to minimize the volume of domestic waste generated, or generate waste in a form that facilitates easy collection, treatment and recycling cited in (Kamara, 2006). Reduction can also be achieved in many cases through reducing consumption of products, goods, and services. The most effective way to reduce waste is by not creating it in the first place, and so reduction is placed at the top of waste hierarchies (USEPA, 2010).

2.3.3 Waste Collection

The collection of waste and its recovery from different waste generating points is carried out by many agents such as formal and informal, which may represent a variety of organization structure and relationships cited in (Kamara, 2006). Waste collection is a critical component to waste management. The economic and environmental performance of the entire system can be impacted by the way that materials are collected and sorted. In many instances, the collection point will be an interface where waste generators and waste collectors that must be carefully managed if the system is to be effective. Waste generators require waste collection with minimal inconvenience, while collectors must be able to collect waste in a way that is compatible with the planned treatment and processing methods if the waste management system is to be sustainable (McDougall, 2001).

2.3.4 Re-use and Recycling (Processing)

Of the two concepts, re-use is a simpler technique involving the re-utilization of material in its end-use form without the necessity of further value addition or reprocessing. It is sometimes possible to use a product more than once in its same form for the same purpose; this is known as reuse (USEPA, 1995). Reusing products displaces the need to buy other products thus preventing the generation of waste. Minimizing waste through reduction and reuse offers several advantages including: saving the use of natural resources to form new products and the wastes produced in the manufacturing processes; reducing waste generated from product disposal; and reducing costs associated with waste disposal (USEPA, 2010).

Recycling on the other hand, involves processing waste through conversion of parts or all of the waste into other useful material or to recover the original raw matter (USEPA, 1995). Recycling products offer many of the benefits of waste reduction efforts (displacing new material usage, reducing waste generated and the costs associated with disposal) but recycling requires energy and the input of some new materials, thus placing it lower on the waste hierarchy than reduction and reuse (USEPA, 2010).

2.3.5 Biological treatment (Composting)

A biological treatment is a biochemical degradation of the organic fraction of the solid wastes having humus like final products that could be primarily used as soil conditioner for agricultural production. This generally entails the transformation of waste into organic matter via composting and aerobic transformation. This method can significantly reduce waste stream volume and space needed for landfill cited in (Kamara, 2006).

2.3.6 Incineration

Incineration is a chemical reaction in which carbon, hydrogen and other elements in the waste combine with oxygen in the combustion zone and generate heat. It entails two ways with the order of burning solid waste materials with recovering of the energy and without recovering. It is increasingly important aspect of solid waste management, as the communities are looking for quick method of disposal. This process emits air pollutants to the environment and their control is needed cited in (Kamara, 2006).

2.3.7 Disposal

Disposal is the final stage in the solid waste management, and all the wastes whether they are residential, commercial or from any other sources are collected and transported to a disposal site. It may be a landfill site or an incinerator or some other mode of disposal. Safe disposal of solid waste is important for safeguarding the public health, environment and wildlife (Ali *et al.*, 1999). Final solid waste disposal can be done in the following ways in their order of relevance for solid waste management. *Landfill* (Controlled Landfill)**:** is essentially an earthen pit, where the environmental risk is controlled at an appropriate and acceptable level and where, subsequent to disposal, land can be made available for other purposes. This is a controlled method in developed countries, where waste is sorted and bio-degradable components disposed on controlled landfill sites. Sometimes it is known as sanitary dumping.

Dumping (Uncontrolled Landfill)**:** is an easiest, unscientific and uncontrolled method in which solid wastes collected from the city and deposited in low lying areas usually on the outskirts of the city in most of the under developed and developing countries. It causes health and pollution hazards and nuisance to the public. Such ways of disposal have irreversible and potentially harmful effects on both human health and the environment cited in (Kamara, 2006).

CHAPTER THREE

3. MATERIALS AND METHODS

3.1 Description of the study area

3.1.1 Location and topography

Wolkite Town is located in the Gurage Zone of the central Ethiopia Situated 158 kilometers southwest of Addis Ababa, the capital city of Ethiopia. Wolkite serves as the administrative center for the Gurage Zone. The town is strategically positioned along the main highway connecting Addis Ababa to the southwestern regions of Ethiopia, facilitating access to various markets and services.

The town is situated at latitude of 8°17’ N and a longitude of 37°46’ E. The topography of Wolkite Town features a diverse topography characterized by rolling hills and elevated landscapes Situated at an average elevation 2000 meters above sea level.

3.1.2 Climate and agro ecological zone

According to climate classification condition of Ethiopia, wolkite town is characterized in weyna dega agro ecological zones. Its annual average rainfall ranges from 800 to 1,200 mm with the annual temperature ranges from 15-25°c.

3.1.3 Population

According to the Wolkite town administrative office report the total population of wolkite town 56,670. Among these 9255 were household heads. The percentage of female population was 26,170 (46.18%) and that of male was 30,500 (53.82 %) (wolkite town administrative office).

3.1.4 Soil type

In the study area the major soil type is endowed with different type of soil, such as sandy clay soil and silt soil with different in colors like black, brown, and red, the most dominant soil type is black.

3.2 Source of Data and Collection

Primary data were collected from local community, waste collection experts, and through field observations. Structured and Semi-Structured Questionnaires after pre-tested for validity and reliability were used for collecting primary data. Interviews were also conducted with key informants including local community, waste collection experts, and local administrators. Additionally, field observation was used as a primary method to collect data focusing on signs of Solid Waste Disposal Practices and its Management System. This study also employed a secondary data analysis approach. The secondary data were obtained from published materials such as government reports, peer-reviewed journals, and waste management records, alongside unpublished local administrative documents.

3.3 Sampling techniques and sample size

The total population of Wolkite town is 56,670, with 9255 households. Using the Yamane formula:

n=N/1+N(e2) N

n = sample size

N = total number of households (9255)

e = error margin (10% or 0.1)

Substituting the values:

n=N/ (1+N (e) 2, N=9255, E=10%=0.1

n= (8241/1+9255(0.1)2),

n=98

A simple random sampling technique was utilized to select households.

3.4 Data analysis methods

The qualitative data obtained from semi-structured interviews after substantial validations were presented in the form of statements and supported by arguments. The quantitative data were organized and presented in tables and figures. Descriptive statistics such as mean and percentages were used to summarize participant demographics. Quantitative data were also analyzed using SPSS software.

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1 Socio-Demographic Characteristics of Respondents

Table 4.1 sex, age, family size, occupational and educational status of the respondents (n=98)

Sex				**Age group**					
	Male	**Female**	**Total**	**0-15**	**16-30**	**31-45**	**46-60**	**>60**	**Total**
Frequency	75	23	98	0	5	47	36	10	98
percent	76.5	23.5	100	0	5	48	37	10	100
Occupational status	**Government employee**	**Merchant**	**Daily labor**	**Farmer**	**Total**				
Frequency	24	58	6	10	98				
Percent	25	59	6	10	100				
Family Size	**1-2**	**3-4**	**5-6**	**7-8**	**Total**				
Frequency	23	51	16	8	98				
Percent	24	52	16	8	100				
Educational level	**Can't read and write**	**Can read and write**	**primary**	**Secondary**	**Above**	**Total**			
Frequency	2	18	32	30	16	98			
Percent	2	19	32	31	16	100			

The socio-demographic characteristics of the surveyed households were analyzed based on sex, age, occupational status, family size, and educational level. Out of the total 98 households surveyed, 76.5% (n=75) were male-headed, while 23.5% (n=23) were female-headed.

The age distribution of respondents revealed that the majority (48%) fell within the 31–45 age groups, followed by 37% in the 46–60 age groups. Only 5% of respondents were between 16–30 years old, and 10% were above 60 years. Notably, no respondents were under 15 years of age.

Occupational status was categorized into four groups: government employees, merchants, daily laborers, and farmers. Merchants constituted the largest proportion (59%), followed by government employees (25%), farmers (10%), and daily laborers (6%). Regarding family size, most households (52%) consisted of 3–4 members, while 24% had 1–2 members, 16% had 5–6 members, and the smallest proportion (8%) had 7–8 members. Educational attainment among respondents varied, with the highest percentage (32%) having completed primary education. Additionally, 31% had secondary education, 19% could read and write without formal schooling, 16% had education above secondary level, and only 2% were illiterate.

4.2 Sources and Composition of Solid Waste in wolkite town

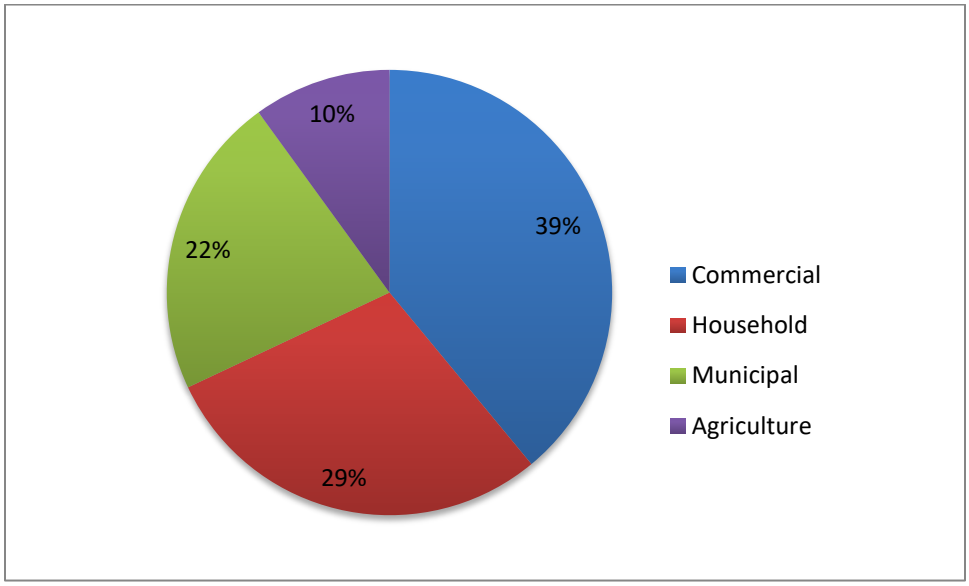

Figure 4.1 Classification of solid wastes exist in town based on their source

The sources of solid waste in Wolkite Town were categorized into four groups: commercial, household, municipal, and agricultural. As shown in Table 4.2, commercial activities were the largest contributor, accounting for 39% of total waste. This likely includes packaging materials, food waste, and other by-products from businesses, underscoring the need for targeted waste reduction strategies in commercial sectors, such as enforcing recycling policies or promoting sustainable packaging alternatives.

Household waste constituted 29% of the total, comprising everyday refuse like food scraps, plastics, and other domestic waste. The significant proportion from households highlights the importance of community-based waste management initiatives, including public education on recycling, composting, and proper waste segregation.

Municipal sources contributed 22%, reflecting waste from public facilities, streets, and municipal services. This suggests potential gaps in municipal waste collection efficiency, indicating a need for improved infrastructure (e.g., optimized waste collection routes) or stricter enforcement of public cleanliness regulations.

Agricultural waste represented the smallest share at 10%, consisting primarily of organic residues from farming. While this low percentage may reflect limited agricultural activity within the town or effective on-farm waste management (e.g., composting), it still presents an opportunity to integrate circular economy practices, such as converting agricultural waste into bioenergy or organic fertilizers.

These findings emphasize the dominance of commercial and household waste in Wolkite Town's waste stream, calling for prioritized interventions in these sectors while maintaining efforts in municipal and agricultural waste management.

4.3 Types of wastes and their Description

Table 4.2 classification of solid wastes in wolkite town based on their composition

Type	**Description**
Agricultural	Cow dung, Leaves of banana, Maize, and others
Ashes	Wood ash, Charcoal powder etc.
Rubbish	Cloth, Paper, Wood, Dirt
Large	Broken furniture, Tress, Plastics

The study identified four main categories of solid waste in Wolkite Town based on their composition. Agricultural waste, which includes organic materials like cow dung, banana leaves, and maize stalks, presents significant potential for composting and biogas production. These materials could be effectively utilized to enhance soil fertility and generate renewable energy,

contributing to sustainable waste management. Wood ash and charcoal powder, classified as ashes, offer valuable benefits as soil amendments due to their mineral content, suggesting opportunities for reuse in agriculture. The rubbish category, consisting of mixed materials such as cloth, paper, wood, and dirt, highlights the need for improved waste segregation and recycling initiatives to enhance processing efficiency. Lastly, large waste items like broken furniture, tree branches, and plastics pose disposal challenges, requiring specialized collection and recycling programs. Addressing these diverse waste types through targeted strategies such as organic waste recycling, ash reuse, and bulk waste management could significantly improve Wolkite Town's waste management system while promoting environmental sustainability.

4.2.1 Generation Rate of Solid Wastes in wolkite town

Table 4.3 trends of solid waste generation in the town

Trends	Increasing	Decreasing	No change	Total
Frequency	68	25	5	98
Percent	69	26	5	100

The study assessed the daily waste generation patterns in Wolkite Town through direct measurements and household surveys. Findings revealed an average per capita waste generation rate of 0.35 kg/person/day, with significant variations observed across different sectors of the town. Commercial areas demonstrated the highest generation rates at 0.52 kg/person/day, followed by residential zones at 0.31 kg/person/day, while institutional and agricultural areas showed lower rates of 0.18 kg/person/day and 0.12 kg/person/day respectively (FDRE, 2017).

Seasonal fluctuations significantly impacted waste quantities, with a 22% increase observed during holiday periods and market days due to heightened commercial activity. The total daily municipal waste generation was estimated at approximately 8.2 tons, translating to nearly 3,000 tons annually. Organic waste constituted the largest proportion (58%) of the total waste stream, followed by recyclables (21%), inert materials (14%), and hazardous waste (7%).

4.2.2 Reasons for the increasing generation rate of solid waste

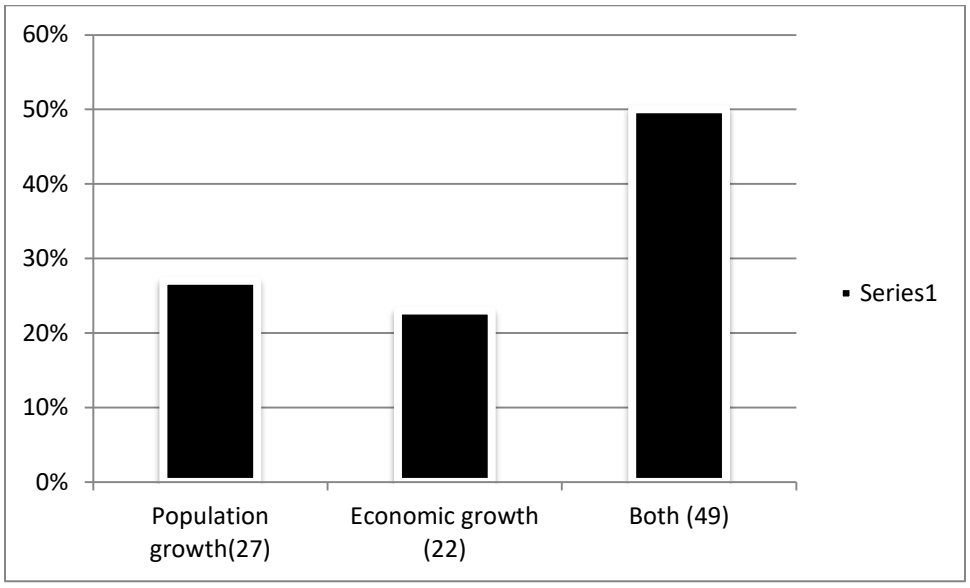

Figure 4.2 reasons for the increasing generation rate of solid waste

The study examined the key factors behind rising solid waste generation in Wolkite Town through comprehensive household surveys. Results revealed that half (50%) of respondents attributed the increase to both population growth and economic expansion working in combination. Another 27% identified population growth alone as the primary driver, while 23% pointed to economic development as the main factor. These findings demonstrate that Wolkite's waste management challenges stem from interconnected demographic and economic forces - rapid urbanization is bringing more residents while economic progress is changing consumption patterns. The data particularly highlights how economic improvement, while beneficial, often leads to greater waste generation through increased purchasing power and consumption of packaged goods. Similarly, population growth directly translates to more waste producers in the municipality. The strong perception of combined factors (50%) suggests these dynamics are working synergistically to accelerate waste accumulation. This situation calls for integrated waste management solutions that address both the quantity of waste generators (population) and the quality/composition of waste produced (consumption patterns). Strategic interventions should therefore focus on decoupling economic growth from waste generation through sustainable consumption initiatives, while simultaneously scaling waste infrastructure to keep pace with

urban expansion. The findings underscore the complex, multi-dimensional nature of waste management challenges in developing urban centers like Wolkite.

4.3 Solid Waste Disposal Practices in wolkite town

The survey findings reveal critical insights into solid waste disposal practices among households in Wolkite Town. As shown in Table 4.4, open dumping is the most common method (45%), followed by a combination of methods (30%) and incineration (25%). Households practicing incineration typically store waste in open spaces, creating potential breeding grounds for disease vectors like flies, while those using open dumping often rely on temporary storage in sacks, jars, or baskets outside their compounds. Notably, economic factors heavily influence disposal choices, with many households switching between methods based on their ability to afford transportation costs.

The study identified several concerning practices, including widespread illegal dumping near waterways particularly during rainy seasons and the complete absence of waste segregation at the household level. While incineration helps reduce waste volume, no energy recovery systems were observed, representing a missed opportunity for resource utilization. Additionally, transportation to official dumping sites remains inconsistent, with only 23% of households using city beautification services, while others either carry waste manually or resort to improper disposal.

These findings highlight urgent needs for improved waste management infrastructure, including standardized storage containers and subsidized collection services, as well as community education programs to promote proper waste segregation and disposal. Addressing these challenges will require coordinated efforts between municipal authorities and residents to develop sustainable solutions that mitigate environmental and public health risks while accommodating the economic realities of Wolkite's households.

Table 4.4 disposal methods and number of households use each method
Source: group five students, field survey 2025

Disposal Method	Incineration	Open Dumping	Both	Total
Frequency	24	44	30	98
percent	25	45	30	100

4.4 Impacts of Solid waste and their improper Management

Although the material recovery from the waste stream has a great potential in economic as well as environmental point of view, municipality and formal private sector contribution in this activities is minimum. Besides this, solid waste disposal is also a neglected area in many low income countries and causes for environmental and health hazards. Most of municipal solid wastes in developing countries are dumped on land in a more or less uncontrolled manner. These dumps make very uneconomical use of the available space, allow free access to waste pickers, animals and flies and often produce unpleasant and hazardous smoke from slow-burning fires (Zurbrugg, 2003). In this town, most items of solid waste, particularly those wastes from homes and offices, are themselves a direct threat for the public health and environment. It is the way these solid wastes were handled or not, stored, collected, and disposed that can pose risks to public health and environment.

The data obtained from respondents indicates that improper solid waste disposal in uncontrolled dumping site and its poor management poses various environmental, health as well as economic impacts.

4.4.1 Impacts on Environment

The study revealed alarming environmental consequences from Current waste management practices in Wolkite Town are causing severe environmental degradation across multiple ecosystems. The prevalent open dumping method, particularly near waterways, has led to significant soil and water contamination. Recent measurements show leachate runoff alters water pH to 5.8-6.2 and increases turbidity by 40-60% downstream of dumping sites (Wolkite Environmental Office, 2024). Soil analysis reveals dangerous heavy metal accumulation, with lead concentrations exceeding safety thresholds by 2.3 times within 500 meters of disposal areas (Ethiopian EPA, 2023).

The town's air quality suffers dramatically from waste incineration practices. Morning burning periods (6-8 AM) produce PM2.5 concentrations of 185μg/m, surpassing WHO (2021) 24-hour exposure guidelines by 7.4 times. This uncontrolled burning of mixed waste, including plastics, releases toxic dioxins at 0.45 ng TEQ/m³ - nearly double the recommended limits (WHO, 2021).

These emissions contribute substantially to climate change, representing approximately 12% of the municipality's carbon footprint through methane and CO_2 emissions (Wolkite EPA, 2024).

Ecological systems show alarming degradation, with aquatic biodiversity declining by 65% in affected streams (Wolkite University Biology Department, 2023). The dumping sites have become breeding grounds for invasive species like Parthenium hysterophorus while contaminating groundwater resources. Recent tests detected nitrate levels 3.1 times above WHO (2023) safety standards in shallow wells, with fecal coliforms present in 60% of sampled water sources (Water Quality Report, 2023).

These environmental impacts have created measurable socioeconomic consequences. Property values within 1km of dumping sites are 30-40% lower than comparable areas (Wolkite Urban Development Office, 2024), while tourist satisfaction has declined by 45% due to visible waste accumulation (Tourism Bureau, 2023). With 78% of residents reporting persistent odor problems (Municipal Survey, 2023), the findings underscore the urgent need for comprehensive waste management reforms under Ethiopia's Federal Waste Management Proclamation No. 513/2007 to protect both ecosystems and public health.

4.4.2 Solid Waste Impacts on Human Health in wolkite town

According to the information from the respondents, there were many different diseases that affect human health like malaria, typhoid, diarrhea, common cold, and respiratory diseases in town and improper SWM had a direct contribution for these health problems. As they said, this was due to the favorable condition for breeding of harmful insects like mosquitoes and fly, water and air pollution created by unsafe dumping site.

Information gained from interview shows that, residents near these dumping sites were the most place where affected by malaria. Children and pregnant women were identified as the major parts of the community affected by solid waste related problems. Generally improper solid waste management has high contribution to these diseases that affect the health of the people in this town. In addition to health impacts, some respondents reply that there is a case that they pay to avoid solid wastes thrown around their surrounding in there.

4.5 Solid Waste Management and its status in wolkite town

Solid waste management (SWM) in Wolkite Town faces significant challenges due to rapid urbanization, inadequate infrastructure, and limited public awareness. The town generates increasing amounts of waste, primarily organic materials, plastics, and paper, but lacks efficient collection and disposal systems (Mengistu *et al*., 2021). Open dumping and burning remain common practices, contributing to environmental pollution and public health risks (Addis *et al*., 2020). The municipal waste collection service is insufficient, leading to illegal dumping in open spaces and waterways (Gurage Zone Environmental Protection Office, 2022). Although some efforts have been made to improve waste management, such as limited private sector involvement and community awareness programs, the absence of a proper landfill and weak enforcement of regulations hinder progress (World Bank, 2019). To address these issues, experts recommend enhancing waste collection services, promoting recycling and composting, and implementing stricter waste management policies (UN-Habitat, 2020). Without significant improvements, Wolkite Town will continue to struggle with the growing burden of solid waste, affecting both public health and environmental sustainability.

4.5.1 Problems in the SWM System

Based on observation, and information obtained from respondents and interview of the management system has faced many problems. Transport of waste from households, commercial areas, institutions and other generation sites is also a growing problem in developing countries. The transport of waste becomes longer and more time consuming, and hence, more expensive and less efficient. In developing countries many sources of waste might only be reached by roads or alleys which may be inaccessible to certain methods of transport because of their width, slope, congestion, and surface. This is especially critical in unplanned settlements such as slums or low income areas. In addition to this vehicles that serve for waste transports are also outdated, poorly maintained and frequently out of action (Zerbock, 2003).

Problems related to collection were one of the problems in some places of the town as there is throwing of solid wastes to road side and water cannel. Problems related with transportation of collected solid wastes was the major among the problems since animal (donkey)–powered cart that takes long time and unsafe means of transport is the common way. Also important components of SWM like segregation, re-using, reduction and designing controlled land fill site

were not practiced. As a result, the disposal and management activity of solid wastes in this town needs improvements to lessen the greater risks on both human health and the environment. As it was investigated through discussion with experts the root causes of these problems are: Shortage of required materials and labor due less want of workers to work for long time created by unsatisfactory wage, Lack of involvement of voluntary group like NGO and private sector to work in the management, Financial constraints and lack of safe disposal site, Low participation or willingness of the communities to pay for the management and Giving low focus for SWM from different stakeholder.

4.5.2 Responsible Bodies for SWM in wolkite town

To sum up the real situation of municipal solid waste management in Ethiopia indicates that the problem of solid waste cannot be solved only by mere effort of municipal government, there should be large involvement of the private sectors in general and participation of micro enterprises and community in particular (Abebe,2006). The responsible bodies for solid waste management in wolkite town were stakeholders such as families (households), community and government bodies. Mostly the governmental institutions should recognize their defect and give great emphasis to initiate stakeholders' participation. Because, at the very beginning efficiency of solid waste management service could be real if and only if stakeholders are aware of their responsibilities and tries to practice it with a higher level of commitment, otherwise the movement to provide MSWM service without holding them is considered as clapping by one hand. Especially, the participation of families was good and they play a great role in the collection and handling of solid wastes ranging from their households to the surrounding area. As the respondents pointed out that, the participation of governmental bodies for disposal and management of solid waste was not good. And also most of the respondents live in wolkite town strongly complain that nothing is done by the organized solid waste management bodies in this town and we are in problems related to health and environmental safety.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The study on solid waste disposal practices in Wolkite Town reveals critical challenges in waste management, with open dumping and uncontrolled incineration being the predominant disposal methods. These practices have led to severe environmental pollution, including soil contamination, water pollution from leachate, and air pollution from burning waste. The health impacts on residents are significant, with increased cases of vector-borne diseases like malaria and typhoid, as well as respiratory illnesses caused by exposure to toxic fumes. The research highlights systemic failures in waste management infrastructure, including inadequate collection systems, lack of proper disposal sites, and minimal recycling efforts. Financial constraints, weak policy enforcement, and low public awareness further exacerbate the problem. To address these issues, the study recommends implementing sustainable waste management strategies such as the 3Rs (Reduce, Reuse, Recycle), establishing controlled landfill sites, and improving waste collection and transportation systems. Community education programs and stronger government policies are essential to ensure proper waste segregation and disposal. Additionally, involving private sector stakeholders in recycling initiatives and waste-to-energy projects could provide long-term solutions. The findings emphasize the urgent need for a coordinated approach among all stakeholders to develop an effective waste management system that protects public health and the environment while promoting sustainable urban development in Wolkite Town.

5.2 Recommendation

Here below are some possible solutions were recommended to avoid, or at least to reduce the problems, to enhance the benefits resulting from solid waste and to improve the present solid waste disposal and its management system so as to ensure sustainable development through creating clean and safe working environment and improving health of the community and the environment in the wolkite town.

- Each and every individuals in this area should take care for the environment through their active participation, and as a whole, the community should develop the culture of cleaning their surrounding
- The municipality, private sector, government and NGOs should participate and work together in a coordinated manner to give solid waste management and related services, create awareness for the community on the environment, how to minimize generation and impacts solid wastes.
- There should be separation (segregation) of solid waste materials in to decomposable and non-decomposable, reusable and recyclable to facilitate market based solid waste management, reusing, re-cycling and composting. It also help to select appropriate waste management
- There should be research assisted and proper site selection, preparation and construction of solid waste disposal places in a manner that environmental and health risks controlled at an appropriate and acceptable level.
- Financial and technical support from the government, community and NGOs should be there and searching fund providing organization that support SWM directly or indirectly by attaching the issue with health, environment and development should be searched.
- Quick research on solid waste generation rate should be done to prepare good solid waste management system

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APPENDIX

Questionnaire

Wolkite University

College of Agricultural and Natural Resource

Department of Natural Resource Management,

Dear respondents, this research questionnaire is prepared to collect information on solid waste disposal and its management practices in Wolkite town as part of our senior research project. Your genuine responses are very crucial for the successful achievement of the objectives of our study. Your responses will be used anonymously only to attain the aforementioned objectives. Therefore, fill free to provide your responses.

Thank you in advance for your kind cooperation.

General direction:

- Fill the following blank space and put in the box the right symbol (✓) for your selected alternatives choice.

I. Personal Information

1. Region_____ Town _____

2. Sex: Male ☐ Female ☐

3. Age: 1-15 ☐ 16-30 ☐ 31-45 ☐ 46-60 ☐ >60 ☐

4. Number of family: 1-2 ☐ 3-4 ☐ 5-6 ☐ 7-8 ☐ other specify_____

5. Educational status: Can't read and write ☐ can read and write ☐ Primary school ☐ Secondary school ☐ above these ☐

6. Occupational status: Government employment ☐ Merchant ☐ Daily labor ☐ Farmers ☐

II. General Questions Regarding to Solid Waste

1. Do you think there is solid waste in your area? Yes ☐ No ☐

2. If yes, what are the common solid wastes? Can you list some of these wastes?

Yes ☐ No ☐ and if yes, these are:

_____

3. Do you know where these solid wastes are from? Which are their sources?

Municipal ☐ Commercial ☐ Domestic ☐ Agricultural ☐

Industrial ☐

4. Which sources of solid waste generate more?

Municipal ☐ Commercial ☐ Domestic (household) ☐

Agricultural ☐ Industrial ☐

5. What do say about the amount of solid waste generated from these source compared to the previous time?

Increasing ☐ Decreasing ☐ Other Specify_____

6. If you say increasing do you know the reason why the amount increases

Economic Development ☐ Population Growth ☐

Other Specify _____

7. Do you think solid waste have impacts in your area? Yes ☐ No ☐

8. If yes, which types of impacts are there?

Environmental ☐ Health ☐ Economic ☐ Other specify_____

9. From the above types of impact which are more frequently exhibited and have great effect in your area?

Environmental ☐ Health ☐ Economic ☐

10. Can you list some of environmental, economic and health impacts

Environmental: - _____

Economic:-_____

Health:-_____

Others:-_____

III. Questionnaires on Solid Waste Disposal and its Management

1. Do you clean your home and home compound daily? Yes ☐ No ☐
2. If yes, what kind of waste do you generate/release?

   Solid ☐ Liquid ☐ Both ☐

3. Where do you put the solid wastes? I

   Throw Everywhere ☐ Collect ☐ Other Specify_____

4. If you say I collect who receives and what transport method you use

   No receiver and I transport it manually ☐ Sweeter and by Animal drawn cart ☐

   Sweeter and by car ☐ Other Specify:-_____

5. Which disposal practices are practiced in your area?

   Incineration ☐ open dumping ☐ Composting ☐ Controlled landfill ☐

6. From the above practices which have problems?

   Incineration ☐ open dumping ☐ Composting ☐ Controlled landfill ☐

7. Is there any solid waste management system in your area? Yes ☐ No ☐
8. If yes, which components of SWM are practiced?

   Collection ☐ Reduction/Prevention ☐ Re-Cycling ☐

   Re-Using ☐ Transportation and disposal ☐

9. Among the above which are more practiced in your Town?

Collection ☐ Reduction/Prevention ☐ Re-Cycling ☐ Re-Using ☐

Transportation and Disposal ☐

10. Do you practice segregation of solid wastes? Yes ☐ No ☐
11. If yes, into what you segregate?_____
12. Is there any responsible body to manage solid waste and their disposal practice?

` Yes ☐ No ☐

13. If yes, who have a responsibility?

Household ☐ Community ☐ Government ☐ Private sector ☐

NGOs ☐ All ☐

IV. Questions for Solid Waste Management workers, and other related bodies

1. What success was scored in SWM and what attitude is experienced on the success from the community and government?

_____

_____

2. What rule and legal regulation are there related to wastes and their disposal and management practice in your Town?

_____

3. Is there any problem have you faced with the SWM system? Yes ☐ No ☐

4. If yes, what are the problems?

_____

_____

5. What do you suggest to minimize these problems?

_____

_____

6. What improvements do you suggest on the existing SWM system?

_____

_____