

MEKELLE UNIVERSITY



COLLEGE OF SOCIAL SCIENCES AND LANGUAGES

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

**MUNICIPAL SOLID WASTE MANAGEMENT PRACTICES: THE
CASE OF ADIGRAT TOWN, EASTERN ZONE OF TIGRAY,
ETHIOPIA**

**A THESIS SUBMITTED TO THE DEPARTMENT OF GEOGRAPHY
AND ENVIRONMENTAL STUDIES IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF ARTS
IN GEOGRAPHY AND ENVIRONMENTAL STUDIES**

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THESIS APPROVAL FORM

We, the undersigned, members of the Board of Examiners of the final open defense by Fesseha W/selassie Fissuh have read and her thesis entitled “municipal solid waste management practices: the case of Adigrat town, Eastern zone of Tigray, Ethiopia”, and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfilment of the requirements for the degree of masters of arts in geography and environmental studies.

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DECLARATION

I, Fesseha W/selassie Fissuh, hereby declare that the thesis entitled “ municipal solid waste management practices: the case of Adigrat town, Eastern zone of Tigray, Ethiopia”, submitted by me for the award of the Degree of Masters of arts in geography and environmental studies in Mekelle University through the department of geography and environmental studies is original work and it has not been presented for award of any other Degree, Diploma, Fellowship or Other similar titles of any other university or institution.

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This is to certify that the project work entitled “municipal solid waste management practices: the case of Adigrat town, Eastern zone of Tigray, Ethiopia,” is a bona-fide work by Fesseha W/selassie Fissuh who carried out the research under our guidance. Certified further, that to the best of our knowledge the work reported herein doesn’t form part of any other project report or dissertation on the bases of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABBREVIATIONS AND ACKRONMYS

COVID	Corona Virus Disease
CSA	Central Statistical Agency
CPHEEO	Central Public Health and Environmental Engineering Organisation
EU	European Union
EPA	Environmental Protection Agency
FDG	Focus Group Discussion:
GDBD	Green Development and Beautification Department
MSEs	Micro and Small Enterprises
MSW	Municipal Solid Wastes
MSWM	Municipal Solid Wastes Management
SDGs	Sustainable Development Goals
SPSS	Statistical Package for the Social Science
SWM	Solid Waste Management
UNEP	United Nation Environmental Program
UNDP	United Nation Development Program
USA	United States of America
WASH	Water, Sanitation, and Hygiene

ABSTRACT

It is widely acknowledged in developed countries that proper solid waste management is crucial for economic vitality, in addition to securing environmental safety and human health. On the contrary, developing nations like Ethiopia, often fail to realize these economic advantages. Instead, they frequently turn to illegal waste dumping, leading to easy exposure to harsh hazards such, as environmental pollution and public health crises. Hence, the main purpose of this study was to assess of municipal solid waste management practices in Adigrat town, Eastern zone of Tigray, Ethiopia. Accordingly, 196 out of 5852 households of in 3 kebeles of the town were selected using systematic random sampling. Structured questionnaire having both closed-and-open ended questions was administered to the respondents. Moreover, data through interviews and focus group discussion were gathered as supplements to the questionnaire. After the data has been collected, descriptive statistics- tables, graphs, percentages, mean and standard deviation and inferential statistics tools - linear regression were used for analysis purpose using with the help of SPSS version 24. The results of the findings revealed that despite high awareness of solid waste management, irregular collection forced the households to store waste for over a week, leading to common practices of roadside and drainage dumping (48.8 percent), and open burning (34.8 percent) and discard the wastes using labourers (16.4 percent). The findings also showed low effectiveness of the town's solid waste management because of collection gaps, no storage, poor enforcement, vehicle shortages, and budget issues. Thus to address issues in municipal solid waste management, it's recommended to raise awareness and provide infrastructure like separate bins for waste sorting, increase accessible collection points and promote their proper use, and support households in reducing, reusing, recycling, and recovering waste to minimize generation and maximize resource use. Moreover, to improve municipal solid waste management, the municipality, in collaboration with stakeholders such as households, private sectors, institutions and NGOs should provide adequate resources like collection vehicles and storage, develop better treatment facilities, expand and ensure reliable collection services, establish and enforce clear waste management policies (including source separation and proper disposal), and allocate sufficient financial resources for infrastructure, personnel, and program implementation.

Keywords: Household solid waste, Solid Waste, Solid Waste Generation, Household awareness and attitude, Dumping

CHAPTER ONE

INTRODUCTION

1.1. Introduction

Municipal solid wastes (MSW) are unwanted materials or wastes primarily generated from households and municipal services (Verma and Memon, 2016). Numerous factors, including seasonal and climatic conditions, population growth, urbanization, and economic development, intensive packaging of goods, informal settlement, urban agriculture, raising standards of living, and food consumption patterns, have an impact on the production and composition of municipal solid waste (Alicia et al., 2018). Understanding the volume, make-up, and characteristics of MSW is crucial for the appropriate treatment and management of these wastes (Han et al., 2018).

Waste management is a basic human need and can also be regarded as a basic human right (UNEP, 2015). However, Muhammad and Manu (2013) indicated that it still constitutes a serious problem in many Third World cities. As urbanization lead to rapid growth, the rate of solid waste generation has twice than its corresponding population growth (Getahun, 2011).

MSW in urban areas has increased dramatically in recent years as a result of increasing population, urbanization, and improved lifestyles. According to the World Bank, MSW created in urban areas is currently over 3.5 million tons per day, with that number predicted to rise to around 6.1 million tons per day by 2025 (World Bank, 2019). Various societal variables, such as population growth and rapid socioeconomic global development, have contributed to the rapid expansion in supply and demand for goods and products over the previous few decades. For effective waste management, new strategies are required to develop varied and flexible urban models. Urbanization is currently one of the major contributors to solid waste output in most parts of the world (Chen, 2018). An effective SWM system is now a global concern that requires sustainable solid waste management primarily in developing countries (Fadhullah et al, 2022).

Solid waste management is becoming a big concern for cities administration task in developing countries. This is mainly due to the magnitude of rapid urbanization and increasing population growth; which in turn has greatly accelerated municipal solid waste generation rate in the urban environment. Thus, rapid urbanization and population growth in Ethiopian

towns/cities have resulted in a significant increase in the municipal solid waste (MSW) generation rate and composition (Hayal et al, 2014).

Different approaches are used by countries to manage solid waste in order to prevent its impacts on the environment and health. Until recently, solid waste management (SWM) services in Ethiopia were mainly the responsibilities of municipalities, which results in inadequate service provision reflected by lack of proper collection, poor sanitary facilities, improper planning and co-ordination (Edmealem, 2013).

Municipal Solid Wastes management problem in Ethiopia is a major issue owing to its fast-growing economy, expansion of urbanization, and industrial development in its major cities (Eshetu, 2021). Hence, the MSWM problem in Ethiopia is a critical issue affecting the environment, human health, and economic activities (Hailemariam and Assegid, 2014), and it is especially affecting the quality of life of the local communities. MSWM problem is getting worse and is one of the serious crosscutting issues of Ethiopia. Even though the responsibility for MSWM in Ethiopia is given to municipalities through a decentralization policy, most are unable to solve their waste problems (Nebiyu, 2020).

1.2. Statement of problem

Solid wastes are unwanted and sometimes hazardous non-liquid, non-soluble and non-decomposable or decomposable materials generated from municipality, industry and commerce as well as agriculture and other related sectors (Mundie et al., 2014). However, in many unindustrialized countries including Ethiopia, the main sources of solid wastes are generated from households and agriculture (Teshome, 2021).

Improper solid waste management (SWM) in the world nowadays is considered a socio-environmental concern due to the source of air, water, and soil pollution and causes serious health risk consequences (Eshwari, et al, 2019). The accumulation of uncollected waste, insufficient waste management systems, open dumping and open burning of solid waste, defecating and urinating in open land, in and around human settlements and work areas are very widespread practices. This is further, worsened by the less collection rates which is a major challenge to the health status of the urbanites and increase the poor status of waste management (Omar, 2021).

Solid waste management is a big challenge for most developing countries including Ethiopia. Studies indicated that, households' perception, awareness, attitudes, and behaviour towards solid waste had significant impact on SWM (Manunebo and Ndombe, 2020). In the last few

decades, there was a significant increase in solid waste generation in some cities of Ethiopia. This is largely because of rapid urbanization coupled with increased urban population and a rather economic development in the country (Hailemariam and Assegid, 2014).

Because cities and municipalities cannot manage such an accelerating rate of solid waste generation and compositions in the factors of ineffective technologies, low-income levels of the people, lack of good governance, leadership, low awareness and attitudes of the people, and cultures (Modak et al., 2015). Quantifying the amount of solid waste generated which is varies widely depending on socioeconomic factors of individual households is a fundamental step for developing sustainable and financially viable SWM systems (Lebersorger and Beigl, 2011). And while a majority of households may be aware of the negative impacts of improper waste disposal, their attitudes and behaviors may not reflect this knowledge (Sultana et al., 2021). To achieve the successfulness of MSW management, there are not only the providing infrastructures by local government, but also understanding public concerns, knowledge and attitude (Babaei, et al, 2015). Ethiopia is a low-income developing country, with only 17% of its population residing in urban centers (UNDP, 2015). Yet, solid waste management is very poor in the country for the reason that now Ethiopia is facing high rural to urban migration and rapid urbanization per annum most important to congestion and expansion of slums and informal settlements with poor solid waste management problems and the urban dwellers are consuming further resources than rural dwellers and so generate huge quantities of household solid waste (Gedefaw, 2015).

Adigrat town is one among, where there is rapid growth of urban population as well as constraint in the management of solid wastes and its improper management seriously affects the public health and degrades environment. Most studies conducted so far in line with this study give more emphasis to the issues like spatial coverage of SWM service (Akmel, 2002), solid waste minimization (Gebrekidan et al, 2024a) which are very far distant from now and even special emphasis is given to the recycling scheme of solid waste generally the primary focus of developed nations (Haile, 2016). But such assessments do not guarantee to conclude about the practices and the challenges of solid waste management at household level. Therefore, this study was intended to fill the current literature gap related to the municipal solid waste management practices in Adigrat town.

1.3. Objective of the Study

1.3.1. General objective

The general objective of this study was to assess municipal solid waste management practices in Adigrat town, Eastern zone of Tigray, Ethiopia.

1.3.2. Specific objectives

The study focused on the following specific objectives:

1. To quantify the amount of solid waste generated from individual households?
2. To determine the various challenges encountered during solid waste collection and disposal in Adigrat town
3. To examine the existing management practices of solid waste in Adigrat town
4. To evaluate attitudes and awareness of households about solid waste management practices

1.4. Research Questions

At the end of this study, the researcher attempted to answer the following basic research questions.

1. How much solid waste is generated from the households in the study area?
2. What problems are encountered during solid waste collection and disposal at Adigrat?
3. How the solid waste management has practised in the town?
4. What are the attitudes of households about solid waste management practices in the town?

1.5. Significance of the Study

The study would be expected to have valuable benefits for communities, urban planners, researchers, municipal authorities and administrators, private information, and policymakers who are concerned in the advertising of household solid waste management practices to take measures to improve current solid waste management practices and to decrease the solid waste generation rate and its factors for addressing environmental problems and finally contribute to shifting towards a further environmentally sustainable society.

Consequently, the outcomes of this study would mainly assist the urban residents to propose the reality solid waste management practices, systems and strategies by focusing on resolving their major limiting factors and attitudes. By means of this, the study would be contributed to minimizing socio-economic and environmental problems and the challenges of solid waste in

the study area. And the findings of this study can serve as a baseline for other researchers who want to do a further research on municipal solid waste management practices.

1.6. Scope of the Study

This study was focused on the existing municipal solid waste management practices in Adigrat town. Studying whole kebeles of the town within the available budget, resources, and materials was difficult. Therefore, the study was limited in size and scope in a manageable way. As a result, three densely settled residential spots in Adigrat due to centrally located with numerous banks, government and non-governmental organizations, hotels, and shops were selected purposefully. And then one zone from each kebele using lottery method was selected. Consequently, this study was limited to the solid waste management practices on the zone 3 of Kebele 02, zone 1 of Kebele 03 and zone 2 of Kebele 05 within the study year from March to May 2025 in the study area.

1.7. Limitation of the Study

Recognizing that no research is without its challenges, this study encountered a few limitations. Due to this fact, most of the households were busy and had no enough time to respond to questionnaires and interview. Some of them who have enough time were also reluctant to fill in properly and return the questionnaire as per the required time. However, the researcher was able to minimize some of these problems by openly discussing on the objective of the study.

The return rate of the questionnaires was also maximized with the help of colleagues who encouraged respondents to complete and return them. A significant challenge was the scarcity of current and relevant literature on the topic, particularly within the Ethiopian context. To minimize this, the researcher extensively utilized library and internet resources.

Although a variety of socio-demographic variables can influence solid waste generation, could have been, as a limitation, this study's analysis has only addressed education level, household size, and monthly income to find the relationship between waste generation and socioeconomic variables. Despite these limitations, every effort was made to ensure the study's completeness.

1.8. Organization of the paper

This paper had five chapters. Chapter one dealt with an introductory part of the research including background of the study, statement of the problem, objectives of the study,

research questions, the significance of the study, the scope of the study, organization of the paper, and operational definitions. Chapter two was about a theoretical and empirical review of related literature based on the objective. Chapter three dealt with research methodology including the description of the study area and research methods. Chapter four presented results and discussions of the study. Finally, chapter five was about conclusions and recommendations.

1.9. Definition of Key Terms

Household solid Waste: refers to any waste material such as garbage, trash derived from households like single and multiple-family homes, hotels and motels, bunkhouses, ranger stations, crew quarters, campgrounds, picnic grounds, and day-use recreation areas (Moh, 2017).

Kebele: is the vicinity of the ‘smallest administrative unit’ part of the area which has small groups of people and this governmental area serving as a system of political unit's (Collins, 2014).

Solid waste management practice: refers to the professional occupied or continual implements of solid waste; so, these activities involve decreasing or removing the volume of solid wastes those which can be polluted to the water body, environments, and roads (Berhan and Berisa 2015).

Solid waste management: are the gathering, transporting, processing, and dumping of solid materials to decrease their effect on human health, environment, and aesthetics (Yimer and Sahu, 2014).

Solid wastes: are the materials which occur from different human and animal activities and discarded as useless or unwanted such as refuse, garbage, and rubbish (Rana, 2007).

Waste: is unwanted or unusable materials to be discarded after its primary use or that is worthless, defective, or useless (Berisa and Birhanu, 2015).

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter mainly emphasized on reviewing appropriate related literature about municipal solid waste management practices. The chapter is organized in two parts. The first part of the chapter presented concepts relate to generation household solid waste, attitudes and awareness of households about SWM, Challenges during SWM s. The second part presented reviews of variety related empirical studies about SWM practices around the globe and Ethiopia.

2.1. Theoretical review of literature

2.1.1. Concept of solid waste management

Any type of waste that is hard or not in a liquid or water-like state is referred to as solid waste (Alemayehu, 2022). Solid waste is the garbage, refuse, sludge, and other abandoned items from commercial, industrial, mining, agricultural and community activities (Kumar and Samadder, 2016). Solid waste refers to the range of garbage arising from animal and human activities that are discarded as unwanted and useless. Waste can be categorized based on material, type in to plastic, paper, glass, metal, and organic waste. Categorization may also be based on hazard potential, including radioactive, flammable, infectious, toxic, or non-toxic. Categories may also pertain to the origin of the waste, such as industrial, domestic, commercial, institutional, or construction and demolition (Rick, 2017).

According to Augustino et al (2015), solid waste is made up of organic and inorganic waste materials that comes about as a result of human and animal activities and is no longer needed which needs to be discarded due to its valueless to the user.

Solid waste management is a growing challenge to many rapidly urbanizing areas. Procurement or recycled content supplies and equipment and education are also part of SWM is refer to as the proper and correct handling of waste product at the lowest cost and minimum distraction and pollution to the environment. There is threat for need to manage waste to reduce the threat to the environment. Modern waste management approaches encourage reduced waste generation, re-use, recycling, composting, and safe disposal through landfills; however, these are often not practiced. In developing countries, a large proportion of waste is not re-used (Abdollahi, 2022).

2.1.2. Types and Sources of Municipal Solid Waste

Municipal solid waste typically includes similar waste from households, businesses and trade, office buildings, institutions, and small companies. Global urbanization increases the growth and complexity of municipal solid waste like plastics, electronics, and related derivatives. Solid waste can be categorized into sources which are agricultural waste, industrial waste, domestic household waste, Institutional waste and commercial waste (Khan et al., 2022).

- A. Agricultural solid waste mainly includes spoiled food waste from crops, orchards, vineyards, dairies, feedlots, farms, agricultural residues, and hazardous waste (Akinrinmade, 2020). In contrast, improper disposal of agricultural waste generates greenhouse gases such as carbon dioxide, nitrous oxide, and methane, threatening humans and the natural environment (Kaab et al., 2019).
- B. Industrial solid waste usually comprises steel slag, tailings, ash, red mud, waste tire, rubber, and special wastes generated by industries, in addition to wastes from light and heavy manufacturing, fabrication, construction sites, power plants, and chemical plants (Li et al., 2021).
- C. Residential or household solid waste is highly varied and greatly depending on the socioeconomic level of the household (Miezah, 2015).
- D. Institutional solid waste is waste materials that generated from schools, hospitals and health care facilities, government centers of offices, banks and prisons (Nkosi, 2014).
- E. Commercial solid waste always creates from property used mostly for the purpose of buy and sell or commerce that involves the transfer of goods and services from one person to another often in exchange for money. In general, the commercial solid waste includes paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes' (Yim et al., 2014)'.

2.1.3. Functional Elements of Solid Waste Management

The functional elements of solid waste management activities include the management of municipal solid wastes from the point of generation to final disposal activities as follows (Ahsan et al., 2014).

1. **Solid waste generations:** The creation or generation of solid waste is the usual outcome of every human activity wherever resources are using. Mining of raw material, productions of goods, consumptions, solid waste management's and others can produce solid waste. In addition to this, solid waste creation is also associated with urbanization

and international trade; because the rate of materials used now is thus large both in amounts and averages; in general, more use of natural resources and manufacturing production processes produced extremely more solid waste generation which makes problem on the environmental quality and human health at the global level if it is not managed accurately (Adeniran et al., 2017). Having knowledge of the sources and types of solid wastes together with data on the composition and generation rates is the basic to the design and process of the useful element related through the management of solid wastes. Solid waste generation rates of developed countries are higher than the developing ones and attribute to the difference in technological advances (Gebremedhin et al, 2016). The two main factors causing the rate of waste generation are increasing population and changing consumer behavior (Yukalang et al., 2017).

2. **Solid waste storage:** Solid waste storage is one of the fundamental processes of solid waste elimination from highly accumulated areas; On the other hand, Solid waste storage means the temporary control of solid wastes in the standard method after solid waste is generated former gatherings and removals. Therefore, any solid wastes should be stored in the proper storage area or containers. But, to do this activity the containers have to be accessible in adequate numbers and ability to correctly store all types of solid waste at the collection time and behind the collection (Afon, 2016).
3. **Municipal Solid Waste Segregation System:** Collection of segregated municipal waste from the source of its generation is an essential step in solid waste management. Inefficient waste collection service has an impact on public health and aesthetics of towns and cities. Collection of wet and dry waste separately enhances the potential of cost-effective treatment of such wastes and of deriving optimum advantage from the recyclable material fed into the system. Waste collection service is divided into primary and secondary collection (CPHEEO, 2016).
4. **Solid waste processing:** After separating the decomposable and non-decomposable solid wastes the processing activity would be ahead in the material treatments by means of biological technique to convert their compositions and characters of decomposable solid waste materials; but, the non-decomposable solid waste materials need the recycling process that represents the changing of solid waste materials into new raw material products. However, this kind of processing is not possible in developing countries due to financial and technological constraints (Uncha and Afework, 2018).
5. **Solid waste collection:** Solid waste collection is one of the main components of municipal solid waste management (Tassie et al., 2019). In urban areas of Ethiopia,

formal solid waste collection is mostly conducted by micro and small enterprises that collect waste door to door and transport the waste to facilities and disposal points (Ferede, 2018). Additionally, informal groups, called street boys and scavengers, collect solid waste in many urban areas of Ethiopia (Meaza, 2016). Door to door collection system is the most typical procedure in urban areas (Bello et al., 2016). Most industrialized nations use a door-to-door collection system, but because of financial and administrative constraints, municipalities in developing nations can only offer this service to a small portion of the population (Bezama and Agamuthu, 2019).

6. **Solid waste transfer:** The solid waste transfer is one the efficient practical element which can be involving the transfer of solid wastes from the minor collection means of transportation to the larger transportation types of equipment and always taking place at the transfer stations (Rathore and Sarmah, 2019). Due to this, solid waste transfer or relocation sites have a significant function in the public's full solid waste management schemes using as the connection among the public's solid waste collection working plan and the last solid waste removal capacities or services. Whereas capacity possession, size, and services giving differ extensively among relocate stations, and they provide similar critical functions that consolidate solid wastes from many collection vehicles into bigger; much amount volume transfer or transport vehicles are used for further efficient delivery to far-away dumping site. Here its easiest form, the transfer location is a capacity by selected receiving areas where solid waste gathering vehicles are discharging their loadings (Yadav et al., 2016).
7. **Solid waste transportation:** According to Kaza, et al (2018), waste collection in the Sub-Saharan Africa region frequently happens in two steps. Donkeys, tricycles, and handcarts are frequently employed to move rubbish from individual residences to an aggregation site. Waste is transported to the final disposal site using trucks and small vehicles from the aggregation site (Mohammed and Elias, 2017).
8. **Disposal:** Waste disposal is the final step in municipal solid waste management to protect the environment and people from solid waste impacts (Berisa and Birhanu, 2015). As per the OpenWASH report (2016), Ethiopia relies on landfills (such as burial pits and open dumping) and thermal processing (burning and incineration) for waste management. A key challenge, however, is the lack of standardized waste disposal sites in the majority of Ethiopian towns and cities.

2.1.4. Strategies of Solid Waste Management

The waste hierarchy can be used to manage waste, aiming to minimize its generation and impact on the environment. It ranks waste management options from most to least desirable, starting with waste prevention as the top priority, followed by reuse, recycling, recovery, and finally disposal (Bharati et al, 2017). Traditional trash avoidance, re-use, and recycling activities are forbidden in numerous underdeveloped nations; therefore, some elements of this hierarchy are already in place (Endalkachew, 2018). Sustainable MSWM applies the 4Rs (Reduce, Reuse, Recycle, and Recovery at sources) to minimize trash generation and help meet the Sustainable Development Goals (SDGs) by reducing waste disposal (Meena et al., 2023).

- 1. Reduction/ Prevention:** The highest priority choice in SWM hierarchy is to stop or reduce the solid waste generation at the supply (source). The waste reduction might occur through the designing, producing, and packaging of products with minimum harmful content, minimum volume of fabric, or extended useful life (Endalkachew, 2018).
- 2. Reusing:** According to Bharati et. al, (2017) the most effective approaches to stop the development of waste are to reduce and reuse. It's well recognized that up to 95% of a product's environmental impact occurs before it's discarded, primarily during manufacturing and the extraction of virgin raw materials. According to Bharati et al, (2017) recycling necessitates the separation of waste streams, whether at the source or after collection. This strategy also reduces the amount of trash produced as a product, conserves natural resources, and lowers production and manufacturing costs. Reusing items that are no longer needed by someone can help to reduce municipal solid trash creation.
- 3. Recycling:** Recycling, in addition to reuse, is an obvious solution to the solid waste management problem. It's a crucial approach for collecting solid waste materials and converting them into useful items that can be sold in the market. There are two techniques to reprocess such material: primary and secondary. As a result of environmental concerns, many people feel compelled to recycle. Waste recycling benefits the economy by recovering and repurposing valuable materials. They cut down on the amount of garbage that needs to be collected, transported, and disposed of, as well as extending the life of disposal facilities, saving the agency money (Yohanis and Genemo, 2015).

- 4. Processing and Recovery:** All procedures, equipment, and facilities used to improve the efficiency of other functional components and to recover useful materials, conversion products, produce energy, and compost from solid wastes are included in this functional element. It also comes with a number of advantages. First, it will help to reduce the overall volume and weight of garbage that needs to be collected and disposed of. In addition, it lowers the total cost of garbage transportation to its final disposal site. The author mentioned once more that solid waste processing and recovery began with the separation and processing of wastes at the point of generation (Yohanis and Genemo, 2015).
- 5. Incineration:** Incineration is a mechanism for regulating and completely burning solid waste. One of the most indicative properties of an incinerator that can be employed is the reduction of the initial volume of combustible solid waste by 80-90 percent. This is a waste reduction method, not a waste disposal method, as the ash from the incineration should still be disposed of. It is acknowledged as a viable way of disposing of certain hazardous waste items (such as medical waste) (Yohanis and Genemo, 2015).
- 6. Land Filling:** Land filling is one of the most common ways of municipal solid waste (MSW) disposal in developing countries. Most landfills in Ethiopia operate as open dumps, lacking dedicated management systems (Teshome, 2021)

2.1.5. Knowledge attitude of solid waste management

Household knowledge has a vital role in determining waste management strategies and behaviors. Understanding garbage segregation, recycling, composting, and disposal techniques is essential for reducing environmental and health issues associated with solid waste (Perkumienė, 2023). However, a lack of information and awareness among families can result in ineffective waste management, contributing to pollution and health concerns (Ziraba, 2016).

Household attitudes toward solid waste management have a significant impact on trash disposal practices and community participation in waste management efforts. Positive viewpoints, such as recognizing the importance of waste management and its benefits to health and the environment, may encourage appropriate waste disposal behaviours. Negative attitudes, such as indifference or disregard for waste management, may limit effective garbage disposal and contribute to environmental degradation (Vargas et.al, 2024). Understanding the factors that influence household attitudes is essential for creating effective educational and awareness campaigns to promote environmentally responsible

waste management practices (Debrah, 2021).

2.1.6. Challenges of Household Solid Waste Management

The unrestricted production of solid waste and its unsafe disposal is becoming a global problem (Gorfness, 2019). Urbanization, population growth and modernization have rapidly increased the rate of municipal solid waste production and disposal in many cities around the globe. Solid waste management has remained a challenge to both developed and developing countries globally. As a low-and middle- income country, Ethiopian cities and towns also deal with the environmental costs of pollution due to unregulated landfill waste. As much of the waste is land filled, that represents a loss of materials that could be reused, recycled, or converted to energy to displace the use of virgin materials (Gorfness, 2019).

In urban cities of Low- and middle-income country, management of solid waste remains poor. Improper waste disposal and management may result in health and environmental problems and may become life threatening. Water, soil, and air pollution have been attributed to improper disposal and management of solid waste (Alam and Ahmade, 2015). In addition, Mohammed (2016), stated that most urban areas in Ethiopia use open dumping for waste disposal, which pollutes the surface and groundwater, soil, and natural environment as a whole. In developing countries, less attention has been paid to waste minimization strategies that result in the sending of wastes to dumpsites for final disposal. Openly burning solid waste is another common practice, while incineration is mostly used to treat health care waste in Ethiopia (Demedina-salas et al., 2020).

The rate of solid waste production is increasing with population growth, technological development, and changes in lifestyle (Birara and Kassahun, 2018). In Low- and middle-income country, improper handling and disposal of solid waste contributes to high levels of mortality and morbidity (Adogu, et al, 2015).

2.2. Empirical literature review

2.2.1. Municipal Solid Waste Management in Developed Countries

Based on the study conducted by Ren and Zou (2024), despite its efforts to implement MSW segregation policies, China's have been unsatisfactory with its results. Research often emphasizes public participation, with less focus on the entire policy implementation process. The findings revealed challenges at four levels: policy formulation, implementing agencies, target groups, and the external environment. Issues include policy ambiguity, unclear

authority, government-enterprise cross-functionality, casual attitudes, implementer shortages, poor public participation, and economic disparities.

Based on the study by Pinto et al. (2022), the COVID-19 pandemic placed significant and multifaceted pressures on solid waste management systems in the USA. These challenges ranged from increased waste generation and changes in its composition to operational disruptions, financial burdens, and the critical need to manage potentially infectious waste streams effectively.

According to the study conducted by Chioatto (2023), it was ;earned that the EU has framed a comprehensive regulatory action aimed at shifting Waste Management towards Sustainable Waste Management. The results show that regions in Germany and the Netherlands have moved away from landfill to a greater extent, in favor of higher recycling rates. Conversely, Italy and France regions are these displaying lower performances but with progressive improvement. It is shown that regions with still very low waste collection volumes will have to accelerate the process in order to align with EU targets. In this concern, a burden-sharing system might be advisable.

2.2.2. Municipal Solid Waste Management in Developing Countries

According to Lozano Lazo (2023) study in Santa Cruz de la Sierra, Bolivia, indiscriminate dumping of solid waste in various locations – from roadsides and open spaces to riverbanks and even graveyards – is causing significant flooding, environmental pollution, and public health problems. This situation is largely due to the growing difficulties in municipal solid waste management (MSWM), compounded by a lack of adequate financial resources. The generation of solid waste has been a persistent and crucial concern since the dawn of settled human life.

According to Kibonde, (2014) study on solid waste management in Daresalam: Privatizing and improving revenue collection, reveal that the collection of solid waste in Daresalam has been hampered partly by poor infrastructure and equipment, management arrangements which have not adequately coordinated the intervention of the different actors before and after decentralization of the collection service, inefficient collection and management of reuse of collection charges, designing fault with solid waste collection point, lack of proper landfill among others. The results indicated that the majority of residents in the municipality participated through involuntarily.

A study by Ali and Siong (2016) in Malaysia revealed high level of households' knowledge on solid waste minimisation. However, this high level of knowledge has not translated to rapid decline in household solid waste generation due to the fact that the households are not aware of government's initiative on solid waste minimisation. The households seldom take initiatives that directly or indirectly reduce the quantity of wastes they generate

2.2.3. Municipal Solid Waste Management in Ethiopia

Eshetu (2021) examined the state of solid waste in Addis Ababa during 2016–2020 to provide implications for achieving green architecture concepts through better management of solid waste and its economic contribution. The result reveals that most solid waste is generated from households, followed by commercial centers, street sweeping, industries/factories, hotels, and hospitals, respectively. There are little or no efforts made to segregate solid waste at the source. The generated waste is disposed of in the Reppi open landfill.

According to Endalkachew et.al (2018) study on Bishoftu City Administration, the findings of the study revealed that the current MSWM practice of City is weak and also there is a problem on solid waste reduction strategy: segregation, reuse, recycling, and resource recovery. In addition to this, as stated by (Yukalang, 2017), many cities face problems such as lack of manpower and equipment and financial constraints

As revealed by Abebe (2017a), the volume of solid trash in Addis Ababa and other rapidly rising cities in Ethiopia has been steadily increasing over time, owing due to the country's rapid population growth rate. About 50-60% of the total solid waste discharged by the city's residents was collected, while the rest was left uncollected.

2.3. Conceptual framework

This study adopted the conceptual framework as shown in figure 1 with an approach for proper solid waste management considering community awareness and attitudes, is guided by policies and rules, is responsive to socio-demographic factors, and is enabled by adequate financial, human, and material resources (equipment and vehicles).

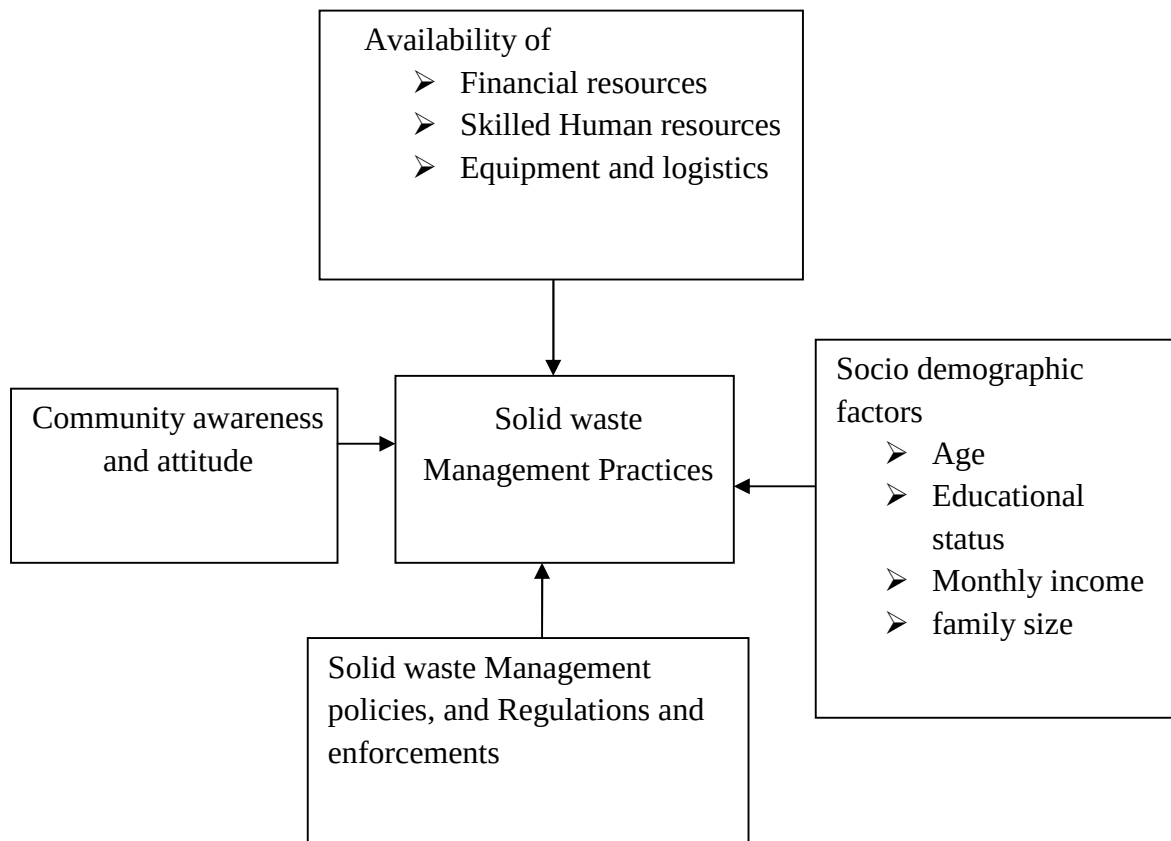


Figure 2.1: Conceptual framework of the study adapted

CHAPTER THREE

RESEARCH METHODOLOGY

This research method part discussed description of study area, research design, sampling techniques and sample size determination, source of data, data collection tools, and methods of data analysis, ethical consideration and data quality control consecutively.

3.1. Description of the Study Area

3.1.1. Location

Adigrat is located in the Eastern zone of Tigray State of Ethiopia, at a distance of 898 Kms to Addis Ababa and 118 Kms to the capital of Tigray Regional State, Mekelle. The town is administrative capital city of Eastern zone of Tigray region. This town has a latitude $14^{\circ}16'N$ $39^{\circ}27'E$ with an elevation ranging between 2000 to 3000 meters above sea level. The area of Adigrat Town is 1,932 hectares. Its average annual temperature is moderate between $15^{\circ}C$ and $20^{\circ}C$ and means annual rainfall is 659.4mm. According to Central Statistical Agency (2018), the population projection figure of the town had been estimated at a total of 112,550.

3.1.2. Geography and Climate

Adigrat is surrounded by a range of mountains. Emba Alaeque Mountain to the west, Erar to North West, Kandaero to North and Genahti to North Erast surrounds the Town from which Alaqwa is the highest. Towards the east, it is delimited by the spectacular edge of the north-eastern Ethiopian escarpment dropping into the lowlands. The Huga River runs through Adigrat. The city is spread widely on both banks of the river. The other surface runoff is coming from Kenda'ero and Genahti ridge crossing the town. Adigrat has a cold semi-arid climate. The overall climate throughout the year is mild and dry. The annual rainfall ranges between 400 and 600 mm, with most of the rain falling in the rainy season (June up to September) (Nikodimos, 2006).

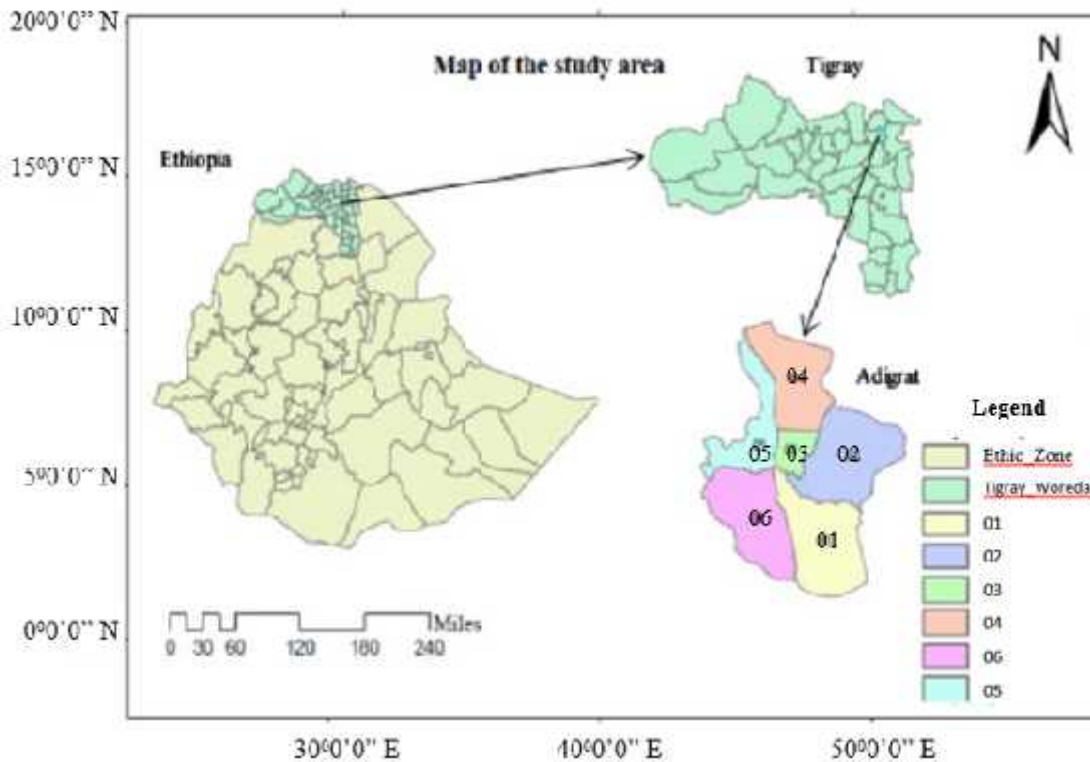


Figure 3.1: Map of the study area (Selamawit et al, 2022).

3.1.3. Population

Based on the 2007 national census conducted by CSA (2007), this town had a total population of 57,588, of whom 26,010 were male and 31,578 females. According to Adigrat municipality, Planning & programming Office estimated the population of Adigrat town to 104334. And as of July 1, 2022, the projected population of Adigrat town was 121,800. And as of September 2024, the household of Adigrat town was estimated to 35,661.

3.2. Research design

The research design involves planning the methods to collect data at a single point in time to describe characteristics or relationships within a population. It depends on the purpose of the research at hand (Pandey and Pandey, 2021). This study used a descriptive cross-sectional survey research design because the observation/data collection was at one point in time. A cross-sectional research design is also better and more effective for obtaining information about the current status or the immediate past of the case under study. It is also appropriate and suitable to use data collection tools such as questionnaires, interviews, field observations, and document analyses (Zegeye et al., 2009).

3.3. Sampling techniques and sample size determination

In this study, the researcher employed both probability and non-probability sampling techniques. Two stage sampling procedure was used in order to select sample from the study area. At the first stage, three kebeles, namely 02, 03 and 05 were selected purposely since these kebeles are densely populated by Adigrat town residents as largely owing to the numerous banks, governmental and non-governmental organizations, hotels, and shops located there. At the second stage, one zone from each kebele was selected using lottery method.

Then the study participants were determined by using systematic sampling techniques to allocate the samples of households proportionally to each zone. Households were selected every 30th interval (by dividing the total households (5,852) to the sample size (196)) using the first selected household as by lottery method as a starting point of reference and then the data collection was done in the right direction from the first chosen household until the required sample size for the zones were achieved. In each selected household only one eligible respondent (usually household head) was taken. In the absence of the household head, other family members took their place. From the total list of 5,852 households in the selected three zones of kebeles, 196 sample households were selected using the following sample size determination formula (Kothari, 2004).

Where,

$$n = \frac{z^2 p \cdot q \cdot N}{z^2 (N-1) + z^2 p \cdot q}$$

N = Total households in the selected three zones of the selected kebeles (5,852),

n = Sample Size, e = the estimation allowable error is (0.03) = 3%

z = Standard variant at 95% confidence level = 1.96,

p = Sample proportion (0.05) = 5%, q = 1-p,

$$n = \frac{1.96 * 1.96 * 0.05 * (1 - 0.05) * 5,852}{0.03 * 0.03 * (5,852 - 1) + 1.96 * 1.96 * 0.05 * (1 - 0.05)} \approx 196$$

Then, 196 households from the selected three zones of the selected kebeles were decided based on proportionate sampling as shown in the table 1 below.

$$n_i = \frac{N_i}{N}$$

For instance, number of sample households for zone 3 of Kebele 02 was

$$n1 = \frac{1,907}{5,852} * 196 = 64$$

Table 1: the proportionate sample size of households for the selected zones of in Adigrat town

Sample kebeles	Sample zones	Number of total households	Number of sample households
2	3	1,907	64
3	1	2,296	77
5	2	1,649	55
Total		5,852	196

Source: Adigrat town, Kebele offices and computed Sample size, 2025

In addition, 5 households from each selected zone totally 15 households were included purposely for measuring daily households' solid waste generation rate.

3.4. Data sources

To achieve the stated objective, the researcher used both primary and secondary sources of data. Primary data were collected from sample households , and the Green Development and Beautification Department head in Adigrat Municipality; whereas, secondary data were collected from government statistics, organizational records, and data from previous studies.

3.5. Tools of data collection

The main tools of data collection instruments were questionnaires, key informant's interview, and field observation.

Questionnaires: the survey questionnaire was designed to address demographic and socio-economic characteristics of respondents and solid waste management practices. The questionnaire was first prepared in English and then was translated into the local language, Tigrigna. The questionnaires were both close-ended and open-ended types. Firstly, questionnaires were piloted by administering to 10 households in order to correct ambiguities) and misleading questions. Finally, the developed questionnaires were distributed to the sampled households.

Key informant interviews: the study involved semi-structured interviews with 5 purposively selected informants (1 Green Development and Beautification Department head, 1 street cleaner and 3 solid waste collectors from micro-enterprises which were engaged in the provision of solid waste management were employed. The information gathered through key informant interviews were used to triangulate with the data collected from household surveys through structured questionnaires.



Figure 3.2: Partial view of key informants

(A) Researcher interviewing GDBD head of Adigrat municipality; (B) and (C) researcher interviewing solid waste collectors

Source: Field Survey, 2025

Field observation: the data gathered through survey questionnaires, and key informant interviews were triangulated with field observation. Personal observation about households' solid waste handling status, illegal dumping areas, and the collection and transportation facilities of solid waste and disposal site of the town direct observation helped to have a better understanding about various facts or phenomena. The researcher took photographs during field observation for empirical evidence.

Focus Group Discussion: FDGs were conducted in the selected 3 zones. Totally 24 households who were not involved in filling out the questionnaires and had adequate awareness about solid waste management practices in the study area were participated in the discussion.



Figure 3.2: Partial view of focus group discussion with the households

3.6. Method of data analysis

To achieve the stated objective, the researcher used both quantitative and qualitative methods of data analysis. The descriptive statistics including frequency mean, standard

deviation and graphical representations were main quantitative tools used to analyse the quantitative data. Statistical package for social sciences (SPSS) software version 24 was used to analyse the quantitative data. In addition, inferential statistics - linear regression model was used to explain the relation between household solid waste generation rate and socioeconomic variables. Qualitative data generated from open-ended questionnaires, interviews, field observation, and photographs were analysed qualitatively by triangulating quantitative data.

In this study, the multiple linear regression model was used to explain the relationship between amount solid wastes are generated (dependent Variable) and, highest level of education of the Household, Family Size, Monthly income (Predictors).

The model specified as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \epsilon$$

Where:

- Y: This is the dependent variable, representing the amount of solid waste generated.
- β_0 : This is the Y-intercept or constant. It represents the predicted value of Y when all predictor variables- educational level, family size, and monthly income (X_1, X_2, X_3)
- ϵ = The error term

3.7. Ethical consideration

Before conducting the data collection, the researcher explained the objective of this study for the respondents. The researcher agreed with respondents in which responses to be used only for this research work. The researcher also explained the importance of conducting this research for concerned bodies in the study area. A clear explanation is to make the participants confidential in giving genuine responses to those questions. The data collection was begun after obtaining permission from those concerned bodies.

3.8. Data quality control

After the collection, the questionnaires were checked thoroughly for the completeness and consistencies to ensure the data quality before going to the data analysis stage to verify its correctness.

CHAPTER FOUR

DATA ANALYSIS AND INTERPRETATIONS

This Chapter presents the results on the characteristics of the households and, the current management practices of solid waste in Adigrat town. Data were collected through structured questionnaire. Moreover, data through interviews and focus group discussion were gathered as supplements to the questionnaire. Out of 196 questionnaires distributed, 192 were duly filled and returned. This marks the response rate of 98 percent. According to Porter and Umbach (2006), at least (80 percent) response rate is enough for a descriptive survey study in social science research.

4.1. Demographic Characteristics of Respondents

It was necessary for the study to determine the demographic characteristics of the respondents are a representative sample of the target population for generalization purposes.

Table 4.1: Demographic Characteristics of Respondents

Item	Category	Frequency	Percent
Sex	Male	77	40.1
	Female	115	59.9
	Total	192	100.0
Age (year)	20-35	56	29.2
	36-50	78	40.6
	51-65	40	20.8
	Above 65	18	9.4
	Total	192	100.0
highest level of education of the Household	illiterate	19	9.9
	Grade 1-4	11	5.7
	Grade 5-8	29	15.1
	Grade 9-12	76	39.6
	Diploma & university degree	57	29.7
	Total	192	100.0
Occupation of the Household	Business man	46	24.0
	Governmental or NGO	54	28.1
	Daily laborer	24	12.5
	Housewives	68	35.4
	Total	192	100.0
House ownership condition	Private house	116	60.4
	Rental house	76	39.6
	Total	192	100.0
Family Size	1-3	60	31.3
	3-6	67	34.9
	7-10	56	29.2
	Above 10	9	4.7
	Total	192	100.0
Monthly income of the Household (Birr)	<= 1500	47	24.5
	1500-3000	98	51.0
	3000-5000	38	19.8
	Above 5000	9	4.7
	Total	192	100.0

Source: Field Survey Data, 2025

As revealed in table 4.1, most (59.9 percent) of the respondents were females. This was due to the fact that women are disproportionately responsible for managing household solid waste due to ingrained gender roles and societal expectations. In line with this Amoah (2023) pointed out that women as primarily responsible for domestic tasks, including waste management, while men are perceived to engage in other areas of household activity. Although the results showed that the male households were fewer than their female counterparts, for the purpose of this study the males were well represented since they were accounted for more than one third of the total.

With regard to age of respondents, majority (40.6 percent) of the respondents were within age range of 36 and 50 followed by 29.2 percent of them within age range of 25 and 35. On the other hand 20.8 percent and 9.4 percent of them were between 51 and 65 years and above 65 years respectively. Thus, 69.8 percent of the households were within age range of 20 and 50 which implied that majority of the respondents were in the energetic and productive age.

Concerning educational level, most (39.6 percent) of the respondents had grade 9-12 followed by 29.7 percent of them had diploma & university degree qualification. The rest 20.8 percent and 9.9 percent of them were grade 1-8 educational level holders and illiterates respectively. Thus it can be concluded that majority of the households were educated and they could understand the current management practices of solid waste in Adigrat town.

Regarding occupation of the households, more than half (52.1 percent) of the respondents were businessmen as well as governmental or NGO employees. Similarly, 75.5 percent of the households were earning more than 1500 birr monthly income. Thus higher income and better occupations might have improved solid waste management practices, but also can lead to increased waste generation. Supporting this, Morais et al (2022) stated that individuals with higher-paying jobs or those in professions that involve more disposable items may generate more waste compared to those in lower-income occupations.

With regard to house ownership condition, most (60.4 percent) of the households were private homeowners who may have better solid waste management practices compared to renters who may face restrictions or less convenient access to resources.

Concerning family size, majority (68.8 percent) of the households had more than 3 family members with average family size of 5, which might generally generate more solid waste due to increased consumption and resource usage.

4.2. Generation of household solid wastes

Generation rate is an initial part and a very important in solid waste management systems since it helps the management units in the selection of equipment and budget needed. The generation of solid waste in the study area is the result of human consumption, households' level of awareness on the management practice, household income, family size and the life style of the households. In this study, the generations of waste are measured in kilograms per person per day (kg/person/day).



Figure 4.1: Partial view of daily household solid waste generation measurement (A) Researcher weighing the solid waste; (B) researcher recording the measurement of solid waste.

Source: Field Survey, 2025

Table 4.2: Daily collected solid wastes

Days		Field area	Solid waste (kg)
Day 1		Kebele 02, zone 3	3.6
Day 2		Kebele 02, zone 3	2.3
Day 3		Kebele 03, zone 1	4.0
Day 4		Kebele 03, zone 1	3.5
Day 5		Kebele 05, zone 2	3.0
Day 6		Kebele 05, zone 2	4.0
Day 7		All the 3 zones of the respective 3 kebeles	4.8
Total solid wastes collected			25.2
Solid Waste generation rate (kg/capita/day)			0.336
Estimated solid waste generation of the town	daily		40,924.8
	weekly		286,473.6
	monthly		1,227,744
	annually		14, 937,552

Source: Field Survey, 2025

During the interview, it was learned that the head of the GDBD of the town based their planning and implementation on a daily generation rate of 0.32 kg/ca/day. Contrary to the department's estimation, this study indicates a substantially larger amount of daily and annual household waste produced in the town as shown in table 4.2. To this end, after giving plastic bag for each household, the solid waste was collected from 15 households with an average of five persons per household representing different kebeles of the town on seven (7) consecutive days. Thus the total per capita solid waste generation rate for Adigrat town is estimated to be 0.336 kg/capita/day. Considering total population of 121,800 of the study area, the daily, weekly, monthly, and annually household solid waste generation for the study area was estimated to be 40,924.8 kg, 286,473.6 kg, 1,227,744 kg and 14, 937,552 kg respectively. Therefore, the considerably higher generation rate found in this study compared to the town GDBD's and the available capacity indicates a potential overload for the department of the town.

Table 4.3: Generation rate of solid waste of the households by their their income level

Income groups	Income level	Housing	No of sample HHs	Family size	Qt/HH/day(kg)	Generation rate of a group Qt/day/cap(kg)
Higher	>20,500 ETB (>\$6.85/day)	Owner of larger house/ land	3	16	6.10	0.381
Middle	6,500 ETB -20,500 ETB (\$2.15-\$6.85/day)	Renter or owner	5	24	8.23	0.343
Lower	< 6,500 ETB (< \$2.15/day)	Renter	7	35	10.85	0.310
Total			15	75	25.18	0.336

Source: Field Survey, 2025

Before measuring solid waste generation, households were grouped into three income categories – high, middle, and low – using their monthly income and housing condition based on World Bank (2024) report. Accordingly, as shown in table 4.3, the households were categorized in to higher, middle, and lower income groups with daily per capita solid waste generation rate of 0.38 kg/day, 0.34kg/day and 0.31kg/day respectively. This result is roughly comparable to the other studies of 0.33 kg/capita/day in Mekelle (Gebrekidan et al, 2024a), 0.34 kg/capita/day in Jimma (Mekonen, 2017) and 0.32kg/capita/day in Jijiga (Kedir et al, 2022). This shows the high contribution of households to solid waste generation in Adigrat town similar to many Ethiopian towns.

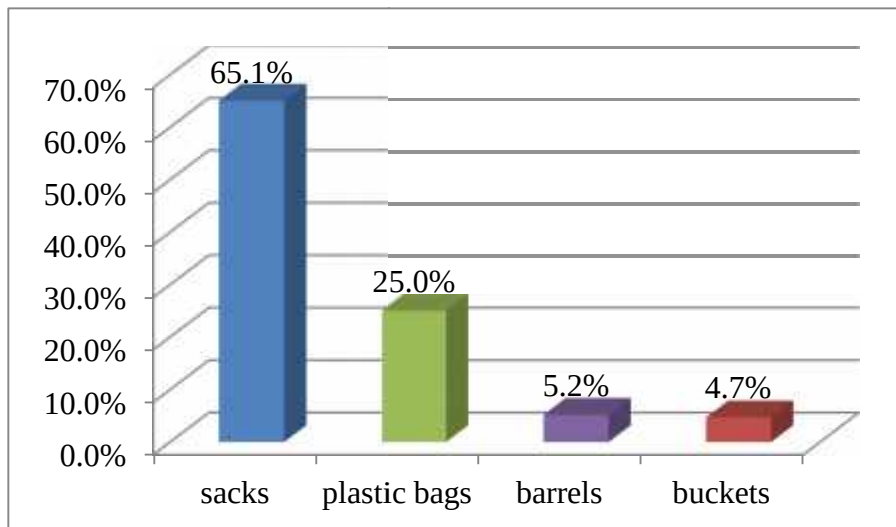


Figure 4.2: Types of households' temporary solid waste storage materials

Source: Field Survey Data, 2025

It is known in Ethiopia, a variety of temporary solid waste storage materials such as baskets, card boxes, bamboo containers, cans, plastic bags, barrels, etc. are used, reflecting a combination of traditional practices, economic factors, and the availability of resources (Hayal, 2022). As it indicated in figure 4.1 above, nearly two third (65.1 percent) of the respondents used sacks followed by 25 percent of them who have used plastic bags for temporary storage of solid wastes. Hence sacks were best preferred for storing solid waste temporarily may be due to their low cost, widespread availability, and ability to hold large volumes of waste. In agreement with Abebe (2017b) stated that the infrequent door-to-door waste collection service also contributes to the sacks popularity though its use can lead to leachate formation and environmental pollution. Similarly, plastic bags were used for waste storage may be due to their ease of use and availability.



Figure 4.3: Partial view of solid waste storages

(A) Sacks and plastic bags filled with solid waste were left on the road median; (B) Sacks and plastic bags filled with solid waste in a residence waiting for door to door service

Source: Field Survey, 2025

Table 4.4: Weekly household solid waste generation by their monthly income

Item	Category	Monthly income (Eth. birr)				Total	Percent
		<= 1500	1500-3000	3000-5000	Above 5000		
How many solid wastes are generated in terms of sacks each week approximately?	half a sack	21	19	7	0	47	24.5
	1 sack	16	61	11	0	88	45.8
	1 and a half sacks	10	18	17	4	49	25.5
	2 sacks	0	0	3	5	8	4.2
	Total	47	98	38	9	192	100.0

Source: Field Survey Data, 2025

As the use of sacks as a primary temporary storage material in Ethiopia, the increased quantity of waste generated due to higher income levels would directly translate to more waste being collected and stored in these sacks. Hence, as clearly shown in table 4.4, most (45.8 percent) of the respondents reported that approximately they generated one sack per week. The results also showed the households with higher incomes tend to generate more waste. As mentioned in figure 4.1 above most the households used sacks for storing solid waste in which it's difficult to have a precise daily generation estimate in kilograms. However, since Hirpe and Yeom (2021) explicitly states that the average municipal solid waste generation rate in different cities and towns of Ethiopia ranges from 0.25 to 0.49 kg/capita/day, a rough estimate for a sack of a solid waste can be determined in kg. Considering a family size of 5 people, and an average 0.37 kg per capita daily solid waste generation, the average week waste generation accumulated in a sack = $7 \times 5 \times 0.37 \text{ kg} \approx 12.95 \text{ kg}$. Thus, a smaller discrepancy is observed when comparing the household waste generated in a week (11.76 kg) measured by weight meter as presented in table 4.3 with the estimates in kilograms derived from sack counts.

Table 4.5: Availability and frequency solid waste collection service?

Item	Category	Frequency	Percent
Do you use door to door solid waste collection service?	Yes	192	100.0
	No	-	-
	Total	192	100.0
The frequency of solid wastes collection is	Week	49	25.5
	More than a week	143	74.5
	Total	192	100.0

Source: Field Survey Data, 2025

While the necessity of solid waste collection in Ethiopia is paramount for public health and environmental protection, its availability remains limited, especially in informal settlements

and smaller towns, and its frequency is often irregular and insufficient, leading to significant challenges across the country (Sisay et al, 2024). Hence, as it revealed in table 4.5 above, all (100 percent) of the respondents confirmed that the door to door solid waste collection service exist. However most (74.5 percent) of the respondents reported that they may wait longer than a week for door-to-door solid waste collection. Whereas the rest 25.5 percent of them received door-to-door solid waste collection services weekly. This implied that longer collection intervals for household solid waste can definitely indicate that waste isn't being collected regularly and on schedule, leading to increased waste accumulation and increased amount of solid waste generations.

4.3. Household solid waste management practices

Proper household solid waste management practices are critically important in Adigrat town in which the rapid urbanization and population growth are undeniably leading to a substantial and escalating problem of solid waste generation, which significantly challenges the town's environmental sustainability and public health.

Improper practices such as inadequate collection, lack of source separation, and reliance on open dumping lead to severe consequences across public health, environmental sustainability, and economic development. Thus, the households' participation in solid waste management trainings and clean-up campaigns is recognized as crucial for improving proper solid waste management practices (Gebrekidan et al, 2204b).

Table 4.6: Household Solid Waste Segregation Practices

Item	Category	Frequency	Percent
How do you keep your daily solid wastes before disposal?	Separated	38	19.8
	All together	154	80.2
	Total	192	100.0
Purpose of separating solid wastes	to uses as firewood	9	4.7
	to use as feeding animals	19	9.9
	to reuse or to exchange to	10	5.2
	Total	38	19.8
Why you don't separate your daily solid wastes before disposal?	Lack of clear	66	42.9
	shortage of solid waste	54	35.1
	Negligence	20	13.0
	shortage of time	14	9.1
	Total	154	100.0

Source: Field Survey Data, 2025

According to table 4.6, it was found that quite large numbers (80.2 percent) of respondents reported for keeping different kinds of waste altogether while the remaining 19.2 percent of

them separated wastes for the purpose of using as feeding animals, as firewood and reuse or to exchange to other items.

Concerning not separating solid waste, most (42.9 percent) of respondents replied lack of clear regulations followed by 35.1 percent who responded shortage of solid waste storage. Whereas the remaining 13 percent and 9.1 percent said they haven't separate waste due negligence and shortage of time respectively. Thus since most of respondents do not separate the waste at all, it led to a less efficient and more environmentally damaging waste management system.

Table 4.7: Household Solid Waste Disposal Practices

Item	Category	Frequency	Percent	Percent of Cases
How do you dispose household solid wastes aside from door to door service?	dumping the wastes at the roadsides and in drainage	101	48.8	52.6
	burn the wastes in open area	72	34.8	37.5
	discard the wastes with labor	34	16.4	17.7
	Total	207	100.0	107.8

Source: Field Survey Data, 2025

As it is seen in table 4.7, the households gave multiple responses to the ways disposing solid wastes aside to using door to door service. Accordingly, most (48.8 percent) of respondents disposed household solid wastes aside from door-to-door service by dumping the wastes at the roadsides and in drainage followed by 34.8 percent and 16.4 percent who burned the wastes in open area and discarded the wastes with labor respectively. This implies that the households would be more prone to improper disposal methods when door-to-door solid waste service is either missing or takes a longer time. In line with this Eshete (2023) indicated in his study that a majority of the households disposed of their solid waste illegally, either in the backyard with sacs or along the roadsides and in gully.

During the interview with solid waste collectors and street cleaners replied as open dumping of solid waste is illegally a prevalent issue in Adigrat town which are generating unpleasant odours, closing sewerages and force liquid waste stagnant in street sides and filling the open spaces.



Figure 4.4: Partial view of impacts of improper solid waste disposal on roadside, open field and drainages

- (A) waste dumped in drainages at zone 2, kebele 05 (14°16'53.3" N, 39°27'37.5" E);
 (B) Solid waste dumped on the road and moved to the edge at zone 1, kebele 03 (14°16'53" N, 39°27'40.1" E);
 (C) Solid waste disposed on open field at zone 3, kebele 02 (14°17'02.5" N, 39°28'18.7" E);
 (D) Solid waste dumped on the road side at zone 1, kebele 03 (14°16'43.6" N, 39°27'48.9" E)
 Source: Field Survey, 2025

Table 4.8: Household solid waste Disposal practices

Item	Category	Frequency	Percent
Do the waste collectors' vehicles are covered and there is no spill over of solid waste upon transport?	Yes	0	0
	No	192	100.0
	Total	192	100.0
Do the waste collectors strictly follow frequency picking-up of waste?	Yes	29	15.1
	No	163	84.9
	Total	192	100.0

Source: Field Survey Data, 2025

According to table 4.8, all (100 percent) of the respondents reported that that waste collector vehicles are uncovered, leading to waste spill over during transport. Also majority (84.9 percent) of the households responded that waste pick-up schedules not being strictly followed though the remaining 15.1 percent confirmed that waste pick-up schedules are strictly followed. It can be concluded from this result that most of the households believed that waste

pick-up schedules are irregular. Supporting this, solid waste collectors and street cleaners during the interview responded that inadequate numbers of waste collection vehicles, breakdowns, lack of fuel and insufficient funding for waste management were disrupting schedules.

In addition, during focus group discussion with the households, some of the most of the contributing factors raised to why waste collectors' vehicles are often uncovered, leading to the spill over of solid waste during transport were combination of economic limitations, infrastructural challenges, regulatory gaps, a focus on immediate collection needs, and potentially a lower prioritization of the environmental and health impacts of spillage. This result implies that the waste management system in the town is irregular, inadequate, and inefficient.



Figure 4.5: Partial view of uncovered vehicles

A) Households were loading solid wastes to uncovered vehicle

B) A vehicle transporting solid wastes exposed/uncovered

Source: Field Survey, 2025

Table 4.9: Participation in solid waste management trainings and clean-up campaigns

Item	Category	Frequency	Percent
Have you ever been participated in solid waste management trainings?	Yes	19	9.9
	No	173	90.1
	Total	192	100.0
Have you ever observed a clean-up campaign in your zone/kebele so far?	Yes	162	84.4
	No	30	15.6
	Total	192	100.0
How many times you noticed a clean-up campaign in the last 6 months?	1 times	134	69.8
	2 times	19	9.9
	3 times	9	4.7
	Total	162	84.4

Source: Field Survey Data, 2025

As can be seen in table 4.9 above almost all (90.1 percent) of respondents haven't participated in solid waste management trainings. This may indicate that information about available training programs might not effectively reach all households. Besides if households don't fully understand the benefits of proper solid waste management, they might not see the value in attending training.

Community based regular clean-up campaign practice is important for having a clean environment in a town like Adigrat. With regard to a clean-up campaign, a quite large number (84.4 percent) of respondents confirmed for clean-up activities in their zone/kebele and the rest 15.6 percent did not involve in clean-up campaigns so far. However, most (69.8 percent) of the households claimed the participation in public clean-up activities were once in the last six months. Thus, it can be understood that there was rarity of household solid waste clean-up campaigns. This might stem from lack of awareness and prioritization as well as a lack of adequate support and infrastructure.

4.4. Households' awareness and Attitude toward solid waste management practices

When households are aware of waste management issues and hold positive attitudes towards sustainable practices, they are more likely to engage in behaviors like waste reduction, source separation, and proper disposal. Conversely, a lack of awareness and negative attitudes contribute to poor waste management (Bidu et al, 2024).

Table 4.10: Households' awareness towards solid waste management practices

Item	Yes		No	
	Frequency	Percent	Frequency	Percent
Is solid waste source of pollution for the environment?	192	100.0	-	-
Do you think dwellers of Adigrat town have clear and adequate awareness about solid waste management systems?	143	74.5	49	25.5
Burning of solid wastes causes health risks (eg. bronchitis and asthma)	173	90.1	19	9.9
Illegal dumping of solid waste causes diarrhoea, typhoid, and cholera.	192	100.0	-	-
Improper dumping of solid wastes can eventually lead to pollution of rivers, lakes and wells	192	100.0	-	-
Do you know illegally disposing or burning solid wastes can affect your surrounding?	192	100.0	-	-
Do you have the awareness about the negative consequences of poor solid waste management	164	85.4	28	14.6

Source: Field Survey Data, 2025

As shown in the table 4.10 above, all (100 percent) of respondents had awareness that illegal and improper dumping or burning of solid wastes can lead to pollution of rivers, lakes and wells and the environment as whole. As the result it causes diarrhoea, typhoid, and cholera. Similarly, most (85.4 percent) of respondents had awareness about the negative consequences of poor solid waste management followed by 74.5 percent of them believed most of residents of the town have clear and adequate awareness about solid waste management system. It can be concluded from these results that most of the households of Adigrat town recognize the health risks associated with such illegal and improper solid waste disposal practices. In line with this Asfaw et al (2024) stated that despite a general awareness of the problems associated with improper solid waste management, such as environmental and health impacts, many households still fail to implement proper practices. This can be due to factors like lack of infrastructure and economic challenges.

These results implied that almost all the households had awareness about solid waste management. Nevertheless, having knowledge of solid waste management doesn't guarantee that households will actually manage their waste properly. Supporting this Mukena et.al (2024) found high willingness among residents to engage in recycling and waste reduction" indicating awareness however, actual practices were limited due to inadequate facilities and lack of stringent enforcement of waste policies.

Table 4.11: Households' attitude towards solid waste management practices

Item	Disagree		Agree		Strongly Agree		Mean (M)	Standard deviation (SD)
	Freq	%	Freq	%	Freq	%		
Solid waste is one of the environmental problems that need an immediate attention	-	-	104	54.2	88	45.8	3.46	0.5
Every household should have responsibility for the proper collection and disposal of solid wastes	9	4.7	154	80.2	29	15.1	3.10	0.434
Proper solid waste management is important for creating healthy environment	-	-	102	53.1	90	46.9	3.47	0.5
solid waste management is a burning issue in the town	18	9.4	135	70.3	39	20.3	3.11	0.535
The city government should conduct regular supervision and control on illegal dumping of solid waste in the town	-	-	49	25.5	143	74.5	3.74	0.437
solid wastes have health impact	-	-	86	44.8	106	55.2	3.55	0.499
Solid wastes have an environmental impact?	-	-	105	54.7	87	45.3	3.45	0.499
Mean score of the households' attitude toward solid waste management practices							3.41	0.49

Source: Field Survey Data, 2025

For the effectiveness and efficient management of solid waste in a given area, the perception of local communities towards the solid waste management plays a crucial role. To this end, the household respondents involved in the study were asked to rate how much they agreed or disagreed with statements on a 4-point Likert scale reflecting their attitudes toward solid waste management practices. Subsequently, the mean (M) and standard deviation (SD) scores obtained were used to determine the attitude of household respondents toward solid waste management practices. As Eshun et al. (2021) described their interpretation, the scale of attitude assessment was interpreted as 0-1.4 (strongly disagree), 1.5-2.4 (disagree), 2.5-3.4 (agree), and 3.5-4.0 (strongly agree).

As depicted in the table 4.11 above, majority of respondents agreed (M=3.45, SD=0.5) that solid wastes have an environmental impact as a result they agreed (M=3.46, SD=0.5) that it is one of the environmental problems needing an immediate attention.

It appears that a quite large number of respondents tend to agree (M=3.1, SD=0.43) with the statements regarding responsibility of every household for the proper collection and disposal of solid wastes. Furthermore, most of respondents strongly agreed (M=3.55, SD=0.5) that solid wastes have health impact. As a proof of this, the majority of the respondents agreed (M=3.55, SD=0.5) that proper solid waste management is important for creating healthy environment.

In addition, the majority of respondents strongly agreed (M=3.74, SD=0.44) with the assertion that the city government should conduct regular supervision and control on illegal dumping of solid waste in the town. The overall mean score was 3.41 which indicate that the data lies in the agree range of the four-point scale and there was not too much variation around the mean score. A smaller standard deviation 0.49 also suggests that the responses are clustered relatively closely to the mean. Thus, it can be inferred from this result that the attitude of the households towards the solid waste management practices was positive.

4.5. Challenges during solid waste collection and disposal

Geda et al (2011) in his study in Addis Ababa City stated that despite solid waste management is one of the important obligatory functions of urban local bodies, it was not efficiently and properly performed resulting in various sanitation, social and environmental problems. This mainly due to lack of financial resources, institutional weakness, improper selection of technology, transportation systems and disposal options, social problem associated with lack of interest towards environmental cleanliness and sanitation, which have made this service unsatisfactory and inefficient. In agreement with this, this study in

the subsequent sections revealed similar issues in solid waste collection stemming from the improper disposal of household solid waste, unawareness of rules and regulations of solid waste management, and inadequate resources such as infrastructure, vehicles, and municipal budget.

Table 4.12: Improper disposal of household solid waste

Item	Category	Frequency	Percent
Do you think that the solid wastes are managed properly in your zone?	Yes	29	15.1
	No	163	84.9
	Total	192	100.0
What are the reasons for improper solid waste management?	Lack of awareness	46	24.0
	Negligence	49	25.5
	Lack of capacity	68	35.4
	Total	163	84.9

Source: Field Survey Data, 2025

According to table 4.12, quite large number (84.9 percent) of respondents didn't believe for having proper solid waste management. To this regard 35.4 percent of the households reported lack of capacity (limited resources) as the main reasons for improper solid waste management whereas, the remaining 25.5 percent 24 percent of them replied negligence and lack of awareness respectively. Hence most of the households felt inadequate of proper storage materials, poor awareness of managing solid wastes and traditional disposal methods were not enabling them to manage the solid waste at it should be. Supporting this Fereja and Chemedha (2022) stated in their study that low levels of awareness of households toward solid waste management, inadequate access to door-to-door solid waste collection, and low solid waste collection frequency have contributed to improper solid waste management practice.

Table 4.13: Unawareness of rules and regulations of solid waste management

Item	Category	Frequency	Percent
Do you know the rules and regulations of solid waste management of the town	Yes	39	20.3
	No	153	79.7
	Total	192	100.0
Have you ever seen when violators of regulation in solid waste management are penalized?	Yes	10	5.2
	No	182	94.8
	Total	192	100.0

Source: Field Survey Data, 2025

As shown in table 4.13, majority (79.7 percent) of the households didn't fully aware of the specific rules and regulations regarding solid waste management. Consequently, almost all (94.8 percent) of the households haven't ever had seen penalization of violators of these rules and regulations. These results imply that a lack of awareness about the specific rules,

coupled with infrequent penalization of those who violate them, contributed significantly to the ongoing challenges in achieving proper solid waste management in the town.

Table 4.14: Challenges of Municipal Solid Waste Management Service

Item	Category	Frequency	Percent
What are the main problems facing waste collectors during solid waste management service?	inadequate vehicles	52	25.9
	Insufficient budget allocation by the municipality	89	44.3
	Lack of giving awareness training	60	29.9
	Total	201	100.0
How do you weigh up the municipal solid waste management service of the Adigrat town?	Moderate	39	20.3
	Low	153	79.7
	Total	192	100.0
what are the major reasons for Municipal low solid waste management practices	inadequate vehicles	20	10.4
	Insufficient budget	19	9.9
	Lack of temporary storage areas	38	19.8
	Solid waste is not collected quickly	47	24.5
	weak enforcement of rules and regulations	29	15.1
	Total	153	79.7

Source: Field Survey Data, 2025

Based on the table 4.14 above, the households gave multiple responses to problems facing waste collectors during solid waste management service. As the result 44.3 percent, 29.9 percent and 25.9 percent of the households considered insufficient budget allocation by the municipality, lack of awareness training and inadequate vehicles as significant and main problems facing waste collectors during solid waste management service in Adigrat town.

With respect to evaluating municipal solid waste management service, most (79.7 percent) of households replied that the overall evaluation of the effectiveness of municipal solid waste management practices in the town was low. Accordingly, they raised infrequent collection of solid waste, lack of temporary storage areas, weak enforcement of rules and regulations, inadequate vehicles and insufficient budget as major reasons for the low effectiveness of municipal solid waste management practices in the town. In relation to this GDBD head in Adigrat municipality office during the interview reported solid waste collectors as MSEs supported by safety net programs and operating under municipal oversight in the town, were vital for initial waste collection. However due to the large volume of waste being generated, coupled with widespread improper dumping, managing the entirety of the urban wastes was far beyond their capacity. As the result, he mentioned inadequate infrastructure, lack of waste separation, inadequate vehicles and fuel, dumping solid waste, insufficient salaries and the resulting complaints that has hindered effective solid waste management practices.

4.6. Association between Waste Generation and socioeconomic Variables

According to Castro and Ferreira (2023), the linear regression is used to predict the value of the continuous dependent variable based on the values of the independent variables. Hence in this study linear regression analysis was used to find the relationship between waste generation and socioeconomic variables.

Table 4.15: Linear regression analysis of household solid wastes generation rate

Coefficients					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1	(Constant)	-.400	.197	-2.028	.044
	highest level of education of the Household	.049	.024	.149	.042
	Family Size	.227	.038	.497	.000
	Monthly income	.422	.048	.825	.000

a. Dependent Variable: How many solid wastes are generated in terms of sacks each week approximately?

Source: Field Survey Data, 2025

In this study the researcher wanted to know if there was a relationship between level of education, family size, and monthly income of the households (independent variables) with amount of solid wastes are generated (dependent variable). Accordingly, as revealed in the above table 4.15, the regression model with level of education ($p < .05$), family size ($p < .001$), and monthly income ($p < .001$) of the households are statistically significant predictors of how many solid wastes are generated in terms of sacks each week. Thus monthly income and Family size have the strongest positive relationships with solid waste generation (indicated by their high Beta values and extremely low p-values). As income and family size increase, the amount of waste generated also increases. Similarly education level also has a statistically significant positive relationship with solid waste generation, though the effect size is smaller compared to income and family size. This suggests that as the highest education level in a household increases, so does solid waste generation in the town. In agreement with Endeshaw and, Mequanent (2022) in their study in Gondar town indicated that education level, and family size significantly ($p < 0.05$) contribute to the household generation rate. Similarly, Teshome et al. (2023) in their study in Yirgalem town reported that monthly income, family size and of educational level of the household generally have statistical significance with solid waste generation.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

The study was sought to assess municipal solid waste management practices in Adigrat town, Eastern zone of Tigray, Ethiopia. In particular, the study provides answers to the following four main research questions: (1) how the solid waste management has practised in the town? (2) what problems are encountered during solid waste collection and disposal at Adigrat, (3) what are the attitudes of households about solid waste management practices in the town? and (4) how much solid waste is generated from the households in the study area? Thus this chapter presents the conclusions and recommendations drawn from the study. Descriptive methods were used to analyze the data set in view of the research problem and objectives set out at the beginning of the thesis. This chapter has two sections. The first section draws the conclusion of the study. And the second section forwards recommendations for specific action and suggestions for future research.

5.1. Conclusions

Based on the results of findings, the possible conclusions regarding municipal solid waste management practices were drawn.

Based the results of the finding, average daily generation of solid waste in the study area was 40,924.8 kg. This study revealed a significant disparity between this study's waste generation rate (0.336 kg/capita/day) and the town SBPDD's (0.32 kg/capita/day), as well as the current handling capacity, which could result in a substantial burden on the department.

The findings of the study revealed that due to low cost, easily availability, and ability to hold large volumes, sacks was best preferred for temporary storage of solid waste.

It was also concluded from the findings that the household solid waste were not being collected regularly and on schedule so that storing more waste on their premises for more than a week due to inadequate numbers of waste collection vehicles, breakdowns, and lack of fuel and insufficient funding for waste management.

It was also deduced from the findings that that the households' knowledge and attitudes on solid waste and solid waste management is high but the level of practice is very poor. Most households dumped the wastes at the roadsides and in drainage and burned in open air when door-to-door solid waste service is either missing or takes a longer time.

The results of the findings also revealed that as a result these improper dumping led to generation of unpleasant odours, sewerages closure and force liquid waste stagnant in street sides and filling the open spaces.

The result of the findings revealed that most of the households felt inadequate of proper storage materials, poor awareness of managing solid wastes and traditional disposal methods were not enabling them to manage the solid waste properly.

It was also concluded from the findings that the overall evaluation of the effectiveness of municipal solid waste management practices in the town was low due to infrequent collection of solid waste, lack of temporary storage areas, weak enforcement of rules and regulations, inadequate vehicles and insufficient budget.

5.2. Recommendations

Based on the findings of the study, the following possible areas of intervention were recommended to overcome problems linked to municipal solid waste management practices.

These recommendations could be addressed at household / community level, municipality level, NGO level and institutional level so that stakeholders could take advantage of it and implement these recommendations:

1. Household and Community Level:

- **Promote waste segregation at the source:** It was found that there were low levels of separating solid waste. Therefore, it is recommended to raise awareness and provide the necessary infrastructure (e.g., separate bins) to facilitate the separation of waste into different categories (e.g., organic, recyclable, non-recyclable).
- **Improve access to appropriate disposal sites:** Limited access to proper waste disposal sites and infrequent door-to-door waste collection services contributes to illegal dumping. Thus increasing the availability and accessibility of designated collection points and promoting their proper use is crucial.
- **Promote the 4Rs:** It was found that the households' awareness and attitude toward solid waste management was encouraging; however, it is insufficient on its own to ensure sound solid waste management. Hence the households should be supported to reduce, reuse, recycle, and recovery at the household level to minimize waste generation and maximize resource utilization.

2. Municipality Level:

- **Invest in infrastructure and logistics:** This study showed the overall municipal

solid waste management practices in the town was low due to lack of temporary storage areas and inadequate vehicles. Thus, the municipality in collaboration and coordination with different stakeholders such as university, hotels and business men should provide adequate waste collection vehicles, storage containers, and developing or improving waste treatment and disposal facilities.

- **Improve collection efficiency and coverage:** It is found that the town suffers from irregular and inadequate waste collection services. Thus the municipality needs to expand their collection networks and ensure consistent and reliable services.
- **Develop and enforce regulations and policies:** it was understood that a quite large number of study participants didn't know the rules and regulations of solid waste management of the town. Therefore, clear policies and regulations regarding waste management, including source separation and proper disposal, need to be established and effectively enforced.
- **Increase funding and budget allocation:** The study has proved that the waste collectors lacked sufficient budget during solid waste management service. Hence, adequate financial resources are essential for investing in infrastructure, human resources, and implementing effective waste management programs.

3. NGO Level

- **Facilitate community mobilization and awareness:** NGOs in collaboration with concerned bodies should play a significant role in raising awareness, mobilizing communities, and promoting behavioral change towards better waste management practices.
- **Support capacity building and training:** NGOs can provide training and technical assistance to communities, municipalities, and other stakeholders on various aspects of solid waste management.
- **Advocacy and policy influence:** NGOs can also advocate for better policies and regulations related to solid waste management and promote the inclusion of community needs in decision-making processes

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MEKELLE UNIVERSITY
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Appendix I: Questionnaire for the Households in Adigrat town

Dear Respondent,

I am a student at the Mekelle University and doing this study as a partial fulfilment of the requirement for the award of Master of Art degree in Geography and Environmental Studies. This study is aimed at assessing municipal solid waste management practices: the case of Adigrat town, Eastern zone of Tigray.

You are assured that high level of confidentiality will be observed when presenting the data. The information you provide here will be very helpful to ensure attainment of the expected objectives under this study. Thus I kindly request you to give your genuine and honest answer. Please note that you are not required to provide your name.

Thank you for your cooperation in advance.

Instruction: Please put tick mark (✓) on the box of the appropriate alternative or fill the provided blank spaces with correct answers for the following questions.

Part I: Background information about the respondents

1. Sex: A. Male () B. Female ()
2. Age: A. 20-35 years () B. 36-50 years () C. 51-65 years () D. Above 65 years ()
3. Educational Status:
A. Illiterate () B. Grades 1-4 () C. Grade 5-8 () D. Grade 9-12 ()
E. Diploma and University degree ()
4. Occupational status: A. Business man () B. Governmental or NGO employee ()
C. daily laborer () D. Housewife ()
5. House ownership condition: A. Private house () B. rental house ()
6. Family size: A. 1-3 () B. 3-6 () C. 7-10 () D. Above 10 ()
7. Household monthly income: A. Less than or equal to 1500 birr () B. 1500-3000 birr ()
C. 3000-5000 birr () D. Above 5000 birr ()

Part II: Generation of household solid wastes

8. Do you have temporary solid waste storage? A. Yes () B. No ()
9. If your answer to the question 8 is yes, what kinds of materials used for storage of the solid wastes?
- A. sacks () B. plastic bags () C. bins, () D. barrel () E. buckets ()
10. Do you use door to door solid waste collection service? A. Yes () B. No ()
11. If your answer to the question 10 is yes , the frequency of solid wastes collection is
- A.. Less than 3 day B.3-6 days () C. Week () D. More than a week ()
12. How many solid wastes are generated in terms of sacks each week approximately?
- _____

Part III: Household solid waste management practices

13. How do you keep your daily solid wastes before disposal?
- A. Separated () B. All together
14. If your answer to the question 13 is “separated”, for what purpose do you separate? to
- A. To use as firewood () B. to use as feeding animals () C. to use as fertilizer () D. Others () specify _____
15. Do you dispose household solid wastes, aside from door to door service?
- A. Yes () B. No ()
16. If your answer to the question 15 is yes, how do you dispose it?
- A. dumping the wastes at the roadsides and in drainage () B burn the wastes in open area () C. discard the wastes with labor () D. Others () specify _____
17. Do the waste collectors strictly follow frequency picking-up of waste?
- A. Yes () B. No ()
18. Have you ever been participated in solid waste management trainings?
- A. Yes () B. No ()
19. Do the waste collectors’ vehicles are covered and there is no spill over of solid waste upon transport? A. Yes () B. No ()
20. Have you ever observed a cleanup campaign in your zone/kebele so far?
- A. Yes () B. No ()
21. If your answer for question No 20 is yes how many times you noticed in the last 6 months ?_____

Part IV: Households' awareness about solid waste management practices

Item	Yes	No
22. 1.Is solid waste source of pollution for the environment?		
22.2. Do you think dwellers of Adigrat town have clear and adequate awareness about solid waste management systems?		
22.3. Burning of solid wastes causes health risks (eg. bronchitis and asthma)		
22.4. Illegal dumping of solid waste causes diarrhea, typhoid, and cholera.		
22.5. Improper dumping of solid wastes can eventually lead to pollution of rivers, lakes and wells.		
22.6. Do you know illegally disposing or burning solid wastes can affect your surrounding?		
22.7. Do you have the awareness about the negative consequences of poor solid waste management		

Part IV: Households' attitudes about solid waste management practices

Item	Strongly agree	Agree	Disagree	Strongly disagree
23. 1. Solid waste is one of the environmental problems that need an immediate attention				
23.2. Every household should have responsibility for the proper collection and disposal of solid wastes				
23.3. Proper SWM is important for creating healthy environment				
23.4. SWM is a burning issue in the town				
23.5. The city government should conduct regular supervision and control on illegal dumping of solid waste in the town				
23.6. solid wastes have health impact				
23.7. Solid wastes have an environmental impact?				

Part V: Challenges during solid waste collection and disposal

24. Do you think that the solid wastes are managed properly in your zone?

A. Yes () B. No ()

25. If your answer for question number 24 is no, what are the reasons for improper solid waste management?

Lack of awareness () B. Negligence () C. Lack of capacity () D. Others ()

26. What are the main problems facing during solid waste management service? (you can have more than one choice)

Lack of vehicles () Insufficient budget allocation by the municipality ()

Lack of giving awareness training.... ()

27. Do you know the rules and regulations of solid waste management of the town?

A. Yes () B. No ()

28. Have you ever seen when violators of regulation in solid waste management are penalized?

A. Yes () B. No ()

29. How do you weigh up the municipal solid waste management service of the Adigrat town?

Very high () B. High () C. Moderate () D. Low ()

30. If your answer for question number 29 is low, what are the major reasons? _____

Thank you!

Appendix II: Key informant Questions

A. Interview questions for Green Development and Beautification Department head

1. Did your department provide education or training to the community about SWM?
2. What are major challenges of your department?
3. Have you ever been participated in solid waste management trainings?
4. Do you feel your organization has efficient capacity to handle MSWM responsibilities?
5. Do you think residents of Adigrat town have clear and adequate awareness about solid waste management systems?

B. Interview questions for solid waste collectors and street cleaners

1. Have you ever been participated in solid waste management trainings?
 2. . Do you think residents of Adigrat town have clear and adequate awareness about solid waste management systems?
 3. What can you suggest to improve the current solid waste management practices in the town in general?
 4. Do you believe that the service provisions by the waste collectors are satisfactory?
A. Yes () B. No ()
 5. If your answer for question number 4 is “No”, what do you think the problem behind?
-

Appendix III: Focus group discussion questions for the households

1. Do you have adequate awareness about proper solid waste management?
2. Do you have rules and regulation locally in SWM? If there exist to what extent it is practical?
3. What are the main challenges you face during SWM disposal in the town?
4. What do you think should be done to improve poor waste management practices in the town?
5. Are there public solid waste containers and street bins placed at the major roads of the town? If yes, how much and is sufficient?

Appendix IV: Structured questionnaires, Tigrigna version

የኔቨርስቲ መቐለ ኮሌጅ ማህበራዊ ሳይንስን ቋንቋታትን ክፍሊ ትምህርቲ ጂኦግራፊን መፅናዕቲ ከባቢን

መሕተቲ ንመራሕቲ ስድራ ከተማ ዓዲግራት

ዝተከበርኻ/ኸን ተሳታፊ/ት እዚ መፅናዕቲ ኣነ ኣብ የኔቨርስቲ መቐለ ተምሃሪት እንትከውን እዚ ንጂኦግራፊን መፅናዕቲ ከባቢን ብማስተርስ ድግሪ ንምምራቕ ከምሓደ ረቋሒ ዝውሰድ መፅናዕቲ ኢዩ። እዚ መፅናዕቲ ናይ ቤት ፅሕፈት ማዘጋጃ ከተማ ዓዲግራት እዋናዊ ተግባራት ምሕደራ ደረቕ ጎሓፍ ንምግምጋም ዝግለመ እዩ። ውፅእቲ እዚ ሓበረታ ንዝተሓሰበሉ ዕላማ እንትቀርበሉ እዋን ብልዑል ደረጃ ምስጢር ከምዝተሓዘ ከረጋግፀልኹም/ኸን ይፈቱ።

ኣብዚ እትህቡዎ/ባኡ ሓበሬታ እዚ መፅናዕቲ ትፅቢት ዝግበረሉ ዕላማታት ንምዕዋት ኣዝዩ ሓጋዚ ክኸውን እዩ። በዚ ድማ ሓቀኛን ቅኑዕን መልስኹም/ኸን ክትህቡ/ባ ብትሕትና ይሓትት። ኣብዚ መሕተት ስምኹም/ኸን ምፅሓፍ ኣየድልን።

ንተሳትፎኹም/ኸን ኣቀዲመ የመስግን።

መምርሒ፡ ነዞም ዝስዕቡ ሕቶታት ካብቶም መማረቂታት ኣብቲ ጎኒ ትክክለኛ መልሲ ዘሎ ሳፁን እዚ ምልክት (✓) የእትግ/ዎ ወይ ድማ ኣብቲ ዝተዋህበ ባዶ ቦታታት ቅኑዕ መልሲ ይምልኡ/ኡ።

ቀዳማይ ክፋል ፡ ብዛዕባ እቶም መልሲ ዝሃቡ ድሕረ ባይታ ሓበሬታ

1. ፆታ፡ ሀ ተባዕታይ () ለ ኣንስተይቲ ()
2. ዕድመ፡ ሀ. 20-35 ዓመት () ለ. 36-50 ዓመት () ሐ. 51-65 ዓመት () መ. ልዕሊ 65 ዓመት () ()
3. ኩነታት ትምህርቲ፡ ሀ/ መሃይም () ለ 1-4 ክፍሊ () ሐ 5-8 ክፍሊ () መ 9-12 ክፍሊ () ሰ.ዲፕሎማን የኔቨርስቲ ዲግሪን ()
4. ናይ ስራሕ ኩነታት፡ ሀ.ንግዳዊ ሰብኣይ () ለ.ሰራሕተኛ መንግስቲ ወይ ዘይመንግስታዊ ትካል () ሐ.መዓልታዊ ሽቃላይ () መ.በዓልቲ ገዛ ()
5. ኩነታት ዋንነት ገዛ፡ ሀ ናይ ብሕቲ ገዛ () ለ ናይ ክራይ ገዛ ()
6. ብዝሒ ስድራቤት፡ ሀ 1-3 () ለ 3-6 () ሐ 7-10 () መ ልዕሊ 10 ()
7. ወርሓዊ እቶት መራሒ ስድራ፡ ሀ ካብ 1500 ብር ንታሕቲ ወይ ማዕረ () ለ 1500-3000 ብር () ሐ.3000-5000 ብር () መ.ልዕሊ 5000 ብር ()

ካልኣይ ክፋል፡ ምውህላል ደረቕ ጎሓፍ ገዛ

8. ግዝያዊ መእከቢ ደረቕ ጎሓፍ ኣለኹም/ኣለወን ዶ? ሀ እወ () ለ ኣይፋልን ()
9. ንሕቶ 8 መልስኹም/ሰን እወ እንተኾይኑ፡ ንመኽዘን እቲ ደረቕ ጎሓፍ ዝውፅል እንታይ ዓይነት ንብረት እዩ?
ሀ. ዓሺናታት () ለ.ፕላስቲክ ቦርሳታት () ሐ. ዘንቢል፤ () መ.በርሚል () ሰ.ባልዲታት ()
10. ተጠቀምቲ ግልጋሎት ገዛዝ ኣናዞሩ ደረቕ ጎሓፍ ንዝእክቡ ትካላት እኹም//የን? ሀ እወ () ለ ኣይፋልን ()
11. ንሕቶ 10 መልስኹም/ሰን እወ እንተኾይኑ ፡ ብብክንደይ እዋን?
ሀ.. ትሕቲ 3 መዓልቲ () ለ.3-6 መዓልቲ () ሐ. ሰሙን () መ. ልዕሊ ሰሙን ()
12. ኣብ ሰሙን ብግምት ብመንፅር ዓሺና ክንደይ ደረቕ ጎሓፍ ይውህለል? _____ .

ሳልሳይ ክፋል፡ ልሙድ ተግባራት ምሕደራ ደረቕ ጎሓፍ መራሕቲ ስድራ

13. መዓልታዊ ደረቕ ጎሓፍካ ቅድሚ ምጉሓፍካ ብኸመይ ትሕዞ?
ሀ. ተፈላልዮም () ለ. ኩሎም ብሓባር ()

14. ሀ/ ንሕቶ 13 መልስሻ “ኩሎም ብሓባር” እንተኾይኑ፡ እቲ ምኽንያት እንታይ እዩ?
ሀ. ንምፍላይ ንፁር ደንቢ ዘይምህላው ለ. ሕፅረት ዐ ምኽዛን ርጡብ ኅሓፍ ሐ. ሸለልትነት መ. ሕፅረት ግዜ
15. ንሕቶ 13 ዝሃብካዮ መልሲ “ተፈላልዮም” እንተኾይኑ፡ ንምንታይ ዕላማ ተፈላልዩ/ያ? ሀ. ከም ነዳዲ ንምጥቃም () ለ. ከም መመገቢ እንስሳታት ንምጥቃም () ሐ. ከም መዳበርያ ምጥቃም () መካልእ () _____ ይግለፁ/ግ
16. ካብ ተጠቃሚነት ግልጋሎት ገዛገዛ እናዞሩ ደረቅ ኅሓፍ ንዝእክቡ ትካላት ኣገልግሎት ወፃኢ፡ ደረቅ ኅሓፍ ገዛ ብኸመይ ትጉሕፍዎ/ፋኡ? (ካብ ሓደ ንላዕሊ ምምራፅ ይከኣል እዩ)
ሀ. ኅሓፍ ኣብ ወሰን መንገድን ኣብ ፋናቱራን ቢንቶ ምድርባይ () ለ ኅሓፍ ኣብ ክፉት ቦታ ምንዳድ () ሐ. ኅሓፍ ብሓይሊ ሰብ ምጉሓፊ () መካልእ () _____ ይግለፁ/ግ
17. እቶም ኣከብቲ ኅሓፍ ስራሕ እዞን ምእካብ ኅሓፍ ብጥብቂ ይኸተሉ ድዮም?
ሀ እወ () ለ ኣይፋልን ()
18. ኣብ ስልጠናታት ምሕደራ ደረቅ ኅሓፍ ተሳትፍኩም/ፊን ይፈልጡ/ጣ ዶ?
ሀ እወ () ለ ኣይፋልን ()
19. እተን ደረቅ ኅሓፍ ዝእክባ መካይን ኣብ ከይዲ ንዕዞኡን ኅሓፍ ንከየፍስሳ ዝተሸፈነ ድየን? ሀ እወ () ለ ኣይፋልን ()
20. ክሳብ ሕዚ ኣብ ዞንኹም/ቀበሌኹም ወፍሪ ፅሬት ተዓዚብኩም/ናኦ ዶ ትፈልጡ/ጣ?
ሀ እወ () ለ ኣይፋልን ()
21. ንሕቶ ቁፅሪ 20 መልስኹም/ሰን እወ እንተኾይኑ ኣብ ዝሓለፈ 6 ኣዋርሕ ክንደይ ግዜ ኣስተብሂልኹም/ለናኦ? _____

ራብዓይ ክፋል፡ ንቕሓት መራሕቲ ስድራ ብዛዕባ ተግባራት ምሕደራ ደረቅ ኅሓፍ

ሕቶ	እወ	ኣይፋልን
22.1. ደረቅ ኅሓፍ ንከባቢ ምንጪ ብከላ ድዮ?	()	()
22.2. ነበርቲ ከተማ ዓዲግራት ብዛዕባ ስርዓት ምሕደራ ደረቅ ኅሓፍ ንፁርን እኹልን ንቕሓት ኣለዎም ዶ ትብሉ/ላ?	()	()
22.3. ምንዳድ ደረቅ ኅሓፍ ንጥዕና ሓደጋታት የስዕብ (ንኣብነት ሕማም ሳምብኡን ኣዝማን)	()	()
22.4. ዘይሕጋዊ ምጉሓፍ ደረቅ ኅሓፍ ተምሳሎ፡ ታይፎይድን ሕማም ኮሌራን የስዕብ።	()	()
22.5. ደረቅ ኅሓፍ ብዘይግቡእ ምድርባይ ኣብ መወዳእታ ንሩባታት፡ ቀላታትን ዒላታትን ብከላ ከስዕብ ይኸእል።	()	()
21.6. ደረቅ ኅሓፍ ብዘይሕጋዊ መንገዲ ምድርባይ ወይ ምንዳድ ንከባቢኻ ክፃልዎ ከም ዝኸእል ትፈልጡ/ጣ ዶ?	()	()
22.7. ብዛዕባ ኣሉታዊ ሳዕቤናት ድኹም ምሕደራ ደረቅ ኅሓፍ ንቕሓት ኣለኩም/ኣለወን ዶ	()	()

ራብዓይ ክፋል፡ ኣተሓሳስባ መራሕቲ ስድራ ብዛዕባ ተግባራት ምሕደራ ደረቅ ኅሓፍ

ሕቶ	ብትሪ ይሰማማዕ	ይሰማማዕ	ኣይሰማማዕን	ብትሪ ኣይሰማማዕን።
23.1. ደረቅ ኅሓፍ ሓደ ካብቶም ቅልጡፍ ቆላሕታ ዘድልዮም ከባብያዊ ፀገማት እዩ።	()	()	()	()
23.2. ነፍሲ ወከፍ ገዛ ደረቅ ኅሓፍ	()	()	()	()

ብግቡእ ናይ ምእካብን ምጉሓፍን ሓላፍነት ክህልዎ ይግባእ።				
24.3. ግቡእ ምሕደራ ደረቅ ኅሓፍ ጥዑይ ሃዋህው ንምፍጣር ኣገዳሲ እዩ።	()	()	()	()
23.4. ምሕደራ ደረቅ ኅሓፍ ኣብዚ ከተማ ኣንገብጋቢ ዋኒን እዩ።	()	()	()	()
23.5. ምምሕዳር ከተማ ንዘይሕጋዊ ምድርባይ ደረቅ ኅሓፍ ስሩዕ ክትትልን ቁፅፅርን ከካይድ ይግባእ።	()	()	()	()
23.6. ደረቅ ኅሓፍ ኣብ ጥዕና ዕልዋ ኣለዎ።	()	()	()	()
23.7. ደረቅ ኅሓፍ ኣብ ከባቢ ዕልዋ ኣለዎ?	()	()	()	()

ሓምሻይ ክፋል፡ ኣብ እዋን ምእካብን ምጉሓፍን ደረቅ ኅሓፍ ዝፍጠሩ ብድሆታት

24. ኣብ ዞንኹም/ኅን ግቡእ ምሕደራ ደረቅ ኅሓፍ ዶ ይካየድ?
 ሀ እወ () ለ ኣይፋልን ()
25. ንሕቶ ቁፅሪ 24 መልስኹም/ሰን ኣይፋልን እንተኾይኑ፡ ዘይግቡእ ምሕደራ ደረቅ ኅሓፍ ዝፈጥሩ ምክንያታት እንታይ እዮም?
 ሀ ንቕሓት ዘይምህላው () ለ ሸለልትነት () ሐ ዓቕሚ ምጉዳል () መ ካልኣት ()
26. ኣብ እዋን ግልጋሎት ምሕደራ ደረቅ ኅሓፍ ዘጋጥሙ ቀንዲ ፀገማት እንታይ እዮም? (ካብ ሓደ ንላዕሊ ምርጫ ክህልው ይኸእል እዩ)
 ሀ/ ሕፅረት ተሽከርካርቲ ..() ለ.ብቤት ፅሕፈት ማዕጋጃ እኹል ምምዳብ ባጀት ዘይምህላው .() ሐ. ስልጠና ንቕሓት ዘይምህላው....()
27. ሕግታትን ስርዓታትን ምሕደራ ደረቅ ኅሓፍ እዚ ከተማ ትፈልጡ/ጣኦ ዶ?
 ሀ እወ () ለ ኣይፋልን ()
28. ኣብ ምሕደራ ደረቅ ኅሓፍ ደንቢ ዝጥሕሱ ሰባት ክቕፅዑ ከለዉ ርኢኹም/ክናኦ ትፈልጡ//?
 ሀ እወ () ለ ኣይፋልን ()
29. ኣገልግሎት ምሕደራ ደረቅ ኅሓፍ ኮሙን ከተማ ዓዲግራት ብኸመይ ትመዝኖ?
 ሀ. ኣዝዩ ልዑል () ለ. ልዑል () ሐ. ማእከላይ () መ. ትሑት ()
30. ንሕቶ ቁፅሪ 29 ዝሃብኩምዎ/ክናኦ መልሲ ትሑት እንተኾይኑ፡ እቶም ቀንዲ ምክንያታት እንታይ እዮም? _____

የቕንዩለይ!