

Title- Evaluating Urban Solid Waste Management Practice: A Case of Adama City, Ethiopia



Nardos Tekla H.

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Urban Planning and Design

Office of Graduate Studies
Adama Science and Technology University

June 2024

Adama, Ethiopia

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Approve of Board of Examiners

I, the advisor of the thesis entitled “**Evaluating Urban Solid Waste Management Practice: A Case of Adama City, Ethiopia.**” and developed by **Nardos Teka H.**; hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

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Declaration

I hereby declare that this MSc Thesis entitled “**Evaluating Urban Solid Waste Management Practice: A Case of Adama City, Ethiopia**” is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

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I, the advisor of this thesis, hereby certify that I have read the revised version of the thesis entitled “**Evaluating Urban Solid Waste Management Practice: A Case of Adama City, Ethiopia.**” prepared under my guidance by Nardos Teka H. submitted in partial fulfillment of the requirements for the degree of Master’s of Science in Urban Planning and Design. Therefore, I recommend the submission of revised version of the thesis to the department following the applicable procedures.

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LIST OF ACRONYMS / ABBREVIATIONS

C&D	Construction and Demolition Waste
DNA	Deoxyribonucleic acid
EPR	Extended producer responsibility
ISWM	Integrated solid waste management
MSE's	Micro and small enterprises
MSW	Municipal solid waste
MSWM	Municipal solid waste management
NGO	Non-governmental organization
PAYT	pay-as-you-throw
PHS	Particularly hazardous substance
PPP	Polluter Pays Principle
SWM	Solid waste management
USM	Urban solid waste management
WtE	waste to energy

Abstract

Improper solid waste disposal is a major problem in most developing country's urban areas. Many studies show that improper solid waste management causes hazardous health, social, environmental and economic impacts on human beings. By using and applying different techniques and methods, the study analyzes solid waste management problems of Adama City. The study used a pragmatism research method. While secondary data was gathered from various quantitative and qualitative materials, primary data were gathered through field observation and interviews that were complemented by self-administered questionnaires. Data from primary and secondary sources were used and analyzed with statistical tools. This study investigates the status of solid waste generation and the composition of some selected neighborhoods/woredas in Adama City, Ethiopia. Based on the study findings solid waste generation in the city is highly affected by the average income, education, family size, house ownership, and reuse/recycling, and composting levels of waste sources. While disposal of solid waste is affected by education level, average income, the level of awareness of individuals, accessibility to training, municipal supervision, and participation of individuals in the cleanup campaign. Due to absence of effective close supervision and monitoring of the sanitation coordination team/experts especially the MSEs the local communities of the city complain about the service they are getting from the municipality. Most of society is not satisfied with the existing municipal solid waste management system. Consequently, some of the residents are obliged to choose illegal dumping as their main SW disposal system. The study conclude that despite the fact that the implementation of SWM practices in the city could hardly be in better shape and SWM in the city has various environmental, social, legal and economic problems. On the basis of the aforementioned findings, it was recommended that suitable solutions for solid waste management should be developed that meet both the general public's expectations and scientific alternatives that are supported by additional research findings.

Key words: environmental contamination, open dumping, urban quality of life, public awareness

CHAPTER ONE

1. INTRODUCTION

Every human activity always produces waste, and these wastes are various in type and are different from one section to another. It is the way these wastes are handled, stored, collected and disposed of that can pose risks to the environment and public health (Chris Zurbrugg, 2003). Solid waste in developing nations is referred to as the everyday items used and discarded as garbage. As long as human beings continue to carry out their exercises on the surface of the earth, waste generation is unavoidable. People from all walks of life deal with a variety of materials on a daily basis. They also discard materials that seem outdated or useless, with the majority of these materials ending up in landfills. The fast increment in population, financial development, urbanization and industrialization improves the generation of solid waste at the worldwide level, boosting environmental degradation when such solid waste is not overseen legitimately. Solid waste has expanded in volume all over the world, particularly in developing countries this problem has serious effects on the environment and public wellbeing. The normal way of managing solid waste is causing numerous impacts on the environment, public wellbeing, organization and budgetary issues.

The waste generated by human settlements and the associated problems are similar in developing nations, with variances between regions and locations based on geographic, sociocultural, industrial, infrastructural, legal, and environmental factors (Ahsan et al., 2014). Attention should be paid in developing and transition countries, where the unsustainable management of solid waste is common. Differences should be highlighted between developing big cities and rural areas, where management issues are different, specifically regarding the amount of waste generated and the solid waste management (SWM) facilities available. However, both suffer negative economic, legislatives, political, technical and operational limitations (Ferronato & Torretta, 2019).

Solid waste management (SWM) is a pressing issue for rapidly urbanizing cities around the world, and Adama City in Ethiopia is no exception. The city has experienced significant population growth and urban expansion, leading to increased waste generation and mounting challenges in managing this waste effectively (Tefera & Sterk, 2020).

Solid waste management is a critical issue that impacts communities worldwide, and my motivation to work in this field stems from a deep-seated belief in environmental sustainability and the well-being of societies. Solid waste, if not managed properly, can lead to pollution, health hazards, and ecological degradation. By addressing solid waste management, we can mitigate these negative impacts and create cleaner, healthier environments for current and future generations.

Adama is experiencing rapid urban growth, which has led to an increase in the generation of solid waste. This urbanization presents both a challenge and an opportunity to implement innovative waste management solutions that can keep pace with the city's development. Having grown up in Adama, I have a deep personal connection to the city. I am familiar with its culture, people, and the unique challenges it faces. This personal connection fuels my passion and commitment to improving the city's waste management practices.

By working on solid waste management in Adama, we can make tangible improvements to the city's environmental quality, public health, and overall livability. Implementing effective waste management strategies not only reduces pollution and environmental degradation but also creates opportunities for economic development, job creation, and community empowerment.

In summary, my motivation to work on solid waste management in Adama city is driven by a combination of personal experience, a desire to protect the environment, improve public health, contribute to sustainable development. By focusing my research on Adama, I hope to develop and implement waste management strategies that can serve as a model for other rapidly growing urban areas. My goal is to make a meaningful difference in my hometown, ensuring a cleaner, healthier, and more sustainable future for generations to come.

1.1 Background of the study

Solid waste management (SWM) is a critical aspect of urban planning and environmental sustainability, significantly impacting public health, ecological balance, and the quality of life in urban areas. The rapid urbanization and industrialization witnessed globally have exacerbated the challenges associated with waste management, necessitating innovative and effective solutions (Hoornweg & Bhada-Tata, 2012). Traditional waste management practices, which primarily involve collection and disposal, are increasingly becoming insufficient due to the growing volume and complexity of waste generated (Gupta & Singh, 2022).

Since urbanization characterized by the rapid growth of cities and an increasing concentration of population in urban areas, it presents numerous challenges and opportunities for city management. Among these challenges, solid waste management (SWM) stands out as a critical issue due to its direct impact on public health, environmental sustainability, and urban livability. As cities expand, the volume and complexity of waste generated by households, businesses, and industries grow, complicating efforts to manage this waste effectively (UN-Habitat, 2020). The relationship between urbanization and SWM is multifaceted. On one hand, urbanization leads to increased waste generation due to higher consumption rates and diversified waste streams. On the other hand, it provides opportunities for implementing advanced waste management technologies and practices. However, many rapidly urbanizing cities, particularly in developing countries, face significant barriers such as inadequate infrastructure, limited financial resources, and insufficient policy frameworks (Hoornweg & Bhada-Tata, 2012).

Solid waste mismanagement is a global issue in terms of environmental contamination, social inclusion, and economic sustainability, which requires integrated assessments and holistic approaches for its solution. Attention should be paid in developing and transition countries, where the unsustainable management of solid waste is common. Differences should be highlighted between developing big cities and rural areas, where management issues are different, specifically regarding the amount of waste generated and the solid waste management (SWM) facilities available. However, both suffer negative economic, legislative, political, technical and operational limitations (Ferronato & Torretta, 2019).

According to Chris Zurbrügg (1998) in numerous developing countries, the most common methods of final solid waste disposal are open dumping in uncontrolled locales and the open

burning of waste fractions. These two strategies can be a great arrangement for the time being but they cause the fumble of the leachate produced in the last disposal locales, which imposes serious health risks to humans. This circumstance is declining in slum zones with extra issues of high-density population, activity, and air and water contamination. Uncontrolled disposal in open spaces near water bodies is an issue far reaching in these settings, which compares to public health issues. The environmental consequences of inadequate waste management are well-documented in numerous researches. Air and water pollution, soil contamination, and the release of greenhouse gases contribute to climate change and ecosystem degradation (Li et al., 2019 and Wang et al., 2020).

Based on Ahsan et al., (2014) research on the assessment of solid waste management systems in developing countries, during the last few decades, the problems associated with solid waste management (SW) have acquired an alarming dimension in developing countries. The high population growth rate and increase in economic activity in urban areas of developing countries combined with the lack of training in modern solid waste management practices complicate efforts to improve solid waste management services.

In developing countries, the per capita generation of solid waste in urban residential areas is much less compared with the developed countries; however, the capacity of the developing countries to collect, process, dispose of, or reuse the solid waste in a cost-effective manner is significantly limited compared with the developed countries. Numerous studies highlight the persistent challenges associated with solid waste management. Lack of infrastructure, inadequate funding, and issues related to waste composition are recurrent themes (Pires and Martinho 2017).

Solid waste management involves the collection, transport, processing, recycling, or disposal of waste materials. Effective SWM aims to reduce the adverse effects of waste on human health and the environment. According to Tchobanoglous et al., (2014), SWM encompasses various activities, including waste generation, storage, collection, transfer and transport, processing, and disposal. The hierarchy of waste management prioritizes waste prevention, followed by reuse, recycling, recovery, and disposal (EPA, 2021).

Modern SWM strategies emphasize a comprehensive approach that includes waste minimization, recycling, resource recovery, and environmentally sound disposal methods. The waste management hierarchy, which prioritizes waste prevention, followed by reuse, recycling,

recovery, and disposal, serves as the guiding principle for sustainable waste management practices (EPA, 2021).

Recent advancements in technology have opened new avenues for improving SWM efficiency and sustainability. Smart waste management systems, which utilize sensors and data analytics, have enhanced the efficiency of waste collection and processing operations (Kumar et al., 2023). These systems can optimize collection routes, monitor waste bin levels, and predict waste generation patterns, thereby reducing operational costs and environmental impacts.

Recycling and resource recovery remain pivotal in the quest for sustainable SWM. Innovations in recycling technologies, such as automated sorting systems and advanced material recovery facilities, have significantly improved the quality and efficiency of recycling processes (Liu et al., 2022). Additionally, the development of waste-to-energy (WtE) technologies offers a dual benefit of waste reduction and renewable energy production. Techniques like anaerobic digestion, incineration, and gasification convert waste materials into energy, thereby reducing landfill dependence and contributing to energy sustainability (Tan et al., 2023).

Policy and regulation also play a crucial role in shaping effective SWM strategies. Governments and municipalities are increasingly adopting policies that promote sustainable waste management practices, such as extended producer responsibility (EPR) and pay-as-you-throw (PAYT) schemes. These policies incentivize waste reduction and recycling by holding producers accountable for the end-of-life management of their products and charging consumers based on the amount of waste they generate (Gupta & Singh, 2022).

Public awareness and participation are other essential components of successful SWM strategies. Educational campaigns and community engagement initiatives are crucial for fostering responsible waste management behaviors among citizens (Kumar et al., 2023). By raising awareness about the environmental and health impacts of improper waste disposal and the benefits of recycling and waste reduction, these initiatives can drive significant improvements in waste management practices at the community level.

In general, addressing the challenges of solid waste management requires a multifaceted approach that integrates technological advancements, effective policies, public participation, and innovative waste processing techniques.

1.2 Statement of the problem

Solid waste management is a challenge for the cities' authorities in developing countries mainly due to the increasing generation of waste, the burden posed on the municipal budget as a result of the high costs associated with its management, and the lack of understanding over a diversity of factors that affect the different stages of waste management and linkages necessary to enable the entire handling system to function (Kumar & Banerjee, 2020). Inappropriate solid waste management (SWM) might be a major public health and natural concern within the urban zones of various fast-growing cities in so called developing countries. The issue of solid waste management (SWM) is more critical in the metropolises of many low-income countries, which are confronted with rapid and unplanned urbanization as well as a high incidence of poverty (Kubanza & Simatele, 2019). In Ethiopia, there is a big deficit in solid waste management, and it has become a very alarming problem in our cities.

Adama City, one of Ethiopia's rapidly urbanizing centers, is facing significant challenges in managing its solid waste effectively. The city's population growth, urban expansion, and economic activities have led to an increase in waste generation, which is not being managed sustainably.

The efficiency of waste collection in Adama is a significant issue, with current systems only managing to collect about 65% of the waste generated daily (Beyene et al., 2021). Open uncontrolled dumping and open burning are very common ways of household solid waste and municipal solid waste disposal methods in the city. Also the city lacks sufficient proper places for solid waste collection and disposal. The collected solid waste is disposed of in residential, commercial, public areas and furthermore, on the corners of roads or streets. This leaves a considerable amount of waste uncollected, which contributes to environmental pollution and public health hazards. The extent of this problem is so severe that most of the residents are obliged to live around these unsanitary areas, thereby highly exposing themselves to the risk of becoming victims of environmental, social and health problems. In addition, this situation has made a great contribution to widespread pollution (air pollution, soil pollution and water pollution) and related social problems.

Adama City generates approximately 200 tons of solid waste per day, primarily composed of organic material, which constitutes around 60% of the total waste stream (Tefera & Sterk, 2020).

This high volume of waste, coupled with the organic nature of much of it, presents unique challenges and opportunities. However, the city's limited capacity to process and utilize this organic waste for composting or biogas production results in substantial environmental and health risks.

Over the years, several studies and projects have focused on addressing the solid waste management (SWM) challenges in Adama City. These efforts have ranged from academic research to practical interventions aimed at improving waste collection, recycling, and disposal processes.

For example, a study by Tefera and Sterk (2020) analyzes the waste composition and generation rates in Adama City and Provide critical data necessary for designing targeted waste management strategies such as composting and biogas production. While projects by Local NGOs (Beyene et al., 2021) focus on educating residents on waste segregation and recycling and demonstrated the positive impact of community engagement and education on SWM practices.

Study by Beyene et al. (2021) investigated the efficiency of waste collection and transportation in Adama and highlighted the operational inefficiencies and the need for better logistical planning and modern equipment. On the other hand a study by Tefera and Sterk (2020) evaluated the existing SWM infrastructure, including landfills and brought attention to the critical state of landfill management and the need for improved infrastructure.

The above studies and other various studies and projects aimed at addressing solid waste management (SWM) challenges and discuss potential solutions or strategies. These efforts have provided valuable insights into the city's waste management issues and have proposed several strategies for improvement. However there remain significant gaps that hinder the effective management of solid waste in Adama. These include the need for longitudinal data on waste generation, detailed infrastructure development plans, scalable community initiatives, specific policy recommendations, and strategies for integrating new technologies with existing systems. Addressing these gaps is crucial for developing a more effective and sustainable SWM system in Adama, ultimately enhancing environmental quality and public health.

Thus, this paper attempted to fill these gaps and to study varying problems seen in Adama city in relation to solid waste management practice.

1.3 Research objective

1.3.1 General Objective

The general objective of this study is to evaluate urban solid waste management practice in Adama City.

1.3.2 Specific Objective

The specific objectives of the study are:

- To examine the process being employed in the collection and disposal of solid waste in Adama City.
- To assess public perception and behaviour regarding SWM in Adama City.
- To explore underlying factors affecting the process of solid waste management in Adama City.
- To propose an alternative planning approach in response to the existing solid waste management in Adama City

1.4 Research questions

Based on the current reality of the waste collection and disposal process, policy and legal frameworks, practices, and problems in Adama city, this research attempts to provide relevant information that will help in studying the current solid waste management circumstances in Adama city. The information includes several community and municipality legislations and policies, community behavior, environmental and social surveys on the targeted city. As a result, the study attempts to respond to the following major inquiries:

1. How has solid waste in Adama City been collected and disposed of?
2. What is the level of societal perception and attitude regarding the management of solid waste in Adama City?
3. What are the potential factors affecting the process of solid waste management in Adama City?
4. What is the most effective planning strategy to address the issues with solid waste management in Adama City?

1.5 Significance of the study

Through the comprehensive exploration of this study, improper solid waste management and its impact on the environment and public wellbeing will be assessed. In addition, the study will try to cover the methods to increase public understanding and give a higher appreciation for the importance of proper solid waste disposal and management options. This study will help other researchers explore the problem in more depth, depending on the current state of the problem.

Generally, the study will contribute a solid understanding of solid waste disposal and management problems in Adama City and their impact on the environment and human beings. This research will help to improve the current state of the city's solid waste management problems and the findings of this study will directly benefit the city's municipality and the people.

1.6 Scope of the research

The geographic scope of this research is limited to Adama City, Oromia Regional State of Ethiopia. The study is carried out in a few chosen neighborhoods. The scope of the study is that, after assessing and identifying the status, development, management challenges, present problems and people's awareness associated with solid waste management in Adama city, the study will come up with strategic recommendations and conclusions for a proper solid waste collection and final disposal system. Additionally, the study reviews methods used in the solid waste collection and disposal system of the city, and it will review major problems in the process of urban waste management in the city.

In order to provide a thorough understanding of the waste stream and effective waste management strategies, it is important to consider a wide range of waste streams while choosing a research area. It can also help to gather comprehensive data on the waste composition and design effective solid waste management strategies tailored to the specific needs of the region. The following are some of the key waste categories that the study considered:

- **Municipal Solid Waste (MSW):** This includes household waste, commercial waste, and institutional waste. Designing suitable disposal and recycling facilities requires an understanding of MSW composition.
- **Construction and Demolition Waste (C&D):** these wastes Generated from

construction and demolition activities, including include concrete, wood, metals, and other materials. In order to lessen environmental effect and encourage recycling, proper management of these wastes is crucial.

- Organic Waste: This includes food waste, yard waste, and other biodegradable materials. Developing strategies for composting or anaerobic digestion can help reduce the environmental impact of organic waste.
- Plastic Waste: Given the global concern about plastic pollution, understanding the types and volumes of plastic waste in a particular area is important for designing effective recycling programs.
- Electronic Waste (e-waste): Discarded electronic devices and components can contain hazardous materials. Given the increasing volume of e-waste, it's important to consider the safe disposal and recycling of electronic products.
- Special Wastes: Certain wastes, such as tires, batteries, and fluorescent bulbs, fall into special categories that require unique disposal methods due to their potential environmental impact.

Based on the above waste streams and their economic activities, population size, availability of solid waste disposal facilities and solid waste production amount Hangatu, Gada, Dabe Souloqee, Bokkuu Shanan, Odaa, Dagaagaa, Irreechaa and Biqa are the selected woreda for the research.



Fig. 1. Selected sites for the study

Source: Adama city administration office

1.7 Limitation of the research

- **Research areas:** Since the research data collection depends on having access to some solid waste dumping areas, there were some limitations because of some serious negative environmental and social impacts. These impacts incorporate terrible odor, infectious infections and interaction with the individuals who live around the range. However, the necessary information was obtained with the assistance of those who live in the area.
- **Measure used to collect the data:** After completing the elucidation of the findings, the way in which the assembled information inhibited the capacity to conduct an exhaustive analysis of the results. For a few reasons, there were some specific questions that were not included in the survey, which could have made a difference in addressing a particular issue that emerged afterward within the study.
- **Access:** The process of data gathering includes having access to people, organizations, municipal data, or documents. Lack of these data or reliable data limits the scope of the

analysis. Yet the research tried to cover the missing parts from other recently done studies and projects.

- **Language:** Since Oromiffaa is the state working language, there were some difficulties in the process of translating documents from governmental offices to Amharic and English.

1.8 Organization of the Study

The thesis is organized into five chapters. Each chapter systematically and effectively examines the content and data of the study accordingly. The fundamental chapter in the thesis is further demonstrated as follows.

Chapter One: Introduction to the study introduces the thesis by lighting the main topic of the study, research problem, objectives, research question, significance, scope, limitation and organization.

Chapter Two: Literature Review is a chapter that discusses key definitions about solid waste management and includes conceptual definition of terms, theoretical literature review, gaps of literature review, review of empirical review.

Chapter Three: is a Research Methodology which discusses the methodologies used in the research. It covers research approach, research methodology, methods of data collection, type and source of data, sampling, sample size, analysis technique and description of study area.

Chapter Four: Result and Discussion is a chapter that discusses the results of qualitative and quantitative data findings. Subjective quantitative data are gotten from field observation, topographic maps. The qualitative data are analyzed based on a questionnaire survey, field observation notes, and printed documents.

Chapter Five: Conclusion and recommendation is the concluding part of the research. The chapter made a conclusion based on the findings. The study concludes the results and discussion as well as it stated four recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter is to provide a general theoretical framework about solid waste management and its impact in Adama city; related to this, it also presents the actualities of previous findings, equivocalness, and arguments about the concept that has been researched. In addition, it clarifies more empirical concepts about the general concept of solid waste management practices and solid waste collection in the final transfer process. This method helps to analyze the affect successfully.

2.2 Conceptual Definition of terms

Municipal solid waste: Municipal solid waste (MSW) is defined as waste collected by the municipality or disposed of at the municipal waste disposal site and includes residential, industrial, institutional, commercial, municipal, and construction and demolition waste (Hoornweg et al., 2015).

Municipal solid waste management (MSWM): includes the collection, transfer, resource recovery, recycling, and treatment of waste. The main target is to protect population health, promote environmental quality, develop sustainability and provide support for economic productivity (Jaison Chatsiwa et al., 2016).

Contract: An agreement between two or more parties regarding the delivery of works, supplies, or services related to SWM that is written and enforceable by law.

Competent authority: Any person or organization that has the legally delegated or invested authority, capacity, or power to perform (or delegate the performance of) a designated function. The competent authorities for waste management in Ethiopia are the regional and municipal governments.

Open burning: open burning is the burning of unwanted material in the open air where smoke and toxic fumes are released directly into the atmosphere, therefore affecting the environment. Often, such practice is done outdoors, where household waste materials are burned as a means of

waste disposal, away from an incinerator or a furnace chamber. The lack of a chimney or stack predisposes the atmosphere to more air pollution from open burning (Disastrous Effects and Solutions of Open Burning, n.d).

Open dumping: An open dump is an illegal waste disposal site and should not be confused with a permitted solid waste landfill or a recycling facility. If allowed to remain, open dumps often grow larger and may attract the dumping of both solid and hazardous wastes (Open Dumping, n.d.).

Environmental contamination: Environmental contaminants are any physical, chemical, biological, or radiological substance or matter that has an adverse effect on air, water, soil, or living organisms (Environmental Contaminants, 2019)

Guideline: A document or set of materials that provides direction or advice as to a decision or course of action for improving SWM systems.

Hazardous waste: A liquid, solid, enclosed gas, or sludge waste with qualities that are damaging to human health or the environment.

Integrated solid waste management (ISWM): a coordinated use of a set of waste management technologies or methods, each of which can play a part in a larger municipal solid waste management system and which come together to form a recognizable system.

Litter: trash, such as paper, cans, and bottles that is left lying in an open or public place. Other names include garbage, refuse, junk, waste, debris, scraps, detritus, trash, and rubbish.

Policy: A plan or course of action set by the government intended to influence and determine decisions, actions, and practices in the SWM sector.

2.3 Theoretical literature review

In this section, the study investigates truths and hypotheses that offer assistance to the issue beneath the study area reviewed and presented underneath.

Solid waste management (SWM) is a critical aspect of urban and rural development, encompassing the collection, transportation, processing, and disposal of solid waste. As global populations continue to grow and urbanization accelerates, effective SWM becomes increasingly important for environmental sustainability, public health, and overall quality of life. This literature review aims to synthesize and analyze key research findings, methodologies, and trends

in the field of solid waste management, focusing on various aspects of waste generation, collection, treatment, and disposal.

2.3.1 Solid Waste Generation

Solid waste generation is a critical issue in contemporary urban management, driven by rapid population growth, urbanization, and changing consumption patterns. Understanding the dynamics and determinants of solid waste generation is essential for developing effective waste management strategies.

Solid waste generation is an unavoidable byproduct of every operation involving the usage of resources, extraction of raw materials, manufacture of products, consumption, and waste management all generate wastes (Chris Zurbrugg, 2003). Recent studies indicate that solid waste generation is increasing globally, with significant variations across regions and countries. According to Kaza et al. (2018), global solid waste generation is projected to rise from 2.01 billion metric tons in 2016 to 3.40 billion metric tons by 2050. This growth is particularly pronounced in low- and middle-income countries due to urbanization and economic development. In high-income countries, waste generation rates are relatively stable but remain high due to high consumption levels. For instance, the United States generates about 4.5 pounds of municipal solid waste per capita per day, primarily consisting of paper, food, and plastic waste (EPA, 2021). On the other hand low- and Middle-Income Countries are experiencing rapid increases in waste generation. Sub-Saharan Africa and South Asia are projected to see their waste generation double by 2050, driven by urban population growth and changing consumption patterns (Kaza et al., 2018).

Several factors influence the amount and composition of solid waste generated, including economic development, urbanization, population growth, and consumption habits.

Economic Development: Economic growth is closely linked to waste generation. As incomes rise, consumption patterns shift towards more packaged goods and higher volumes of waste. Cheng and Urpelainen (2021) found that economic growth in emerging economies leads to a significant increase in per capita waste generation.

Urbanization: Urban areas tend to generate more waste per capita than rural areas due to higher consumption levels and different lifestyle patterns. Urbanization also leads to the concentration

of waste generation in cities, posing significant management challenges (Hoornweg & Bhada-Tata, 2012).

Population Growth: Increasing population directly contributes to higher total waste generation. Rapid population growth in urban areas exacerbates the pressure on waste management systems (Kaza et al., 2018).

Consumption Habits: Changes in consumption habits, influenced by cultural, social, and economic factors, affect the volume and composition of waste. For instance, increasing consumption of processed and packaged foods leads to higher levels of plastic and organic waste (EPA, 2021).

2.3.2 Solid Waste Collection and Disposal System Methods

Inappropriate solid waste collection and disposal can create unsanitary conditions, and these conditions in return can lead to contamination of the environment and to flare ups of vector-borne illnesses, that's, diseases spread by rodents and creepy crawlies. The assignments of solid-waste management show complex specialized challenges. It also poses a wide assortment of authoritative, financial, and social issues that must be overseen and solved.

Effective solid waste collection and disposal methods are essential for managing the increasing volumes of waste generated by growing urban populations. The collection, transportation and disposal of solid waste are the most important and costly aspects of the process because of the labor intensity of the work and the massive use of vehicles in the collection and transportation process (Amponsah and Salhi, 2004).

The proper way of collecting and disposing of solid waste includes waste generation, waste handling at the source, waste collection, waste transport and then final disposal. However, in most of the developing countries, the trend of municipal solid waste collection and the final disposal process is a little bit different from this. There are various solid waste collection and disposal system methods.

Solid Waste Collection Methods

Door-to-Door Collection: Door-to-door collection is a prevalent method where waste collectors visit households to collect waste directly from residents. This method ensures high participation

rates and can significantly reduce littering. Guerrero, Maas, and Hogland (2013) found that door-to-door collection systems are effective in urban areas with high population density, providing convenience to residents and reducing the incidence of illegal dumping.

Curbside collection: involves residents placing their waste in designated containers or bags at the curbside, which are then collected by waste management personnel. This method is widely used in many developed countries due to its efficiency and cost-effectiveness. Sarkar (2017) noted that curbside collection could be optimized by using segmented collection schedules and designated collection days, which helps in managing the volume and flow of waste.

Communal collection: these points are designated areas where residents can dispose of their waste in shared containers. This method is often used in densely populated urban areas or informal settlements. While it reduces the need for extensive door-to-door services, it can lead to challenges such as overflowing bins and increased littering if not properly managed. Zurbrügg et al. (2012) highlighted that communal collection points require regular maintenance and community involvement to be effective.

Automated collection systems: include pneumatic waste collection, use a network of underground pipes to transport waste from individual collection points to a central collection station. This method reduces the need for waste collection vehicles and can minimize traffic congestion and emissions. Inghels, Dullaert, and Jacobs (2016) demonstrated that automated systems are highly efficient in high-density urban areas, though they require significant upfront investment and maintenance.

Solid Waste Disposal Methods

Landfilling: is one of the most common methods of solid waste disposal, where waste is buried in designated landfill sites. Modern landfills are designed with liners and leachate collection systems to minimize environmental impact. However, landfilling remains controversial due to issues such as land use, methane emissions, and long-term environmental degradation. Hoornweg and Bhada-Tata (2012) emphasized that proper management and regulation of landfills are crucial to mitigate their environmental impact.

Incineration: it involves burning waste at high temperatures to reduce its volume and mass. This method can generate energy in the form of heat or electricity, making it an attractive option for

waste-to-energy (WtE) initiatives. However, incineration also produces emissions that need to be controlled to avoid air pollution. Tan et al. (2015) showed that advanced incineration technologies with emission control systems can be effective in managing waste and generating energy, though they are often costly to implement.

Recycling and resource recovery: aim to convert waste materials into reusable products, reducing the need for raw materials and minimizing waste sent to landfills or incinerators. This method includes the separation and processing of recyclable materials such as paper, plastics, metals, and glass. Liu, Wang, and Zhang (2022) found that recycling programs are highly effective when combined with public education and robust infrastructure for material recovery facilities (MRFs).

Composting: is the process of decomposing organic waste, such as food scraps and yard waste, into nutrient-rich compost that can be used to improve soil health. This method is particularly effective for managing organic waste, which constitutes a significant portion of municipal solid waste. Adhikari et al. (2010) found that composting programs can significantly reduce the volume of waste sent to landfills and provide valuable organic material for agriculture.

Integrated waste management system: combines multiple methods of collection and disposal to optimize the efficiency and sustainability of SWM. This approach involves the coordination of various processes, including waste reduction, recycling, composting, incineration, and landfilling, to achieve the best environmental and economic outcomes. Wilson, Velis, and Rodic (2015) highlighted that integrated systems require comprehensive planning, stakeholder engagement, and continuous monitoring to adapt to changing waste generation patterns and technological advancements.

In the process of urban solid waste management, the city authority is generally responsible for the administration of SW within the city corporation zones. For the most part, it consists of two utilitarian departments—conservancy and engineering departments (Ahsan. et al., 2014). Based on the study, the conservancy division administers the waste intensive workers for collection and transfer, whereas the engineering department is capable of operation and maintenance operations involved within the waste administration cycle such as collection, on-site storage and transportation vehicles, and ultimate disposal destinations. The salaries of drivers and helpers of waste transfer vehicles are additionally maintained by the engineering section but the salaries and wages of wastes intensive laborers are maintained by the conservancy department.

2.3.3 Conventional Solid Waste Management System

Conventional solid waste management systems typically involve a set of established practices for the collection, transportation, and disposal of solid waste (Pires and Martinho (2017). While specific approaches may vary by region and country, the conventional system often follows a similar framework. Here is an overview of the key components of a typical conventional solid waste management system:

a. **Waste Generation:**

Sources: Solid waste is generated from various sources, including households, commercial establishments, industries, and institutions.

Composition: The waste generated is diverse and can include household waste, commercial and industrial waste, construction and demolition debris, and special wastes like electronic waste.

b. **Waste Collection:**

Collection Points: Collection of waste typically begins at designated collection points such as households, commercial areas, and public spaces.

Collection Methods: Municipalities deploy waste collection vehicles and personnel to gather waste from these points on scheduled routes.

Separation: In some cases, waste may be separated at the source into recyclables, organic waste, and non-recyclables.

c. **Waste Transportation:**

Collection Vehicles: Once collected, waste is transported using specialized vehicles, such as garbage trucks, to transfer stations or directly to disposal sites.

Transfer Stations: In some systems, waste is first taken to transfer stations, where it may be consolidated before being transported to the final disposal site.

d. **Waste Disposal:**

Landfills: Historically, landfills have been a common method of waste disposal. Solid waste is deposited in designated areas and covered with soil regularly.

Incineration: Some regions use waste-to-energy incineration plants where solid waste is burned

to generate energy. This method reduces the volume of waste and produces energy but may raise environmental concerns.

Dumping Sites: In some cases, particularly in low-income regions, waste may be disposed of in open dumping sites, posing environmental and health risks.

e. Landfill Management:

Site Selection: Landfills are often carefully selected based on environmental considerations, such as distance from residential areas, soil composition, and groundwater conditions.

Environmental Controls: Landfills may implement various environmental controls, including liners to prevent leachate migration and gas collection systems to capture methane emissions.

f. Waste Minimization and Recycling:

Awareness Programs: Some systems include public awareness programs to promote waste reduction, reuse, and recycling.

Recycling Facilities: Conventional systems may have designated facilities for processing recyclables, where materials like paper, plastics, glass, and metals are sorted and processed for reuse.

g. Regulatory Framework:

Legislation and Policies: The conventional solid waste management system operates within a regulatory framework that includes national and local legislation, policies, and guidelines.

Enforcement: Regulatory bodies enforce waste management regulations, ensuring compliance by waste generators, collectors, and disposal facilities.

While the conventional solid waste management system has been widely implemented, there is a growing recognition of the need for more sustainable and innovative approaches, such as incorporating circular economy principles, promoting source reduction, and exploring advanced waste-to-energy technologies.

2.3.4 Major problems in urban waste management

The sources of solid waste include residential, commercial, institutional, and industrial activities. In most developing countries, in particular in sub-Saharan countries, waste is thrown onto streets and roadways, where it is left to accumulate. The culture of proper waste collection is not well developed and designed in developing countries.

In developing countries, the management of SW is worsened by unsustainable practices that improve environmental contamination and the spread of diseases. In particular, open dumping in uncontrolled sites, open burning of waste fractions, and the mismanagement of the leachate produced in final disposal sites are the main issues detectable. The situation is worsening in slum areas with additional problems of high-density population, traffic, and air and water pollution. Uncontrolled disposal in open spaces near water bodies is an issue widespread in these contexts, which corresponds to public health issues. Concerning open-air final disposal, the main environmental impacts that are detectable are:

- visual impacts,
- air contamination, odors and green-house gasses (GHG) emission,
- vectors of diseases,
- Surface water and groundwater pollution (Ferronato & Torretta, 2019)

For households, the accumulation of garbage is a private problem and a source of disutility. Strategically, households find it in their best interests to dispose of the waste from their premises so that the pollution from garbage is transferred from the private to the social domain. (Banerjee & Sarkhel 2019)

Landfills were designed and operated in a manner that minimized risks to public health and the environment. But in developing countries, landfills are not managed properly and many people live around the landfills. This kind of issue is a big problem in many developing countries, and it has been the main source of many pollution and health problems.

2.3.5 The Challenges of Poor Solid Waste Management

Solid waste management faces multiple challenges with urbanization, climate change and population growth, adding complexity and dynamics to the issue. The concentration of urban waste requires appropriate disposal facilities, infrastructure, and transportation (Ulgiati and Zucaro, 2019). Since over 90% of waste is burnt or dumped in open spaces in low-income nations, the impoverished are disproportionately affected and particularly vulnerable to the global challenge of solid waste management (Rodric et al., 2010). Due to fast urbanization and population growth the yearly output of waste is predicted to rise by 70% from 2016 levels to 3.40 billion tons in 2050. Compared to those in developed nations, residents in developing countries, especially the poor living in urban, are more severely impacted by unsustainably managed waste (Kaza et al., 2018). Poor solid waste management poses a range of challenges that have far-reaching implications for public health, environmental sustainability, and overall quality of life. Here are some key challenges associated with inadequate solid waste management:

Health Risks: Improper solid waste management, which includes trash from both human and animal sources, attracts rodents and other animals and contributes to the spread of infections and diseases. It also causes pollution from chemicals discharged into landfills and greenhouse gasses, plastic garbage, and respiratory diseases (Somani, 2023). Nose and throat infections, breathing difficulties, inflammation, bacterial infections, anemia, reduced immunity, allergies, asthma and other infections are well documented and increased incidences of poor waste management impacts on public health (Sannigrahi, 2016).

Environmental Degradation: open solid waste dumping and open burning have adverse impacts on the environment. Open dumps release methane from decomposition of biodegradable waste under anaerobic conditions. Methane causes fires and explosions and is a major contributor to global warming. Improper disposal of hazardous waste and untreated landfill sites can contaminate the soil, affecting plant and animal life and disrupting ecosystems (Honest & Saria, 2020).

2.3.6 Public awareness and attitude regarding urban solid waste management

Solid waste is one of the most visible, prompt and serious environmental problems facing municipal authorities and the people. Inappropriate solid waste collection and disposal can create unsanitary conditions, and these conditions in return can lead to contamination of the environment and flare-ups of vector-borne illnesses, that's diseases spread by rodents and creepy crawlies. The assignments of solid-waste management show complex specialized challenges. It also poses a wide assortment of authoritative, financial, and social issues that should be overseen and solved. Due to improper administration and lack of public awareness, numerous developing country's cities are generally contaminated and create wellbeing sufferings and visual impacts for general individuals (Sarker et al. 2012) The environmental degradation as well as wellbeing impact of individuals caused by insufficient disposal of waste can be expressed by the defilement of surface and ground water through direct waste contacts or leachate, air contamination by burning of squanders, spreading of illnesses by distinctive vectors like birds, insects and rodents, or uncontrolled discharge of methane by anaerobic deterioration of squander.

Source division may be a vital arrangement in managing the expanding issue of solid waste in social orders. On the off chance that citizens are well educated with respect to how materials ought to be isolated, source segregation of solid waste by the waste generators is not only ecologically much better but, moreover, exceptionally successful and can be advisable (Dulac, 2001). On the other hand, according to (Rai et al. 2016) research, there is no obligation on the part of households to contribute to waste collection administrations; cooperation is deliberate and one can select out at any time. Households that don't take an interest in paid waste collection administrations either dispose of their waste free of charge if the city provides such collection administrations or dump/burn their squander in open spaces. In such circumstances, households that pay municipal solid waste collection expenses endure negative externalities due both to destitute administrations and the unhygienic waste transfer practices of non-participating households.

2.3.7 4R's principle

To maintain strategic distance from this effect of solid waste, the volume of waste dumped in landfills ought to be decreased by imposing secure working practices. In specific, hazardous or poisonous materials ought to be the essential targets for executing the 4Rs (reduce, reuse, recycle and recover) policies.

Proper waste disposal and management can be done by applying the 4R's principle at the individual level. Reducing means decreasing or lessening the amount of waste generated or produced. Reusing refers to using materials more than once. Recycle means creating a new product or material from used materials or garbage, while Recover means diverting waste material or garbage from the waste stream. This principle can reduce the amount of waste dumped and burned in uncontrolled areas.

Uncollected waste is burned (74.1%) or dumped (15.2%) in open places. Some households and individuals practice solid waste recycling, re-use, recovery, composting, and biogas production. There are many waste minimization options with social, economic and environmental benefits recommended by some authors like Mbuligwe and Kassenga (2004) for Tanzania, Mbeng et al. (2009) for Cameroon, Rotich et al. (2006) for Kenya and Wang et al. (2008) for china (Okot-Okumu & Nyenje, 2011).

2.3.8 Theories Related to Waste Management Policies and Governance Structures

Effective policies and governance structures are necessary to address the growing challenges of solid waste management (SWM). Theories related to solid waste management policies and governance structures highlight the importance of multi-level coordination, regulatory frameworks, and community engagement. There are various theories related to solid waste management policies and governance structures. Some of these theories are reviewed below.

The Hierarchical Governance Theory

Hierarchical governance theory emphasizes the top-down approach in policy implementation where higher levels of government set regulations and standards, and local authorities enforce them. According to Bakker, Kooy, and Shofiani (2018), hierarchical governance is effective in

ensuring uniformity and compliance across different regions. This theory suggests that stringent regulations and oversight by central authorities can lead to improved waste management outcomes.

The Network Governance Theory

Network governance theory posits that effective waste management policies result from collaborative networks involving various stakeholders, including government agencies, private sector players, and non-governmental organizations (NGOs). Provan and Kenis (2008) highlight that network governance allows for flexibility, innovation, and shared responsibilities. This approach is particularly beneficial in urban areas where diverse stakeholders must coordinate efforts to manage waste effectively.

The Institutional Theory

Institutional theory focuses on the formal and informal rules, norms, and values that shape organizational behavior and policy outcomes. Scott (2014) argues that effective waste management policies depend on the institutional environment, which includes legal frameworks, regulatory bodies, and cultural attitudes towards waste. This theory underscores the importance of aligning waste management practices with broader institutional contexts to ensure sustainability and compliance.

Role of Local Authorities in Waste Management

Local authorities play a crucial role in implementing waste management policies and ensuring their effectiveness. They are responsible for organizing waste collection services, managing waste treatment facilities, and engaging with the community. Decentralization theory suggests that transferring authority and responsibilities from central to local governments can enhance the efficiency and responsiveness of waste management services. A study by Oates (1999) found that decentralization allows local authorities to tailor waste management practices to the specific needs and conditions of their communities, leading to better outcomes.

Local authorities must have the necessary capacity and resources to manage waste effectively. According to Wilson et al. (2015), capacity building involves training local officials, providing adequate funding, and investing in infrastructure. Effective resource allocation ensures that local

authorities can sustain waste management operations and adapt to changing demands.

On the other side regulations are essential for setting standards, enforcing compliance, and guiding waste management practices. Effective regulatory frameworks include laws, policies, and guidelines that define the responsibilities of different stakeholders and establish procedures for waste management. Regulations such as EPR and PPP provide the necessary guidelines and incentives.

Extended Producer Responsibility (EPR) is a policy approach that holds producers accountable for the entire lifecycle of their products, including post-consumer waste management. According to Lindhqvist (2000), EPR encourages producers to design environmentally-friendly products and invest in recycling and disposal processes. EPR has been successfully implemented in various countries to manage electronic waste, packaging, and other materials.

The Polluter Pays Principle (PPP) asserts that those who generate pollution should bear the costs of managing it. This principle is fundamental to many environmental policies and is particularly relevant in waste management. OECD (2011) emphasizes that PPP creates economic incentives for waste reduction and promotes the internalization of environmental costs.

Urbanization, Population Growth, and Solid Waste Management Challenges

Urbanization and population growth are two interlinked phenomena that significantly impact solid waste management (SWM) in cities. As urban areas expand and populations increase, the complexity and scale of waste management challenges escalate. There are various theoretical perspectives on how urbanization and population growth contribute to SWM issues.

Urban Metabolism Theory

Urban metabolism theory conceptualizes cities as living organisms that consume resources and produce waste. This perspective helps to understand the flow of materials and energy within urban systems and the resulting waste generation. According to Kennedy, Cuddihy, and Engel-Yan (2007), urban metabolism provides a framework for analyzing how urban growth and development patterns influence waste production. As cities grow, their metabolic processes become more complex, leading to increased waste generation and challenges in managing it efficiently.

Ecological Modernization Theory

Ecological modernization theory suggests that environmental issues, including waste management, can be addressed through technological innovation and institutional reforms. This perspective posits that urbanization, while contributing to waste generation, also provides opportunities for implementing advanced waste management technologies and policies. Mol and Spaargaren (2000) argue that cities can leverage their economic and institutional resources to develop sustainable waste management practices that mitigate the negative impacts of urbanization.

Sustainable Urban Development Theory

Sustainable urban development theory emphasizes the need for cities to balance economic growth, social equity, and environmental protection. This theory advocates for integrated planning and policy approaches that consider the long-term impacts of urbanization on waste management. According to Allen, Broto, and Rapoport (2012), sustainable urban development requires a holistic approach to SWM that includes waste reduction, recycling, and efficient disposal methods. This perspective highlights the importance of sustainable practices in managing the waste generated by growing urban populations.

Demographic Transition Theory

Demographic transition theory explains the changes in population growth patterns over time, typically transitioning from high birth and death rates to low birth and death rates. In the context of SWM, this theory helps to understand how different stages of population growth impact waste generation and management needs. According to Montgomery (2008), as cities undergo demographic transitions, the quantity and composition of waste change, necessitating adaptive waste management strategies to address the evolving challenges.

Systems Theory

Systems theory views cities as complex, interconnected systems where population growth impacts various subsystems, including waste management. This perspective highlights the interdependencies between population dynamics and waste management practices. According to Meadows (2008), systems theory can be used to model the interactions between population growth, waste generation, and management capacities, providing insights into potential

bottlenecks and opportunities for optimization. This approach helps to identify leverage points where interventions can improve the overall efficiency of SWM systems.

2.4 Review of empirical studies

Solid waste management is a critical aspect of environmental sustainability, with far-reaching implications for public health, ecological integrity, and resource conservation. This review synthesizes findings from empirical studies to provide insights into current trends, challenges, and best practices in solid waste management.

Several studies (Ahsan et al. 2014; Chris Zurbrugg, 2003) examined patterns of waste generation in urban and rural settings. Findings suggest that waste composition varies significantly based on factors such as population density, economic development, and cultural practices and also the studies delve into the efficiency of waste collection systems, emphasizing the importance of regular collection schedules and the accessibility of collection points.

Amponsah and Salhi, (2004) contribute insights into waste transportation methods, highlighting the role of technology in optimizing collection routes.

Ahsan. et al., (2014); Ferronato & Torretta, (2019) analyze the effectiveness of waste management policies, highlighting the need for stringent regulations and effective enforcement mechanisms. The study emphasizes the role of extended producer responsibility (EPR) in promoting sustainable waste management practices.

The environmental implications of landfill management are addressed in studies by Sarker et al. 2012, emphasizing the importance of well-designed landfill sites with adequate environmental controls. Challenges such as leachate management and methane emissions are discussed in the context of sustainable landfill practices by Honest & Saria, (2020).

Studies by Mbuligwe and Kassenga (2004) and Dulac, (2001) focus on recycling initiatives, emphasizing the positive impact of community awareness programs on recycling participation.

Empirical studies by Sarker et al. (2012) and Rodic et al., (2010) underscore the significance of community engagement and education in shaping waste management behaviors.

The synthesis of empirical studies reveals a complex landscape of challenges and opportunities in solid waste management. While progress has been made in understanding and addressing

waste management issues, there remains a need for continued research, innovative solutions, and concerted efforts from communities, businesses, and policymakers to achieve sustainable waste management practices.

2.5 Lesson learned and Gap of the literature review

2.5.1 Lesson learned

This research addressed and incorporated different literatures from different journals, articles, publications to achieve the intended aim of the research. Both theoretical and empirical reviews were made. From theoretical review the basics of solid waste management, including waste generation, collection, disposal, and recycling has reviewed and most of literatures provides valuable insights into the complexities and challenges of solid waste management.

This study also learned different solid waste management theories and their respective aspect. The basic relationship between solid waste management, urbanization and population growth has also deeply identified from the theoretical review. Additionally this study learned the importance of integrated solid waste management approaches, community involvement, robust regulatory frameworks, technological innovation, adequate infrastructure, and adaptive systems. From different empirical reviews the study learned different solid waste management techniques and approaches.

In general, from theoretical and empirical review the study understands and learned the process of solid waste management and the need for adaptive and context-specific SWM solutions to address the challenges posed by urbanization and population growth..

2.5.2 Gap of the literature review

Solid waste production and management are becoming major issues in most cities. Solid waste management in urban areas is a complex activity that has a procedure to follow. Like collection, transportation, recycling, resource recovery and final disposal. It is clear that there are several critical studies that have already been done regarding this area especially on household level waste. The studies solve many questions but there are other additional solid wastes (SW), like market place wastes, commercial area wastes, construction wastes and street wastes. The culture, structure, and environmental impact of these wastes are different from one to another. Thus, the researchers have to cover all these wastes.

All the former studies come up with solutions and good critiques of the experience of municipal solid waste management. However, at the country level, there is not enough research on the wastes listed above and on the question of how to change people's attitudes towards this issue.

CHAPTER THREE

MATERIALS AND METHODS

In this chapter, the study provides a selection of research approaches, research design research methods, materials, techniques, analysis methods, sources of data, sampling techniques, data presentation, and instruments for data analysis were discussed in detail. Which are adopted in this specific study and they are highly interrelated with the research questions and the research objective and helped to investigate a lot of research issues likewise. It also determined and explored different techniques of methods that are used in the study and by what means they will be applied to the study

3.1 Description of the study area

According to Adama city profile, Adama is the third largest city in Ethiopia next to Addis Ababa and Direedawa in terms of population size. Adama is the center of different conferences, industrial and commercial activities. Thus, large number of people comes in and out daily which contribute its role in the generation of waste. Adama city is located at a crossroad in the southeast of Addis Ababa, at a distance of 99 kilometers and 84.7 kilometers, respectively, along the all-weather route that connects Addis Ababa to the Djibouti seaport. The city runs astronomically from 80 27' 00" to 80 37' 00" North latitude and 390 12' 00" to "390 27' 00" East longitude at an average altitude of 1700 m above mean sea level, according to information acquired from the Adama municipal land management and development office.



Fig 2. Adama city Administration map and location map

Source: web search

According to the master plan created by the Oromia master planning institute, the city has a total area of 31,287.83 hectares with a compact settlement pattern. The city has 18 woredas and six Sub City administrations. From the 18 woredas, five of them are new woredas due to the city expansion and it is surrounded by hills in the north, east and west.

The topography of the city is invariably mosaic and divided into low-lying centers and hill slopes, according to topographical information obtained from satellite images and aerial photos, as Adama City was established in flat and undulating fertile land that ranges from a completely low-lying center of the city to hilly ridges overlooking the city with their unique landscape scenery circumscribing the city.

The altitude steadily drops/declines from all of the city's outskirts to the city center, where the slopes become milder in the heart of the city, which contains significant swaths of the city. According to the city's current master plan, the city is located between 1500 and 1900 meters above sea level. The city's average elevation/altitude is 1700 meters.

3.2 Research approach

There are many different ways to interpret, conduct and investigate the existing reality with a combination of different approaches that will provide a broad understanding of housing, population, public attitude and awareness of sustainable solid waste management and quantity in terms of the composition of solid waste generated.

The research evaluates the effect of urban solid waste mismanagement on the environment and on individuals. The study involves contracting technical and scientific theories or expert descriptions and assessing human behavior or their day-to-day activities. Since the study combines both numerical and cognitive reasoning, it uses an abductive research approach with highly structured data and the support of well-organized measurement.

Since the research develops and assesses people's experiences, social construction and the existing nature of reality, the scientific methods, observable facts and measurement values, generalization of numbers and causal explanation, the philosophy used in this research is pragmatism

3.3 Research method selection

There are three main methods for research those are: qualitative, quantitative, and mixed methods. For this study, the mixed-method was applied to examine the nature of the problem and use qualitative and quantitative methods to quantify the extent of the problem and assess the people's attitude towards SWM. For this analysis site observation, questioning employees, aerial photographs, literature, focus group discussion, published and unpublished materials, articles and in-depth interviews are the sources of data.

Quantitative Methods

Surveys: Structured questionnaires were distributed to households, businesses, and waste management authorities to gather data on waste generation, segregation, collection, and disposal practices.

Observational Studies: Direct site observation in the means of photography and checklist observation was used as the main data collection methods for the research objectives. The initial data collection approach was a direct and controlled observation, by taking site photos and by filling prepared checklists in which the physical qualities and characters of the neighborhoods were assessed and Using checklist the existing solid waste management practices, SWM facilities, waste points and waste types were evaluated.

Qualitative Methods

Interviews: Semi-structured interviews with key stakeholders, including municipal officials, waste management companies, and community leaders were conducted in order to gain insights into the challenges and effectiveness of SWM practices in the city.

Focus Groups: Group discussions with community members to understand their perceptions, behaviors, and suggestions regarding SWM.

Document Analysis: Review of existing reports, policy documents, and literature related to SWM in the study area.

3.4 Method for data collection

In order to obtain a good representative sample, this study uses both qualitative and quantitative methods /hybrid/ to collect reliable and accurate data.

3.5 Type and source of data

A variety of data types and sources were utilized to gain a comprehensive understanding of waste generation, collection, disposal practices, and related challenges. These data types can be broadly categorized into primary and secondary data.

The primary data's were gathered through fieldwork and direct engagement with participants and it included:

- Well-structured survey
- Open and close-ended questions /Questionnaires/.
- Site observation
- Interviews and
- Actual photos.

Secondary data were obtained from existing records and publications and includes:

- Academic Journals
- Government Reports and Statistics
- Technical Reports and
- Policy Documents.

3.6 Data collection tools

3.6.1 Primary data collection

For the evaluation of the present circumstances of solid waste management in Adama City, a well-structured survey with both open and close-ended questions was arranged. The questionnaire was prepared in English and after that, it got translated to the local and national languages, Amharic and Oromiffaa to guarantee a much better understanding of the residents.

There are 18 woredas (smallest administrative unit in Ethiopia) within the city and purposeful testing was utilized in the rottenest areas of the city that have large market places and foremost-mismanaged regions. Finally, questionnaires will be administered to the chosen households from the chosen residential areas, construction areas, commercial areas, market places and individuals from the street. To choose representative family units, commercial areas, and market places from the preferred woredas, orderly sampling based on the records arranged by the Works and Development Bureau of Oromia Regional State was utilized to choose representative families and owners of market places and commercial areas. The evaluation category for their waste management was very influential, not influential and not very influential and also binary logistic relapse was utilized to decide the potential components for inappropriate solid waste management. Apart from household, market places, individuals and commercial areas assessment questionnaires, interviews and focus group discourses with concerned municipal authorities and the construction bureau of Adama City were conducted.

In addition, the research conducted a few interviews with some of the solid waste collection and disposal unions (micro and small enterprises (MSEs)) who work on Adama City solid waste management.

3.6.2 Secondary data collection

The secondary data collection involves a comprehensive and systematic review of web-based search engines, such as Google, Google Scholar and journals which are employed to search for both historical and recent journal articles on topics of similar existing literature, articles and scholars on the behavior of people disposing of garbage and solid waste management. By taking each literature and categorizing it by the continent or cities and by common problem. After taking each literature analyzing and surveying from each categorized document, it prepared brief note about the problem, the methodology they used and their recommendation. After understanding the different problem and the solution recommended by different scholars, then it choose very close and reasonable conclusion for the study.

3.7 Sampling

To determine the sample size, a formula provided by Taro Yamane was utilized. Assuming the city population size was around 453,832 according to the 2012 EC population and housing

census results of the country. With a confidence level of 95% and a Margin of error (0.05), the sample size of 500 was obtained based on the calculation. The formula used was described as follows

$$n = N / (1 + N (e^2))$$

Where,

N- is the total population

n - is the required sample size

e - is the margin error

Despite the fact that the present land use pattern of Adama City is different, the master plan revision made by the Oromia Project Office in 2004 shows that land use coverage for housing is 40%, open space and environmentally sensitive areas (parks, urban agriculture, recreational resources) are 20%, business and commerce/centers and market places/ 10%, manufacturing and storage are 10%, public facilities, cultural archeological sites and special functions are 10%, and infrastructure, utilities and transportation are 10%. Due to time and cost constraints, this study has focused on selected households, business owners, and individuals.

Among the 500 participants, 300 households were chosen proportionally from 18 woredas, and respondents were drawn at random from each stratum. From commercial centers like malls, hotels, furniture and metal industrials, kiosks, cafes and restaurants totally 34 commercial centers were Selected. This selection cover 17 high-income commercial centers like malls, furniture and metal industrials and hotels on the other hand the rest 17 commercial centers are low-level centers like kiosks, Cattle fattening and small café and restaurants. Other 50 responses were selected for the segment of market place, with 25 respondents in each market places (Amede gebeya and 17 gebeya).

For the construction waste evaluation 50 construction sites were selected and for schools 16 schools were selected. The rest 50 respondents were selected for on street solid waste evaluation.

Multisampling was used to choose the households, proprietors, sites and individuals. The study utilized both clustered sampling and simple random sampling.

3.8 Sample size

The total sample size of the study is 500 people. According to the third population and housing census result of the country the projected population data in 2012 EC, the size of population of the sparkling city of Adama was 453,832 of which the study area has 18 woredas. In this study, various sections of the city were first assessed and observed roughly, and samples for residences, commercial areas, and market places were chosen from the city's central area and expanding areas. The chosen woredas of the city for residences are Hangaatuu, Gadaa, Dabe Souloqee, Bokkuu Shanan. Odaa, Dagaagaa, Irreecha, and Biiqqaa were chosen as the woredas for commercial and market areas. In contrast, random selection was used to conduct individual interviews in the central area of the city. These samples of household owners, business owners, and individuals were chosen in accordance with the criteria established by the researcher. The standards comprise:

- Solid waste streams
- Economical activities of the kebeles
- Population size of the kebeles
- Distance from waste disposal facilities
- Amount of waste production and
- Access to municipal solid waste collection facilities and litterbins

3.9 Data Analysis

The processes of analysis are followed after site observation. Data were gathered carefully in forms of, photography, observation notes and filled checklists. In order to understand existing condition of the solid waste management practice in Adama city, Visual content analysis was conducted. The first step was to visit the existing waste transfer sites, final disposal points, SWM facilities and use photographs which are acquired through phone camera to create a series of images that illustrates relevant neighborhood condition to understand SWM characteristics in the City. The existing physical characteristics of SWM in the City were assessed by the analysis. The visual content analysis was started by identifying photos which have direct relation with solid waste management standards and qualities and physical future of the existing SWM facilities, those photographs were grouped and organized in the form of explaining specific

condition of existing SWM practice to demonstrate this visual assessment was executed. Those photos were independently identified as which they can clearly explore and which have direct relation with the SWM standards as well as streetscape aspects and explored each future.

Checklist analysis depending on SWM standards were also used in this specific research by this analysis the physical condition of the existing SWM practice and condition was measured and by comparative analysis the SWM standards and practice compared with each element listed in the checklist. In general, the result of the analysis was appraised by discussion and narration by images, tables, and maps.

Descriptive data analysis was used to analyze user's perception towards the existing SWM practice. Before analyzing collected questioner data, a reliability test is made to check the consistency of the data the result showed 0.81 which placed good reliability result this explained the collected data were consistent. After checking the consistency questionnaires, the data were analyzed by generating frequency of respondents for each questioners and by making percentages of each responses to each questions.

In this analysis frequencies and percentages were used to understand the perception of users on existing SWM practice in the city to its livability and those analyzed data have been evaluated and interpreted in numbers and percentages in tabular and graph forms. In addition to understand the relationship of two different variables Cross-Tabulation analysis was used in this study. Two variables which has direct relation with each other examined by placing them on row and column and interpreted in percent and frequency. The audiovisual data gathered through interview were analyzed by transcribing in to text form and relating them with the standards and SWM aspects which are highly explain the specific incidence of the SWM practice.

3.10 Ethical Consideration

The permission letter to do the research was shown for different participants before starting data collection. The study was considerably sensitive for respondent's feelings, opinions and dignity. The research objective was carefully addressed for the participants and explained them how the information gets from them used in this research. The study keep confidentiality of any personals participated in this research and addressed the information gather from the participants only used for this specific research.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 Result for the first objective

4.1.1 Urban solid waste collection and disposal system in case of Adama city

According to the survey done by the Adama City Municipality Office, the total volume of waste produced in Adama annually is estimated at around 210,000 m³. The solid waste comes from households (49%), followed by hotels, restaurants, cafes, and bars (16%), commercial establishments such as market places, shops, garages, etc. (13%), industrial and agricultural solid waste (9%) and construction and demolition waste (6%). The remaining categories represent less than 10% of the waste generated. The current waste generation rate is 0.4 kg/capita/day.

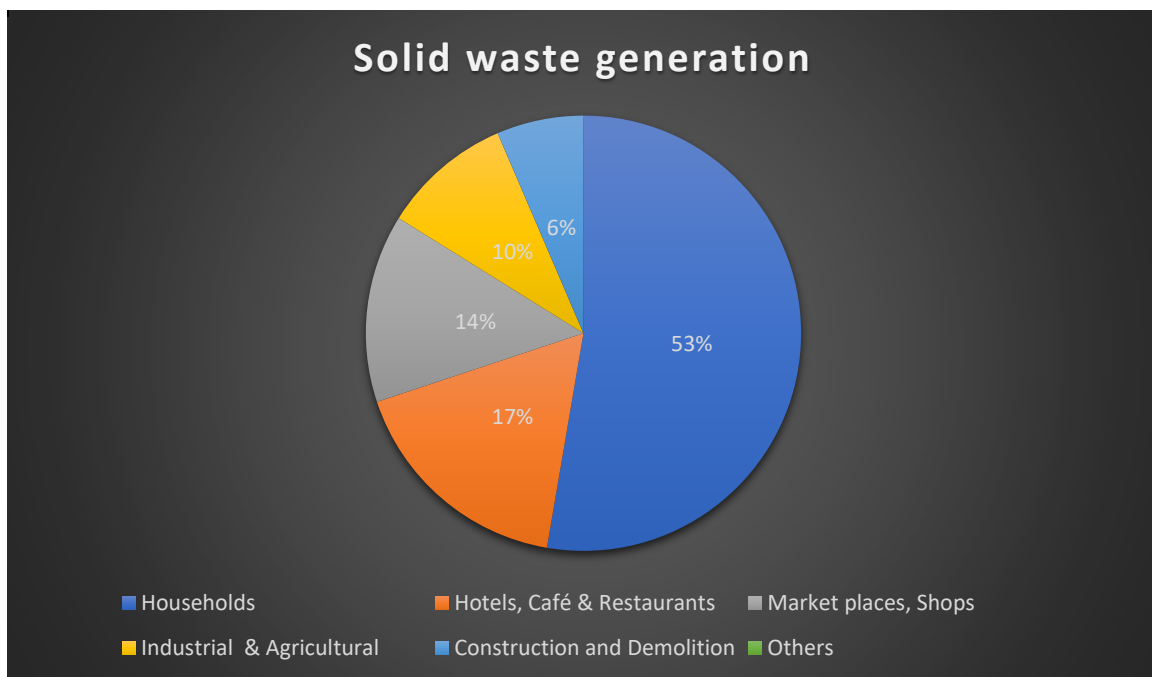


Fig 3. Solid waste generation in Adama city

Source: Adama City Municipality Office

The waste collection process is the most vital and important step in waste management progress because it interfaces the waste producer with the waste collectors. Solid waste collection systems practiced in developing countries is carried out in four ways: communal collection, block

collection, curbside collection and door-to-door collection (UNCHS, n.d.: 11). Based on the findings of the existing waste management practices of the Adama City administration, the following waste collection and disposal system was formulated. It includes waste generation, waste handling at the source, waste collection, waste transport to temporary sites/stations and then final disposal.

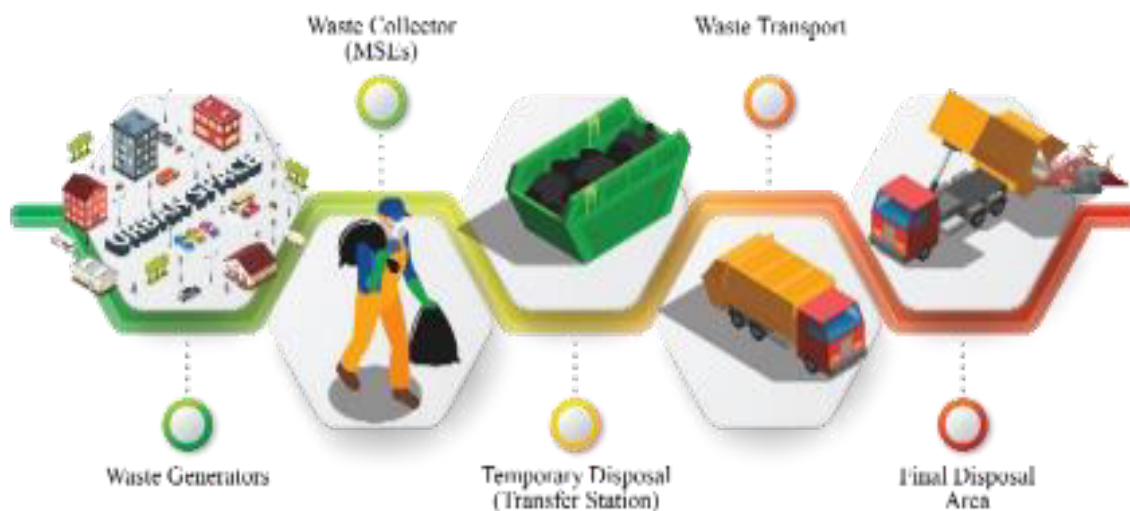


Fig 4. Urban solid waste collection and disposal process of Adama city

As shown in Fig 4. the process of waste collection provided by the municipality starts with door-to-door collection and then the collectors transfer the collected waste to temporary disposal areas/transfer station/waste collection containers and load them on municipal waste collector cars. The pre-collected garbage is then put into containers, which the municipality subsequently transports to the compost preparation plant for the final segregation of decomposable waste. Then, non-decomposable wastes are transported to landfills or final disposal locations by municipal trash transport and disposal vehicles.

Adama City's head of urban beauty and green development stated that starting from the point of waste generation to final disposal, there are two types of collection systems involved, these are primary collection and secondary collection systems.

The primary collection system is collecting solid waste from sources. Materials used to transport the waste from sources to the waste collection containers and the collection of waste varies from one place to another. Polypropylene woven sacks (Madaberiya in the local language) are the major material used for primary collection and other storage materials like metal and plastic

baskets and hard plastic bags.

According to the data collected from the survey the primary solid waste collection service is mainly achieved by MSEs (micro and small enterprises). The municipality set up 51 organized young job seekers or micro and small enterprises (MSEs) who work on this door-to-door solid waste collection process, consisting of 10 members on average. A total of about 5100 youths involved in collecting solid waste from different source streams. These MSEs are almost covering the whole central area of the city. These enterprises utilize a range of small vehicles, like two-wheeler carts, tricycles, handcarts and mechanized carts. Of the 51 enterprises, 21 use mechanized vehicles or truck collection.



Fig 5. MSE vehicles

Source: Site observation 5/26/2022

The frequency of primary collection varies from place to place and by the category of clients. According to the MSE operators, the waste is collected once a week for households living in regular type of houses, twice a week for shops, two/three times a week for households living in condominiums and on a daily basis for hotels and restaurants. The collection fee also varies from one type to another.

The second collection system is done by two parties. They are the secondary collectors (MSEs) and the municipality. The municipality transports the waste from the depot area to the landfill site in two ways. One is done by the use of dump trucks and the second is using skip loaders. The dump trucks are loaded manually at the depot and transport the waste to the landfill site. The skip loaders pick up the waste stored in the skip containers (7 m³ and 8 m³ volume) located at different depots. Skip loaders pick a container at every trip and transport it to the landfill site.

where the skips get empty. The skip containers were transported back empty and replaced at the depot site for the next collection.

Based on the municipality standard and collected data, the skip containers must be empty every day or every two or three days based on the volume of waste collected at the respective depot sites. From the 51-waste collection and transportation enterprises, Five MSEs (secondary collectors) have dump track capacity to transport waste to landfill/open dumping sites. However, it is far from the existing reality. During the site survey, it was observed that a number of skip containers were fully filled with waste, and many people claimed that the skip containers might be untouched for a week or more. In addition, the people state that waste is blown away to the neighborhoods by winds and carried by animals. This situation is highly affecting the environment and the public health of the local communities.



Fig 6. Waste at transferred site

Source: Site observation 5/26/2022

4.1.2 Household solid waste collection and disposal system

However, the survey results in this research indicate that most common household wastes are residues of vegetables and food materials. The waste production of different households varies depending on their living conditions, lifestyles, and incomes, whether they are in urban or rural areas.

The study conducted by the municipality of Adama city administration in 2020 shows that the daily per capita solid waste generation rate of households with low income, middle income, and high-income household is found to be 1.45kg, 2kg, 2.85kg respectively.

Due to their central role in trash generation and their importance as the starting point of the solid waste collection system, households should get special attention. Residential urban solid wastes

are created and handled in ways at the home level that affect their fate later and higher up in the waste chains of garbage collection, transport, and disposal. The municipality offers a door-to-door solid waste collection service for people who live in and around the center of the city.

The regulation for this door-to-door collection of wastes says the collection of waste should be a minimum of two times per week; it says, *“In Adama City, door-to-door collection of wastes from households shall be at a minimum of twice per week, daily from hotels, restaurants and from big commercial centers.”* In the questionnaire, the respondents were asked questions about whether it was enough or not. Here are some responses from the residents of different woredas. *(The answers were chosen based on the person’s brief explanation.)*

W/ro M. a resident from Hangaatuu woreda, says the collectors may not come once a week at all, so sometimes they are obliged to throw away their waste by themselves. In addition to this, she said that during holidays, the volume of waste generation increases because of higher material consumption for the holiday’s celebration, but the municipality didn’t consider this situation, so again, many people are obliged to throw away their waste to the streets, ditches, large gorges and some people who are aware of these MSWM issues put their waste outside their house/ gate by using Madabeira until collection day. Due to this, most of the residential areas got dirty and smelly.

Another resident from Gadaa woreda W/ro Z. says the “waste pickers/collectors came once a week, which is not sufficient. They have to work according to the standard and the regulations set by the municipality but there is no one who controls this situation.”

Ato D. resident from Bokkuu shanan states that there is no door-to-door waste collection around their residential area. They dispose of their household waste in municipal containers and sometimes they dispose of it in large gorges. W/ro A. from Dabe Souloqee also mentions this kind of situation.

The following table generalizes the respondent’s satisfaction level.

Table 1. Satisfaction of solid waste collection system

Date of data analysis: 08/03/2022

Satisfaction of the people	No. of respondents	Respondents by %
Fair	76	25.3
Satisfactory	42	14 %
Unsatisfactory	166	55.3%
Other	16	5.3%

As shown in the above table the survey result in the setting of solid waste collection system 55% of the household's state that they are not satisfied with the existing collection system. On the other hand, 25% of households stated that they are satisfied with the existing collection system; 14% of households said it is fair; and 6% of respondents kept quiet about the collection system.

Although it is inconvenient and not environmentally friendly households use many waste dumping options in order to get rid of their household wastes, such as burning inside their compounds and dumping in open field/drainage canals, and nearby gorges.



Fig 7. Open dumping and Open burning

Source: Site observation 5/24/2022

Home respondents were questioned about where they typically dispose of their household waste in relation to the municipal collection system. The following table provides a summary of the response's outcome.

Table 2. Disposal site of household's solid wastes

Date of data analysis: 08/03/2022

Disposal site	No. of respondents	Respondents by %
In open field	11	3.67%
Burning inside the compound	9	3%
In open drainage canals	5	1.67%
In municipality container/ collection system	239	79.6%
In nearby gorges	36	12%

The above result shows that only 20.4% of the respondents do not use municipal solid waste collection systems. The majority of the respondents (79.6%) use municipal solid waste collection systems.

The respondents were questioned in the survey about the materials they use for short-term waste storage for primary collection, and they were given options to choose from.

Table 3. Storage materials for household solid wastes

Date of data analysis: 08/03/2022

Storage material	Amount	Percentage
Sacks/ Madaberiya	200	66.67%
Hard plastic bags	40	13.3%

Basket	52	17.33%
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According to the results, the majority of respondents (66.7 percent) utilize sacks or "Madaberiya." Furthermore, a sizable portion of respondents (17.3%) use baskets. Hard plastics or small plastic bags are used by 13.3 percent of the sampled population, and metal and plastic pails are used by 2.7 percent of the respondents as alternative collection methods.



Fig 8. Solid waste collection materials in Residential areas

Site observation 5/29/2022

A question regarding the understanding of 4R's principle was posed to every home surveyed. Many households follow certain concepts without being aware of them. In the table below, the principles applied are presented.

Table 4. 4R's principal application

Date of data analysis: 08/03/2022

4R's principle	Used in households
Reduce	✓
Reuse	✓
Recover	✓
Recycle	-

Many households use more than one principle. The most commonly used principles are reuse and recover. The residents reuse many materials after using the original products. These include:

- Reusing glass, plastic or metal cans as storage for solid elements in the kitchen; ▪ Reusing glass and plastic gallon containers for water and oil storage; ▪ Reusing aged plastics and metal materials for gardening purposes. ▪ Reusing cotton or plastic bags for shopping
- Reusing electronics devices after repairing,
- Charitable donations of used clothes, left over foods and other stuff

The other widely used principle in households is recovery. Miss E. resident from Hangaatuu woreda, stated that most of the residents around her area always recover their organic wastes for animal food and compost purposes. She said, “We added many of our organic wastes to soil to help our plants grow and we also gave away other wastes like brewery filters (tela, teji and keribo filters) for the people who are breeding animals like sheep, goats, and cows so that they can take it for animal feed.”

In the residential areas of Adama City, there are people who have cows, goats and sheep. These people make money by selling cow dung cubes and compost from their animals' dung.

Furthermore, these people collect some household waste, like brewery filters from tela, keneto/keribo and teji. In addition, when a tree is cut down in the neighborhood, injera baker women collect the wood for fuel and the owners of animals gather the leaves.

Even though applying the 4R's principle in solid waste management requires a holistic and collaborative approach, involving communities, businesses, policymakers, and waste management professionals, according to the data collected from the survey, multiple principles are being used by the residents.



Fig 9. 4R's Principle around Residential areas

Source: Site observation 5/29/2022

4.1.3 Business/ commerce centers and market places solid waste collection and disposal system

Since commercial waste makes up the second-largest share of waste generation next to household waste, it is crucial to understand its generation and composition. The key problems and the status of SWM in market places and business/commercial centers are evaluated in this section. In order to compare the information acquired in two different bases, the components are divided into two groups.

The business/commercial centers are divided into high-income areas and low-income areas. High-income areas include malls, bars and restaurants, hotels, furniture and metal industrials and cafes. On the other hand, the low-income areas include kiosks, small level cafes and fast-food areas. Amede Market (gebeya, in local language) and 17 Market Place (gebeya) are the two major markets chosen for the market place.

There are 50 total responses for the segment of market place, with 25 respondents in each market place. From commercial centers like malls, hotels, furniture and metal industries, kiosks, cafes and restaurants, a total of 34 commercial centers were assessed. This assessment covers 17 high-income commercial centers like malls, furniture and metal industries, and hotels. On the other hand, the rest of the 17 commercial centers are low-level centers like kiosks, cattle fattening and small café and restaurants.

The waste composition result of the survey showed that biodegradable waste is predominant, followed by plastics and other inorganic materials. This commercial waste composition consists of more than 70% biodegradable materials, and the other 30% consists of plastics, metals and glasses. The biodegradable wastes of commercial wastes include food wastes, papers, vegetables, fruits and garden clippings. According to the study conducted by the municipality of Adama city administration in 2020, the daily per capita solid waste generation rate of the low, middle, and high-income groups is found to be 0.29 kg, 0.4 kg, and 0.57 kg respectively.

The following table shows the commercial centers in relation to their waste.

Table 5. Commercial centers and their waste

Date of data analysis: 08/03/2022

Commercial wastes	Commercial centers							
	Malls	Hotels	Kiosks	Café	Restaurants	Bars	Furniture/metals	School
Paper	*	*	*	*	*	*	*	*
Food waste	*	*	-	*	*	-	-	-
Glasses	*	*	-	*	*	*	*	*
Metals	*	*	-	*	*	*	*	-

Garden clippings	-	*	-	-	*	-	*	*
Plastics	*	*	*	*	*	*	*	*
Vegetables	*	*	*	*	*	-	-	-
Fruits	*	*	*	*	*	*	-	-

As per Adama City's solid waste management standard, the time schedule for commercial centers waste collection is daily. This is around 98% applicable in high-level commercial centers like malls, hotels and industrials. In low-level commercial centers, the collection is not applicable at some points.

According to the findings, practically all high-income businesses use the municipal collection system offered by MSEs. Yet they are dissatisfied with the service they are receiving.

Table 6. High income Commercial centers satisfaction level

Date of data analysis: 08/03/2022

Level of Satisfaction	No. of respondents	Percentage
Fair	2	11.8%
Satisfactory	-	-
Unsatisfactory	15	88.2%
Other	-	-

Ato R. owner of kiosk (small shop) said that the fee for the waste collectors per month is 2000 ETB, which is not fair in relation to their income. Therefore, he prefers to take the collection twice a week.

Like Ato R, W/ro T. owner of a small café, prefers to use the twice a week collection. As per her statement the collection might not be done according to the schedule; the collectors sometimes come once a week and sometimes they might not come at all. "But it is not that much of a problem for folks like me because the predominant waste for businesses like this is left over food and vegetable scraps. Almost all of these kinds of business owners Collect all the left-over foods and give them to beggars and throw away other waste in the gorges when our sacks get full during night time."

W/ro k. owner of Chat Shop said, she did not use the municipality waste collection system. Because she gives away the chat sticks (geraba in the local language) and paper wastes to the injera baker lady who lives around her area and the plastic bottles are collected by random plastic bottle collectors.

With low-level commercial centers, these kinds of scenarios are common. There are many business owners like w/ro T in the city who dump their waste in the nearby gorges, ditches, streets and sometimes in municipal containers. Out of 13 low-level business owners only 5 use the municipal solid waste collection system. The following table shows low-level businesses solid waste disposal systems.

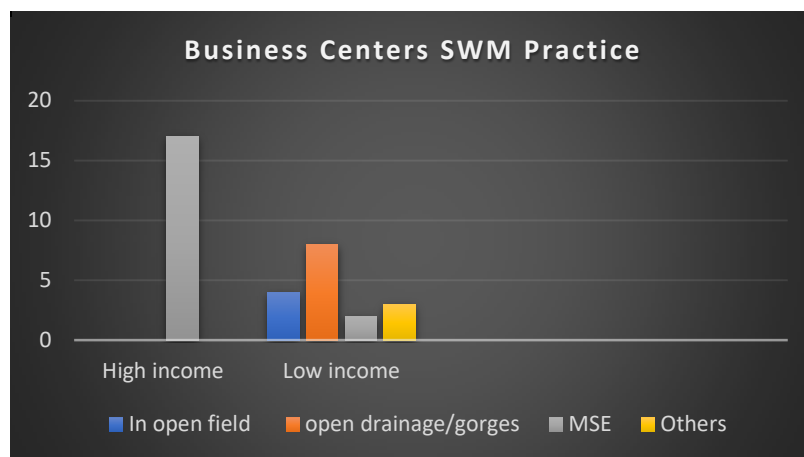


Fig 10. Business centers SWM practice

Date of data analysis: 08/05/2022

Like low-income business centers the situation also exists in both market places (Amede Gebeya and 17 Gebeya). These market places also have high level and low-level traders. The high-level traders are shop owners and the low-level merchants are gulit traders. Here also, many of the high-level traders use municipal solid waste collection; on the other hand, almost all of the gulit traders dump their waste in open drainage canals, nearby gorges and open fields.

In the survey, the gulit traders were asked why they did not use the municipality's collection system. Most of the traders said the fee for waste collection was expensive and they could not afford it. Moreover, most of the traders complain that the municipal waste container around their area is not enough. They said most of the containers are full because of household waste.

Ato T. shop owner in 17 Market place said, “Many gulit traders dump their waste in open fields

or in the drainages, but you cannot blame them. All the nearby waste containers that should serve this market are full of waste because many people who live around here dump their waste there. I am not saying it is a bad thing to dump their household waste there, but the municipality should consider this situation.” Ato T. viewpoint is supported by a large number of traders on both markets. In both markets, having access to enough municipal waste containers is crucial.

Many market place’s solid wastes are disposed of on inappropriate ways. Many wastes are destined for drainage/ditches. This illegal solid waste disposal is affecting the environment and causing health problems. Regarding the environment, the solid wastes that are dumped around and in the ditches are damaging drainage systems by closing the drainage lines, it forces liquid waste to stand on street sides and is highly affecting the beauty of the town and has become a potential threat to public health.



Fig 11. Solid waste disposal on market places

Source: Site observation 5/26/2022

These health issues arose from air, water, and soil pollution. Especially in times of winter, airborne diseases are common. The culture of municipal solid waste management is not well known in most of low income commercial and market centers. Thus, the management system of solid waste is very poor and has become a serious problem in these income level areas.

4.1.4 Street wastes collection

As it was observed throughout the site study, street waste is also becoming a significant problem for the city. There are a number of reasons why these wastes are produced, but the main sources of street waste are trash thrown by pedestrians, trash thrown at random from vehicles, waste from households that are dumped in open fields and trash swept or tossed out of marketplaces and stores. The remaining percentage consists of dust blown from unpaved areas, rotting plants,

leaves, blossoms, and seeds that come from city-dwelling trees and plants, as well as decaying vegetation.

Since Adama City is a residential, commercial, conference, and industrial center of the country, the amount of waste generated is very high. Based on the study done by municipality of Adama city administration in 2020, the waste generation is estimated to be more than 71700 metric tons each year. From this generated waste, more than 3750 metric tons of waste are generated from the streets, and the waste collected by the city's street sweepers is 2340 metric tons. The daily waste generation from streets and ditches is around 17.64 t/d and 13.24 t/d. waste is collected and transported to waste transfer stations. This comprises 63% of the street's waste generation. Hence, a large proportion of the solid waste is left uncollected or disposed of in open spaces, in ditches, and in gorges.

The usage of litter bins is not a widespread practice in the city. 50 respondents were selected for the study of the street waste disposal system. The following table illustrates the usage of litterbins in the city.

Table 7. Usage of litter bins by survey participants

Date of data analysis: 08/03/2022

Disposal	No. of people	percentage
Always	7	14%
Sometimes	12	24%
Never	31	62%

The results of the study revealed that about 62% of respondents illegally dispose of their solid waste in the streets. Many people state that the reason behind this illegal waste disposal is not having a proper and enough litterbin.



Fig 12. Solid waste disposal on streets

Source: Site observation 5/29/2022

In the city, the litterbins are very limited and most of the existing litterbins are out of service and need maintenance. Many litterbins get out of service because of a lack of awareness about the usage of litterbins. Many people use litter bins for services beyond their means. W/ro B. supermarket owner in the city states that some shop owners around her area dump their shop waste, like big and medium size packaging paper boxes in the litterbins. This situation put many litterbins in the city out of service. Moreover, as it was observed in the site survey, there is no awareness among the public especially in remote areas about the exact way of disposal of street garbage. Solid waste was thrown in the greenery, in flower pots that are provided by the municipality for city beautification purposes, on open drainages and on the corners of streets especially in pocket streets.

Another reason for having dirty streets is facility management and provision to dispose of waste. Most of the respondents from the streets of the city claimed that people adapt to the dirty places they are living in, and they think their single waste might not have any harm for the environment. During the questioner people were asked why they throw trash here and there; more than half of the respondents' answer were, 'Everyone does it, everywhere', 'Not a big issue', 'where should I throw?'. More than 80% of the respondents also state that if the city has strict laws and rules regarding littering, if the city is clean enough, if the city has adequate and workable litterbins, and if the people are provided with the right resources to keep the place clean, the city will get better from its mess. People will start following rules, people will be proud of where they are living and would like to retain the city's cleanliness.

According to the data collected from the Adama municipality office, the sector office utilizes a number of solutions to manage and handle street solid waste. The municipality utilizes 67 persons for street sweeping, 22 persons for drainage cleaners, and one team which has 10 members for the informal waste picker's part. However, it became very hard to manage and handle the incensement of street solid waste with existing solid waste management awareness and infrastructure.

4.1.5 Construction wastes

Adama is one of the fastest growing cities in Ethiopia. This rapid growth and urbanization led to a vision of extensive construction that is developing quickly and broadly. Large amounts of waste produced by construction activities have been known to cause major environmental issues. Construction wastes include waste from excavation, waste from demolition of old buildings, waste from new construction sites, and waste from building fit-out and decoration.

Although construction waste generation depends on the applied construction methods and the types of buildings being constructed and demolished, on the site survey it was observed that construction raw materials are also a big headache for the people in the city. Property owners and contractors dump their construction raw materials along the roadsides.

Table 8. Construction waste management practices by survey participants.

Date of data analysis: 08/05/2022

Alternatives	No. of respondents	Percentage
Proper dumping	11	22%
Illegal dumping	34	68%
Reuse, Recycle and Recover	5	10%

In the city, almost 79% of construction waste is dumped illegally and it is common to observe blocked drainages, and blocked streets by heaps of construction waste and raw materials along the roadside and open space. On the questioner, respondents were asked whether they follow appropriate procedures to dispose of construction waste. About 68% of the respondents reveal that they implement improper construction waste management practices by dumping the waste unlawfully. Only 22% of respondents adopted the proper way of managing construction waste by using waste management facilities provided by the municipality. Even though it is a smaller amount, the remaining 10% respondents used other alternatives like recovering, reusing and recycling waste at the source or on other construction sites. The following table shows construction waste management practice in the city.

Almost all construction waste materials can be used as raw materials for new construction. Construction waste materials that are frequently reused, recycled, and recovered in the city

include metal, stone and soil, brick, wood and concrete.



Fig 13. Construction waste disposal on streets

Source: Site observation 5/24/2022

The city's authorities have the responsibility to regulate illegal dumping of construction raw materials and construction waste to safeguard the safety and health of the communities and environment. According to the law, contractors or property owners are obliged to properly dump their raw materials and construction wastes properly. In addition, they are obliged to clean their environment for residential areas within a 20m radius and for commercial areas within a 50m radius. The penalty for improper raw material dumping and construction waste management is around 30,000 ETB. However, from the survey it is observed that the penalty for every mismanagement is 300-3000ETB.

However, waste producers must appropriately handle their waste and transport it by their own

means to the final municipal disposal site. The rise in illegal waste dumping and inappropriate raw material dumping in the city is a result of a failure to effectively control and enforce construction regulations and waste management systems.

According to Ato M. from Adama Construction Biro, it is a major issue to send construction waste to designated disposal sites, and the city administration has found it very challenging to monitor and control illegal dumping due to a lack of coordination, lax enforcement, and the absence of suitable dumping facilities. Therefore, contractors and property owners are forced to employ unlawful dumping due to an inadequate number of sites for the disposal of construction waste and the cost of transportation.

4.2 Result for the second objective

4.2.1 Community awareness and attitude towards solid waste management

Even though it is the twenty-first century, many people are not aware of the harm they are causing to the environment due to improper solid waste composition. The main factors contributing to the current decline in environmental quality and harm to human health are a lack of awareness and poor management of solid waste which is greatly affecting the day-to-day activities of city residents. In this section, public awareness towards solid waste management in Adama City is assessed. In the survey, respondents were asked if they had awareness and knowledge about the impact of improper and uncontrolled solid waste disposal in the city. The following table shows the results of the survey.

Table 9. Public awareness on the effect of improper solid waste management

Date of data analysis: 08/05/2022

Factors	No. of respondents	Percentage
Health issues	163	32.6%
Economy	18	3.6%
Environmental pollution	109	21.8%
More than one factor	107	21.4%
No idea	93	18.6%
Others	10	2%

“Most of the society has awareness; that's why they discard their trash in secret at night, especially in residential areas; nobody throws their waste during the daytime.” (Adama City’s head of urban beauty and green development). The respondents were also asked about why they discard their waste on the streets, ditches, gorges and open fields. The responses were absence of awareness, not assuming ownership of the environment, no strict warnings or punishment, morality, education, cost, not having a clean environment and so on.

The study points out that the most relevant factors for these acts to occur are a lack of environmental culture and a lack of interest in creating effective connections between city authorities and their neighborhood dwellers. The efficient operation of waste management services depends on effective communication between waste management organizations and people.

On the site survey, it was observed that, in addition to closing and harming drainage systems, improper solid waste disposal by residents also forced liquid waste to stand on roadway edges. It also pollutes the air, water, and soil, and the combination of these is affecting the beauty of the city and causing health problems.



Fig 14. Blocked Drainages

Source: Site observation 07/15/2022

The study's findings indicated that inadequate waste collection and a lack of public awareness are the key causes of these problems. Every step, starting from residences, commercial centers, markets and street generation of waste-to-waste collection, segregation, recycling /reusing /recovering /reducing, willingness to pay for services and living conditions of the people who

live in the area of waste disposal, every step of the process depends on the awareness and participation of the community. The success or failure of a good solid waste composition depends heavily on public awareness and attitude changes. Thus, the municipality must spread awareness about the risks associated with improper and uncontrolled solid waste disposal options.

Currently, Adama City Municipality is using communication channels, mass Medias and advertising to raise awareness among its residents. Based on the information obtained from an open discussion with the urban beauty and green development team, the municipality is trying to educate the people by using high performance loudspeakers and by broadcasting announcements twice a day on FM Adama radio. However, the municipality must utilize the full spectrum of communication channels, including advertisements, corporate communications, direct marketing, community participation, internet engagement, social media, and product labeling, in order to greatly increase public awareness in the city.

Additional work must be done to increase public understanding of the composition of municipal solid waste and the involvement of the private sector is necessary. The government must provide the private sector with the freedom to work effectively with all parties involved in raising public awareness.

4.3 Result for the third objective

4.3.1 Solid waste management process challenges

The rate of SW generation is increasing due to urbanization, economic development and population growth. Since Adama City is considered to be the largest hub for conferences, business, transportation, and industry the city has numerous visitors. Due to these, the amount of solid water produced in the city is rising dramatically.

The study result indicated that the city municipality's solid waste management team faces multiple challenges. These challenges include weak waste management efforts, the absence of supervision from municipal offices, limited human resources, a shortage of budget, a lack of education, the absence of responsibility at each level in communities and institutions, a lack of public awareness, limited access to training and community participation in solid waste management services, the absence of strict rules and regulations, an absence of morality and low

coordination among stakeholders.

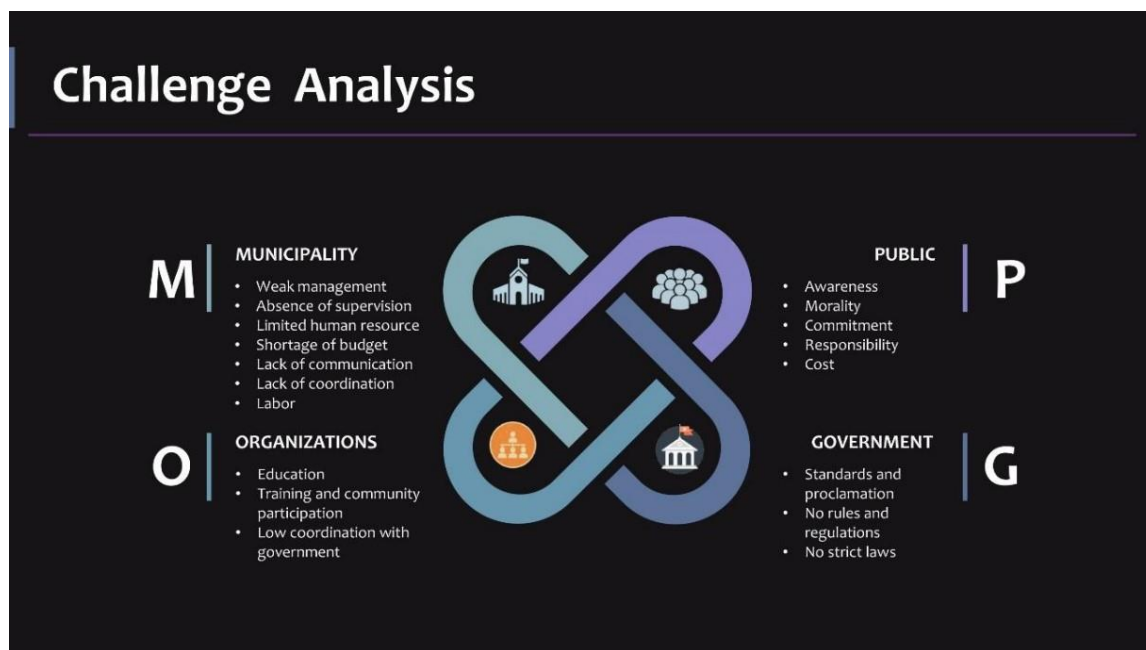


Figure. 15 Municipality's solid waste management challenges

Date of data analysis: 08/03/2022

Ato D. from Adama City's urban beauty and green development team said for the municipality, managing the human resources needed for solid waste management is a major burden. Especially at the kebele and sub-city levels, human resource are very limited

and the employers feel embarrassed by what they do. They are reluctant to admit, "I work on waste management."

Besides this, according to the information obtained from the team leader of the sanitation program of the municipality, the majority of the employers who are assigned to urban beauty and sanitation management do not have the necessary knowledge and required professions in the field or work experience. Professionals in this region do not want to work at the kebele and sub city levels due to the low standard salaries. Thus, upgrading the sanitation department staff at the kebele and sub-city levels to individuals with the required qualifications, experience, and respect for the work is a labor-intensive process.

The study results showed that organizations have less commitment to educate people about solid waste management and to coordinate with the government. Since great achievements require a continuing program of public education and awareness, working with younger generations is

essential for effective solid waste management at the city or country level and schools can play a significant role in this. Now days many of the city's schools lack programs on teaching responsible behavior, morals, and other topics including solid waste management alternatives. In comparison, universities in the city especially Adama Science and Technology University plays an important role in solid waste management by conducting studies and research.

4.4 Result for the fourth objective

4.4.1 Alternative planning approach in response to the existing solid waste management

According to the data gathered from Adama City Municipality's office various non-governmental organizations (NGOs) like USAID are involved in solid waste management and urban greenery programs by developing waste management plans, providing expertise in the design of landfill structures and compost plants, developing different city cleaning programs, supporting funds and awareness raising. Safety net Ethiopia is one of the good examples of solid waste management and urban greenery programs developed by USAID.

During the site survey, it was discovered that iron/steel materials, plastic bottles and torn polythene or plastic items are not left lying around aimlessly because they can be sold to scavengers or koralews (in the local language) for a profit.



Fig. 16 Waste for profit

Source: Site observation 5/24/2022

It is well known that effective waste management needs the cooperation of all relevant parties but individuals and the general public are the first starting point in the process of solid waste generation and composition therefore, the large burden of waste management and waste reduction falls into the hands of the general public. However, households and commercial centers participate in primary waste collection waste separation is not a common culture in the city and it is exposing accidents and environmental health concerns for the people who are living and working close to solid waste disposal facilities.

Even though Ethiopia has various laws, declarations, and other legal frameworks that support the SWM system the study results showed that the implementation of these laws, proclamations and policies is very weak.

In research from the Federal Democratic Republic of Ethiopia (1995) on Article 44 environmental rights in Sub-Article 1, it states: “all persons have the right to live in a clean and healthy environment”, while Article 92 outlines the government's environmental goals in Sub-Article 1: “the government shall endeavor to ensure that all Ethiopians live in a clean and healthy environment”, and Sub-Article 4 indicates that “government and citizens shall have the duty to protect the environment.” On the side of SWM Proclamation No. 513/2007, policies regarding the general obligations of urban administration, solid waste management planning, the inter-regional movement of solid waste, the management of household solid waste, waste collection and storage, transportation, recycling, incineration, disposal, and auditing of solid waste disposal sites are discussed. It also addresses the significance of community participation in its mission (Lemesa & Chunho, 2021).

Additionally, Public Health Protection Proclamation No. 200/2000: Article 12 states, “Any person shall collect waste at an especially designated place and in a manner that does not affect the health of the society and no person shall dispose of solid, liquid or other waste in a manner that contaminates the environment or affects the health of the society.” Despite the fact that these laws, proclamations, and regulations forbid the disposal of solid, liquid, or any other waste in a way that harms the environment or the public's health, the difficulties caused by inappropriate solid waste disposal are evident in various parts of the city.

4.5 Discussion

One of the services the city administration offers to its citizens is solid waste management. It is an essential urban basic service that has a significant impact on public health and the town's ecology. As service quality, environmental effects, and operating costs differ from location to location and type to type, solid waste management is likely the most crucial municipal service and is a requirement for other municipal activities. The rate of solid waste generation widely varies from household to household, marketplace to marketplace, and commercial center to commercial center and it is significantly influenced by socioeconomic conditions and the degree of social development in society. Solid trash generation rates in low-income parties are often lower than those in more affluent parties. High-income regions typically implement more sophisticated waste management practices, including extensive recycling programs, composting, and waste-to-energy technologies. These regions benefit from greater public awareness and participation in waste management initiatives. Conversely, in low-income areas, waste management practices are often rudimentary, with limited recycling and high reliance on open dumping and uncontrolled landfills (Gupta et al., 2022).

Various materials are utilized for the waste collection process. Sakes (Madaberiya) and plastic bags (usually reused ones) are used widely to store waste. On the other hand, for on-site storage before disposal, restaurants, hotels, schools, businesses, and workplaces typically utilize their own bins or containers in various sizes. Despite the fact that these materials vary from one location to another, they are usually used to move waste from its source areas to waste collection containers.

In Adama City, solid waste collection service is operated by the municipality itself and also the municipality outsources some of the work to formally organized micro and small-scale enterprises for income generation, job creation, environmental protection and urban sanitation work implementation. The study's findings indicate that one mode of the city's municipal solid waste management operations is the door-to-door collection of solid waste. The municipality outsourced door to door waste collection services to formally organized micro and small-scale enterprises. On the other hand, there are informal waste pikers who collect solid wastes like metals and plastic bottle from the street and also buy from individuals. Whether residents are doing it knowingly or not, the 4R's principle of reuse and recovery is employed in several areas

of the city, particularly in low- and middle-income homes. In order to enhance the application of the 4R's principle, the municipality should develop a comprehensive waste management strategy that prioritizes recycling, reuse, and reduction over disposal. Figure 16. shows the general household waste management flow in the city.

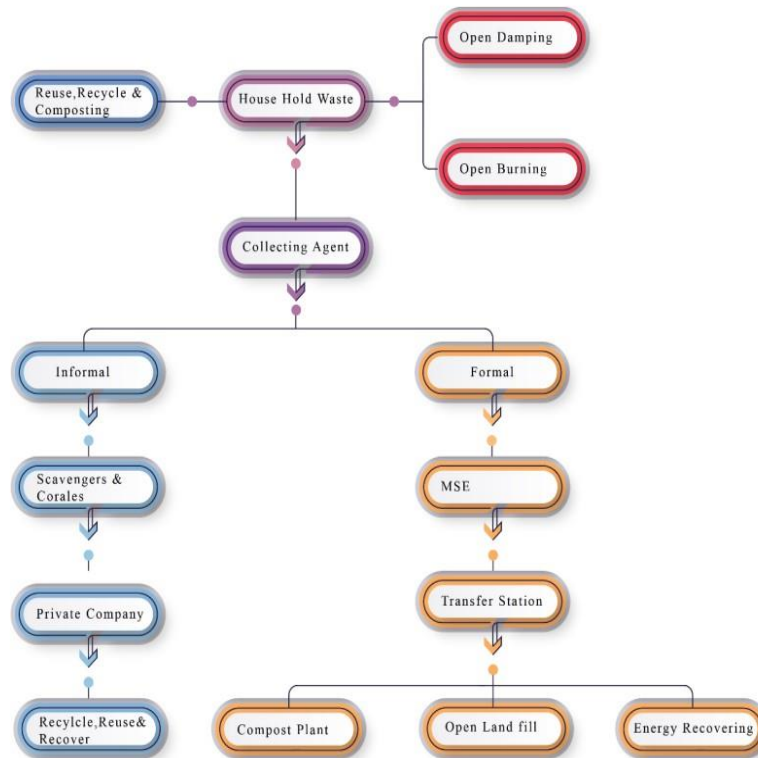


Figure. 17 waste management flow of Adama city

Date of data analysis

Despite the fact that more than 70% of the respondents have access to a door-to-door collection system, more than 50 percent of respondents are dissatisfied with the current solid waste collection and disposal system. More than 30% of the respondents do not have the opportunity to get the service. So that people have to use other disposal means to get rid of their waste. Even though these methods are inconvenient and unfriendly to the environment, the people utilize burning in their compounds, dumping in any nearby open spaces, and paying informal waste collectors. Unfortunately, the majority of informal waste collectors dispose of waste in ways that are a threat to the environment and public health in order to further their own financial interests.

Even though the results indicated an 80% improvement in municipal solid waste collection, the

service is still only provided in a few locations, including residential neighborhoods (which are often those with adequate infrastructure), shopping malls, restaurants, and hotels, all of which are covered by 70–80% of the population. Residents of the city have also voiced their strong disapproval of the frequency and timing of waste collection. The people thought the municipality's attempts to offer effective SWM services were quite weak. Especially the waste transfer containers around residential areas and market places are not enough. The litterbins on the street are also inadequate and most of them are out of service and need maintenance.

These dissatisfactions are not only from the population. The MSE operators are also not satisfied with the existing services. Not having enough waste transfer stations, limited containers and vehicles are their major problems. A shortage of vehicles occurred due to maintenance and scarcity of vehicles. Most of the municipality's waste collectors have been out of service for a long period of time and some of them are under maintenance.

According to Adama municipality solid waste management office data, about 142.8 t/d of waste was collected by door-to-door collection service providers. The municipality then handles the secondary waste collection service. The amount of waste generation in Adama City is estimated to be more than 210 tons per day (t/d) of which 146.58 t/d from residential areas, 30.03 t/d from commercial centers, 12.6 t/d from institutional areas, 3.15 t/d from industrial areas, and 17.64 t/d from street sweeping. About 139.65 t/d of waste is disposed of at the final disposal site. About 136.5 t/d of the generated waste is handled by the municipality itself and about 3.15 t/d is transported to the disposal site by the industry owners.

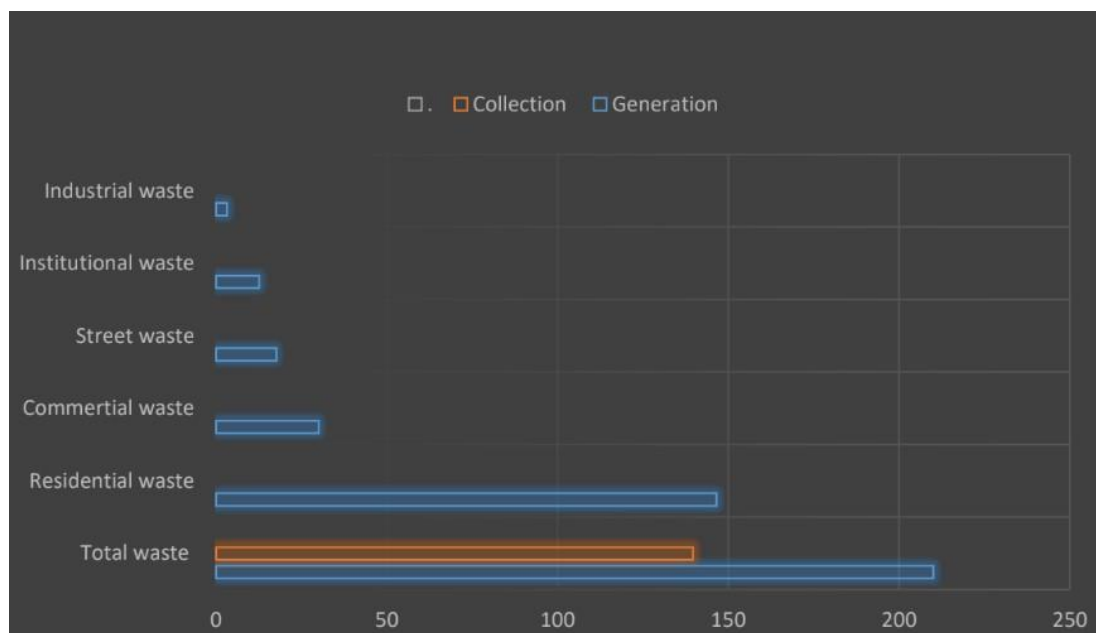


Fig 18. Solid Waste generation and collection

Date of data analysis:

The amount of household generation is initially high and commercial center waste and waste from street sweeping respectively take the next portion. In order to manage waste effectively, waste disposal behavior during solid waste management practices is essential. In Adama City, the culture of waste segregation and proper handling at the source does not happen often. If wastes are correctly separated and stored in accordance with their characteristics it is simpler to handle wastes during the subsequent steps and they may even be employed for further handling. More than 70% of the respondents in Adama who participated in the study's area are less likely to store or segregate solid waste effectively. Therefore, it is challenging for recyclers, decomposers, and other interested parties to handle trash for environmental protection.

Strict government policies, laws, rules and regulations have a great influence on SWM. According to Gupta and Singh (2022), governments play a crucial role in establishing regulations that mandate waste segregation, recycling, and proper disposal. Thus, the government should give priority to the formulation and application of these laws and policies. Moreover, the government should construct a long-term strategy and a system that guide SWM to be part of the public's concern. In addition to long term strategies and developed systems, the government should implement a continuous campaign of public education and awareness supported by legislation and quickly acting enforcement procedures. For example, cities like Singapore, Dubai, Seoul, Maryland etc. have strict laws and penalties for illegal dumping. These cities penalized their residents who were dumping waste in undesignated areas with a fine of up to \$50,000 or imprisonment for a term not exceeding 12 months. Additionally, countries like South Korea have implemented a volume-based waste fee system that helps to reduce waste generation and increase reusing, recovering and recycling of waste at its source (Sakai et al., 2022).

Thus, the government and non-governmental organizations (NGO) involved in the management of solid waste can turn other solid wastes into money, like plastic and steel waste. For example, purchasing or exchanging biodegradable wastes worth 1/10th of their weight for compost or manure. Additionally, the government may compel manufacturers, distributors, and retailers to participate in the recycling process for plastic garbage. For instance, using the sun chip company as an example, it would be beneficial if someone could collect and return 20 to 30 empty sun

chip packets in exchange for one identical or even half-sized packet. In this case, people might stop throwing packages here and there irresponsibly and businesses might see an increase in sales as well.

Community involvement is recognized as a pivotal factor in successful waste management initiatives. Gupta and Arora (2020) conducted a study on the effectiveness of community-based solid waste management programs, emphasizing the role of education and awareness in fostering sustainable waste practices at the local level. A recent article by Kumar et al. (2023) emphasizes that integrating waste management education into school curricula and using social media platforms for awareness campaigns can significantly enhance community participation. Therefore local government and municipality solid waste management authorities should work in collaboration with schools on awareness raising programs. For instance, the municipality may send officials to teach the children and youths how to properly dispose of solid waste and how to use the 4'Rs principle. On the other side, the municipality can organize a contest between schools on their solid waste management plans and strategies.

The adoption of pertinent rules and regulations could encourage source reduction, reuse, and recycling, which would reduce the quantity and scale of illegal dumping and improve municipal solid waste generation and collection practices in the city.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Generally, according to the study, four kinds of analysis are used for identifying improper waste management and its impact on the residents. Most of the study sites including households, commercial centers, market places and streets have different characteristics, which is very advantageous for the research to cover and study waste generation and management at different levels. From the systematic literature review of existing studies and based on the findings of the site observation, questionnaires', interviews, open discussion and site investigation, the following conclusions were drawn.

In the city, a huge amount of waste is generated from households followed by commercial and business establishments, industrial places, construction/demolition and streets.

Solid waste generation in the city is highly affected by the average income, education, family size, house ownership, and reuse/recycling, and composting levels of waste sources. While disposal of solid waste is affected by education level, average income, the level of awareness of individuals, accessibility to training, municipal supervision, and participation of individuals in the cleanup campaign. Due to absence of effective close supervision and

monitoring of the sanitation coordination team/experts especially the MSEs the local communities of the city complain about the service they are getting from the municipality. Most of society is not satisfied with the existing municipal solid waste management system. Consequently, some of the residents are obliged to choose illegal dumping as their main SW disposal system.

The deliberate eradication of society and the legal loophole have grown to be major issues for the town. The majority of the community is aware of the significance of proper solid waste management, the malfeasance of improper solid waste disposal and its various side effects. However, the level of income, negligence, lack of sense of ownership, lack of attention, the inaccessibility of municipal solid waste management services all around the city, and various other factors led to the choice of inappropriate waste disposal methods.

The implementation and enforcement of the existing municipal solid waste management proclamations, public health protection policies and other related laws in the city are not fully competent. Additionally, these laws and proclamations can only serve as a foundation for the formation of policy; they cannot effectively provide direction or deter illegal action. As a result, technical frameworks with strict guidelines are required.

For the MSEs and municipalities, the collection of unsorted waste is another big problem. Sorting waste at the source is not a regular practice in the city. The community mainly collects solid waste without sorting and the major purpose of their collection is just to avoid and keep waste out of their compound. In the city, segregation and sorting of the collected waste mainly take place at the transfer stations and this poses a risk to the safety and health of those who live and work close to these facilities. Additionally, these transfer stations turned into a feeding chain for the spread of diseases that affect both humans and animals.

The city's implementation of sustainable and integrated municipal solid waste management has not been found to be widespread, yet the 4Rs principle is being used among the low and middle-income groups of the population. Even if they do not understand the underlying concepts, they nevertheless apply them through experience and to support themselves economically. In these areas of the community, it is normal practice to save used resources for subsequent use and to salvage damaged items and use them for various purposes.

Generally, despite the fact that the implementation of MSWM practices in the city could hardly be in better shape, the MSWM in the city has various environmental, social, legal and economic problems. Since the process is labor, power, logistics and budget intensive it requires critical attention from all stakeholders.

5.2 Recommendation

- **Policy and Governance:**

As a country, Ethiopia has a number of proclamations and standards for solid waste management issues for all solid wastes, such as residential/household/ wastes, commercial/business area wastes, industry zone wastes, health institution wastes and hazardous wastes. To achieve this, the national institution should Assess the effectiveness of existing waste management policies and regulations in different regions and identifying gaps in enforcement is important.

- **Circular Economy Models:**

The municipality should arrange scientific concepts and alternatives in the process of SW disposal systems and adopt successful experiences from other cities, which will improve the city's environmental conservation and Economical problems and minimize irresponsible waste disposal.

- **Technological Innovations:**

The local authorities should evaluate the efficiency and feasibility of emerging technologies and raise community understanding of the strategies and technologies that help reduce the production of solid waste.

- **Waste Education and Training:**

Since integrating waste management education into the school curriculum is a successful strategy to change people's attitudes regarding waste reduction, reuse, recovery and recycling, all educational institutions should design a curriculum to educate children and youths about the value of minimizing waste production, appropriate disposal techniques, various waste management alternatives, and the causes and effects of inappropriate solid waste disposal. In addition, the city's municipality should come up with well-designed and developed awareness campaigns in schools and Exploring strategies to enhance public participation, awareness, and sense of responsibility in waste reduction and recycling.

- **Private sector involvement:**

If the private sector joins in solid waste management initiatives, the community will benefit from improved service due to competition among enterprises.

- **Facility management:**

The provision of facilities and their management are essential for preventing improper disposal of solid waste and maintaining a clean city. If the neighborhood is provided with adequate resources and the city is kept clean, the community will be proud of where they live and want to keep it that way. So that the municipality can work on facility provision and management,

- **Urban Planning and Design:**

In order to construct sustainable and waste-resilient cities, urban planners should look at how urban morphology affects the effectiveness of waste generation and collection. They should also look into how waste management issues are integrated into urban planning and design.

In the Ethiopian perspective, most of the research and studies conducted around this broad topic focus on the effectiveness and efficiency of an already established municipal solid waste management system. Regular follow-up by the concerned party is required for the in-time collection of containers for disposal of waste and their return afterwards. Yet coming up with strong and effective strategies that support integrated sustainable solid waste management that aims to protect and enhance public health, the environment, and material/energy recovery is necessary. After assessing the existing conditions and problems of the city's MSWM, the study comes up with the following recommendations.

Recommendation for Future Research

Further studies should be conducted on integrated sustainable solid waste management, which aims to safeguard and improve the environment, public health, and energy recovery by taking the current and future social, environmental, and economic conditions of the city into account.

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Appendix 1

Site Observation Checklist for Solid Waste Management Survey

General Information:

1. Site Location:

2. Address:

3. Type of site

- Household ☐
- Commercial ☐
- Public space ☐
- School ☐
- Street ☐
- Market place ☐

4. Date and Time of Observation:

- Date:
- Time:

5. Waste Generation:

a. Waste Types:

- Organic ☐
- Municipal ☐
- E-Waste ☐
- Plastics ☐
- Hazardous ☐
- Construction ☐
- Special waste ☐

b. Waste Quantity:

- Daily:
- Weekly:
- Monthly:

6. Waste collection:

- curbside pickup ☐
- communal bins ☐
- open dumping ☐
- open burning ☐

7. Waste Storage:

a. Type:

- Litter bin ☐
- Waste container/communal bin ☐
- Any designated area for waste ☐

b. Accessibility:

- Accessible ☐
- Not Accessible ☐
- ☐

c. Condition:

- Very good ☐
- Good ☐
- Poor ☐
- Rotten ☐

8. Regulatory Compliance:

- Complies with local waste management regulations ☐
- Do not comply with local waste management regulations ☐

9. Community Awareness:

a. Community Participation:

.....
.....

10. Additional Observations:

- Odor and Hygiene: ☐
- Aesthetic Impact: ☐

11. Photographic Documentation ☐

12. Notes and Comments:

.....
.....

Additional Comments:

.....
.....
.....
.....
.....
.....

Appendix 2

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY
SCHOOL OF CIVIL ENGINEERING AND ARCHITECTURE



DEPARTMENT OF URBAN PLANNING AND DESIGN

MSC PROGRAM

Household Questioner

Dear respondent,

The goal of this questionnaire is to gather preliminary information for the assessment of the current situation for solid waste management practice in Adama City to the fulfillment of MSc in the field of Urban Planning and Design. The information collected by this questionnaire will be used to evaluate the status of the solid waste management practice in the city. Accordingly, your genuine responses are extremely important for this research, so please be free and respond to all the open-ended and closed questions as completely and accurately as possible.

- Participation in the study is completely voluntary.
- All information collected through this questionnaire will only be used for academic purposes.

Thanks a lot for your highly appreciated support.

Sincerely

Nardos Tekla H.
Email; nadihab03@gmail.com
+251-922505166

Section A: Respondent's detail information

Name:

Kebele:

House No.

Date:

Section B: Respondent's General Information

1. Age:

2. Gender:

a. Male

b. Female

3. Marital status

a. Married

b. Unmarried

c. Widowed

d. Divorced

4. Education

a. No education

b. Primary

c. Secondary

d. University graduate

e. Other

5. Income level

a. <1,000ETB

b. 1,000-5,000ETB

c. 5,000-10,000ETB

d. >10,000ETB

6. Occupation

a. Gov't job

b. Private job

c. House wife

d. Business

e. Self service

f. Other

7. How many people are currently living in this house?

.....

8. How long have you lived in this neighborhood?

.....

Section C: Household Solid Waste Management practice related Questions.

9. What type of solid waste comes out from your household?

- Paper and carton
- Glass

- Plastics (bag and bottles)
- Food waste
- Garden clippings
- Metals
- Animal's dung

10. What types of Solid Waste do you often disposed of?

- Recyclable waste
- Non-Recyclable waste
- Others

11. In what type of material do you collect your solid wastes?

- Carton
- Saks/Madaberiya
- Plastics (bag/baskets)
- Old bucket
- Others

12. Where did you usually dispose of your solid wastes?

- On an open field
- Burning inside the compound
- In open drainage canals
- In municipality container
- In nearby gorges
- Other

13. Do you use municipality's solid waste collection system?

1. Yes 2. No

If yes,

A. How often do you use the collection service?

- Once a week
- Twice a week
- Other

B. How much do they charge per month?

- ETB: per month

C. Do you think it's fair?

- Yes
- No

D. What kind of problem do you face regarding to the municipality's solid waste management system?

- Not having a good system for disposal of waste
- Irregular service
- High cost
- Lack of depots/waste containers around the area
- Others

E. How do you evaluate the status of the existing solid waste collection system?

- Fair
- Satisfactory
- Unsatisfactory
- Other

.....

14. How frequently do you dispose of your solid wastes?

- Daily
- Once a week
- Twice a week
- Thrice a week
- Other

.....

15. Do you use different trash bins for waste collection?

1. Yes 2. No

16. Are you willing to do it if you are told by your collection service provider?

1. Yes 2. No

17. What is your practice regarding to these issues?

No.	Practices	Never	Seldom	Sometimes	Often	Always
	I dispose the solid waste regularly.					
	I dispose solid waste to waste collector.					
	I throw solid waste to drain.					
	I throw solid waste to open dump.					
	I collect the solid waste in plastic bag.					
	I throw solid waste to open field.					
	I collect the solid waste in a container.					
	I use different bins for solid waste disposal.					
	I keep all the garbage in one garbage container.					
	I burn the solid wastes when I have bulk amount of waste.					
	I segregate biodegradable (paper, banana peels, cardboard and vegetables) wastes.					
	I use our kitchen solid waste as compost for my garden.					
	I reuse aged plastics and metal wastes as a pot for my garden.					
	I reuse electronics devices after repairing.					
	I reuse glass, plastic or metal cans/bottles as storage.					
	I reuse cotton or plastic bags for shopping.					
	I donate used clothes, left over foods and other					

	stuff.					

18. Which of the following 4R's principles do you use?

- Reuse
- Recycle
- Reduce
- Recover
- Other

19. Are there any public waste containers/depots near your area?

1. Yes 2. No

If yes,

a. How do you describe the state of the containers near your area?

1. Rotting/Rusting
2. Not in a good condition
3. In a very good condition

b. How often do the containers emptied?

1. Once a week
2. Twice a week
3. Thrice a week
4. Every week
5. Don't know
6. Others

20. Do people dump their waste alongside the waste containers/depots instead of putting it inside the containers?

1. Yes 2. No 3. Other

If Yes,

a. Why, in your opinion, people behave like this?

1. Difficult to put waste inside the container due to height of the container
2. Difficult to put waste inside the container due to waste and litter spread around the container
3. Stray animals (dogs, mouse and birds etc.
4. Other

.....

b. Can you identify issues with the solid waste mismanagement?

1. Waste lying around
2. Odor
3. Rats
4. Flies
5. No problem
6. Other

21. Do you think the waste disposal and collection method is a problem in your neighborhood?

1. Yes
2. No

Section D: Awareness on Solid Waste Management related Questions.

22. Have you ever heard about solid waste management?

1. Yes
2. No
3. Don't know

If yes, in what way?

- Over radio
- Over TV
- In public meeting
- In school
- On posters
- Others

23. Have you ever been educated about proper solid waste management?

1. Yes
2. No

If yes, in what way?

- By the municipality
- By the school
- By meetings of social associations

24. Do you think that every people have to know about solid waste management?

1. Yes 2. No

25. Do you think there is enough information available about the impact of solid waste mismanagement in your neighborhood?

1. Yes 2. No 3. Other

26. Did you or any member of the family participate in any community cleanup activities?

1. Yes 2. No 3. Other

27. Do you think that media has the main role in raising public awareness?

1. Yes 2. No

28. In your opinion which of these mass media components are more effective in generating public awareness?

- Radio
- Television
- Newspaper
- Social media

29. In your opinion which of these is a priority concern about waste in your area?

- Littering and bad appearance
- Effect on human health
- Effect on environment
- Others

.....

30. How do you rate the quality of your neighborhood environment as compared to your neighborhood 5 years ago?

1. Much better
2. A little better
3. The same
4. Worse

31. Do you think there is enough information about solid waste mismanagement and its impact?

1. Yes 2. No

32. Do you think household solid waste management committees are important in the community?

1. Yes 2. No

33. What do you suggest Adama city municipality council to resolve solid waste problem?

.....

.....

Thank you for your time!

Appendix 3

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY
SCHOOL OF CIVIL ENGINEERING AND ARCHITECTURE



DEPARTMENT OF URBAN PLANNING AND DESIGN
MSC PROGRAM

Business/ commerce centers and market places Questioner

Dear respondent,

The goal of this questionnaire is to gather preliminary information for the assessment of the current situation for solid waste management practice in Adama City to the fulfillment of MSc in the field of Urban Planning and Design. The information collected by this questionnaire will be used to evaluate the status of the solid waste management practice in the city. Accordingly, your genuine responses are extremely important for this research, so please be free and respond to all the open-ended and closed questions as completely and accurately as possible.

- Participation in the study is completely voluntary.
- All information collected through this questionnaire will only be used for academic purposes.

Thanks a lot for your highly appreciated support.

Sincerely

Nardos Tekla H.
Email; nadihab03@gmail.com
+251-922505166

Section A: Business's general information

Business type:

Location:

Date:

1. How long have you stayed in this Business?

.....

Section B: Business place's Solid Waste Management practice related Questions.

2. What type of solid waste do you generate?

- Paper and carton
- Glass
- Plastics (bag and bottles)
- Food waste
- Garden clippings
- Metals

3. What types of Solid Waste do you often disposed of?

- Recyclable waste
- Non-Recyclable waste
- Others

4. Did you collect your waste in designated area?

1. Yes 2. No 3. Other

ii. In what type of material do you collect your solid wastes?

- Carton
- Saks/Madaberiya
- Plastics (bag/baskets)
- Old bucket
- Others

5. Where did you usually dispose of your solid wastes?

- On an open field
- Burning inside the compound
- In open drainage canals
- In municipality container
- In nearby gorges
- Other

6. Do you use municipality's solid waste collection system?

2. Yes 2. No

If yes,

a. How often do you use the collection service?

- Once a week
- Twice a week
- Other

b. How much do they charge per month?

- ETB: per month

c. What kind of problem do you face regarding to the city's solid waste management system?

- Not having a good system for disposal of waste
- Irregular service
- High cost
- Lack of depots/waste containers around the area
- Others

7. How do you evaluate the status of the existing solid waste collection system in your place?

- Fair
- Satisfactory
- Unsatisfactory
- Other

.....
8. How frequently do you dispose of your solid wastes?

- Daily
 - Once a week
 - Twice a week
 - Thrice a week
 - Other
-

9. Do you use different trash bins for waste collection?

2. Yes 2. No

10. Are you willing to do it if you are told by your collection service provider?

2. Yes 2. No

11. Which of the following 4R's principles do you use?

- Reuse
- Recycle
- Reduce
- Recover
- Other

12. Are there any public waste containers/depots near your area?

2. Yes 2. No

If yes,

a. How do you describe the state of the containers near your area?

1. Rotting/Rusting
2. Not in a good condition
3. In a very good condition

b. How often do the containers emptied?

1. Once a week
2. Twice a week
3. Thrice a week
4. Every week
5. Don't know
6. Other

.....

13. Do people dump their waste alongside the waste containers/depots instead of putting it inside the containers?

1. Yes
2. No
3. Other

If yes,

a. Why, in your opinion, people behave like this?

1. Difficult to put waste inside the container due to height of the container
2. Difficult to put waste inside the container due to waste and litter spread around the container
3. Stray animals (dogs, mouse and birds etc.)
4. Other

.....

b. Can you identify issues with the current solid waste management system?

1. Waste lying around
2. Odor
3. Rats
4. Flies
5. No problem
6. Other

.....

14. Do you think the waste disposal and collection method is a problem in your place?

1. Yes
2. No

15. What is your practice regarding to these issues?

No.	Practices	Never	Seldom	Sometimes	Often	Always
	I collect solid waste properly					
	I dispose solid wastes properly					
	I dispose solid waste to waste collectors					
	I dispose solid waste in to municipality waste containers					
	I throw solid waste to open drainages					
	I dispose solid waste in open field					
	I dump solid wastes alongside the waste containers/depots instead of putting it inside the containers					

Section D: Awareness on Solid Waste Management related questions.

16. Have you attended any awareness programs conducted by local authority regarding solid waste management?

1. Yes 2. No 3. Other

17. Do you think there is enough information available about the impact of solid waste mismanagement in the city?

2. Yes 2. No 3. Other

18. Does your place have any cleanup activity programs?

2. Yes 2. No 3. Other

19. Do you think a regular solid waste management program for your place is important?

1. Yes 2. No 3. Other

20. Do you think solid waste management department is important in your place?

1. Yes 2. No 3. Other

21. Have you ever heard about solid waste management via mass Medias?

2. Yes 2. No 3. Other

22. In your opinion which of these mass media components are more effective in generating public awareness?

- Radio
- Television
- Newspaper
- Social media

23. In your opinion which of these is a priority concern about waste in your place?

- Littering and looks bad
- Effect on human health
- Effect on environment
- Others

.....

24. What do you suggest Adama city municipality council to resolve solid waste problem?

.....
.....

Thank you for your time!

Appendix 4

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY
SCHOOL OF CIVIL ENGINEERING AND ARCHITECTURE



DEPARTMENT OF URBAN PLANNING AND DESIGN

MSC PROGRAM

On Street Questionnaire

Dear respondent,

The goal of this questionnaire is to gather preliminary information for the assessment of the current situation for solid waste management practice in Adama City to the fulfillment of MSc in the field of Urban Planning and Design. The information collected by this questionnaire will be used to evaluate the status of the solid waste management practice in the city. Accordingly, your genuine responses are extremely important for this research, so please be free and respond to all the open-ended and closed questions as completely and accurately as possible.

- Participation in the study is completely voluntary.
- All information collected through this questionnaire will only be used for academic purposes.

Thanks a lot for your highly appreciated support.

Sincerely

Nardos Tekla H.
Email; nadihab03@gmail.com
+251-922505166

Section A: Respondent's general information

Name:

Area:

Date:

Section B: Respondent's detail information

1. Age:

2. Gender:

a. Male

b. Female

3. Education

a. No education

b. Primary

c. Secondary

d. University graduate

e. Other

4. Occupation

a. Gov't job

b. Private job

c. House wife

d. Business

e. Self service

f. Other

Section C: On street Solid Waste Management practice related Questions.

5. What type of solid waste do you often generate when you are outside?

- Paper and carton
- Glass
- Plastics (bag and bottles)
- Food waste
- Metal materials
- Other

.....

6. Where did you usually dispose of your generated waste?

- On the streets
- In open drainage canals
- In litter bins
- Other

.....

7. How often do you use litter bins?

- Never
- Seldom
- Sometimes
- Often
- Always

8. What kind of problem do you face regarding litter bins?

- Litter bins are not available in some areas
- Litter bins are not functional
- Litter bins are full of wastes
- Litter bins are not in a good state
- Others

.....

9. Do you think the litter bins are enough for the city?

1. Yes 2. No 3. Other

10. How do you evaluate the state of litter bins in the city?

- Very good
- Fair
- Good
- Not good
- Other

.....

11. How do you evaluate the status of current solid waste management in the city?

.....

.....

12. What is your practice regarding to the issues listed below?

No.	Practices	Never	Seldom	Sometimes	Often	Always
	I dispose the solid waste properly.					
	I dispose solid waste to litter bins.					
	I throw waste to drainages.					
	I collect the waste in plastic bag.					

	I throw waste to open field.					
	I collect the waste in my bag.					

13. Do you think solid waste disposal and collection method is a problem in the city?

2. Yes 2. No

Section D: Awareness on Solid Waste Management Related Questions.

14. Have you ever heard about solid waste management?

2. Yes 2. No 3. Don't know

If yes, in what way?

- Over radio
- Over TV
- In public meeting
- In school
- On posters
- Others

15. Have you ever been educated about proper solid waste management?

2. Yes 2. No

If yes, in what way?

- By the municipality
- By the school
- By meetings of social associations

16. Do you think that every people have to know about solid waste management?

2. Yes 2. No

17. Do you think there is enough information available about the impact of solid waste mismanagement in the city?

3. Yes 2. No 3. Other

18. Have you ever participated in any community cleanup activities?

3. Yes 2. No 3. Other

19. Do you think that media has the main role in raising public awareness?

3. Yes 2. No 3. Other

20. In your opinion which of these mass media component is more effective in generating public awareness?

- Radio
- Television
- Newspaper
- Social media

21. In your opinion which of these is a priority concern about waste in the city?

- Littering and looks bad
- Effect on human health
- Effect on environment
- Others

.....

22. How do you rate the quality of Adama city's environment as compared to the environment 5 years ago?

25. Much better

26. A little better

27. The same

28. Worse

23. What do you suggest Adama city municipality council to resolve solid waste management problems?

.....
.....

Thank you for your time!

Appendix 5

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY
SCHOOL OF CIVIL ENGINEERING AND ARCHITECTURE



DEPARTMENT OF URBAN PLANNING AND DESIGN

MSC PROGRAM

Construction Site Questioner

Dear respondent,

The goal of this questionnaire is to gather preliminary information for the assessment of the current situation for solid waste management practice in Adama City to the fulfillment of MSc in the field of Urban Planning and Design. The information collected by this questionnaire will be used to evaluate the status of the solid waste management practice in the city. Accordingly, your genuine responses are extremely important for this research, so please be free and respond to all the open-ended and closed questions as completely and accurately as possible.

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Thanks a lot for your highly appreciated support.

Sincerely

Nardos Tekla H.
Email; nadihab03@gmail.com
+251-922505166

Section A: Site's general information

Location:

Date:

1. How long have you stayed in this sector?

.....

Section B: Site's Solid Waste Management practice related Questions.

2. What type of solid waste do the Site generate mostly?

- Wood
- Concrete
- Gypsum
- Glass
- Plastics
- Paper and carton
- Metals
- Others

3. What types of Solid Waste do you often disposed of?

- Recyclable waste
- Non-Recyclable waste
- Others

4. Did you collect site waste in designated area?

2. Yes 2. No 3. Other

5. In what type of material do you collect solid wastes?

- Carton
- Saks/Madaberiya
- Plastics (bag/baskets)

- Old bucket
- Others

6. Where did you usually dispose of site solid wastes?

- On an open field
- Burning inside the compound
- In open drainage canals
- In municipality container
- In nearby gorges
- Other

.....

7. Do you use municipality's solid waste collection system?

29. Yes 2. No

If yes,

F. How often do you use the collection service?

- Once a week
- Twice a week
- Other

G. How much do they charge you?

- ETB: per month/once

H. What kind of problem do you face regarding to the municipality's solid waste management system?

- Not having a good system for disposal of waste
- Irregular service
- High cost
- Lack of depots/waste containers around the area
- Others

I. How do you evaluate the status of the existing solid waste collection system?

- Fair
- Satisfactory
- Unsatisfactory
- Other

8. How frequently do you dispose of site solid wastes?

- Daily
- Once a week
- Twice a week
- Thrice a week
- Other

.....

9. Do you use different trash bins for waste collection?

3. Yes 2. No

If No, why?

.....
.....

10. Which of the following 4R's principles do you use on site?

- Reuse
- Recycle
- Reduce
- Recover
- Other

11. Are there any public waste containers/depots near your site?

3. Yes 2. No

If yes,

c. Do you have access to it?

1. Yes 2. No

d. How do you describe the state of the containers near your area?

4. Rotting/Rusting
5. Not in a good condition
6. In a very good condition

e. How often do the containers emptied?

7. Once a week
8. Twice a week
9. Thrice a week
10. Every week
11. Don't know
12. Other

12. Do you believe that your workers properly collect and dispose of solid?

1. Yes
2. No
3. Other

13. Do you think the waste disposal and collection method is a problem in your site?

3. Yes
2. No

14. What is your site practice regarding to these issues?

No.	Practices	Never	Seldom	Sometimes	Often	Always
	Proper solid waste collection					
	Proper solid waste disposal					
	Dispose solid waste to waste collectors					
	Dispose solid waste in to municipality waste containers					
	Throwing solid waste to open drainages					
	Dispose solid waste in open field					
	Dumping solid wastes alongside the waste containers/depots instead of putting it inside the containers					

Section D: Awareness on Solid Waste Management related questions.

15. Have you ever attended any awareness programs conducted by local authority regarding solid waste management?

2. Yes 2. No 3. Other

16. Do you think there is enough information available about the impact of solid waste mismanagement in the city?

4. Yes 2. No 3. Other

17. Have you ever done a cleaning program outside your site premises?

1. Yes 2. No 3. Other

18. Do you think a regular solid waste management program for site is important?

30. Yes 2. No 3. Other

19. In your opinion which of these mass media components are more effective in generating public awareness?

- Radio
- Television
- Newspaper
- Social media
- Mini medias

20. What do you suggest Adama city municipality council to resolve solid waste management problems?

.....
.....

Thank you for your time!

Appendix 6

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY
SCHOOL OF CIVIL ENGINEERING AND ARCHITECTURE



DEPARTMENT OF URBAN PLANNING AND DESIGN

MSC PROGRAM

Schools Questioner

Dear respondent,

The goal of this questionnaire is to gather preliminary information for the assessment of the current situation for solid waste management practice in Adama City to the fulfillment of MSc in the field of Urban Planning and Design. The information collected by this questionnaire will be used to evaluate the status of the solid waste management practice in the city. Accordingly, your genuine responses are extremely important for this research, so please be free and respond to all the open-ended and closed questions as completely and accurately as possible.

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- All information collected through this questionnaire will only be used for academic purposes.

Thanks a lot for your highly appreciated support.

Sincerely

Nardos Tekla H.
Email; nadihab03@gmail.com
+251-922505166

Section A: school's general information

Name of School:

Location:

Date:

1. How long have you stayed in this sector?

.....

Section B: School's Solid Waste Management practice related Questions.

2. What type of solid waste do the school generate mostly?

- Paper and carton
- Glass
- Plastics (bag and bottles)
- Food waste
- Garden clippings
- Metals

3. What types of Solid Waste do the school often disposed of?

- Recyclable waste
- Non-Recyclable waste
- Others

4. Did your school collect its waste in designated area?

3. Yes 2. No 3. Other

5. In what type of material do the school collect its solid wastes?

- Carton
- Saks/Madaberiya
- Plastics (bag/baskets)
- Old bucket
- Others

6. Where did the school usually dispose of its solid wastes?

- On an open field
- Burning inside the compound
- In open drainage canals
- In municipality container
- In nearby gorges
- Other

7. Do the school use municipality's solid waste collection system?

31. Yes

2. No

If yes,

a. How often do the school use the collection service?

- Once a week
- Twice a week
- Other

b. How much do they charge per month?

- ETB: per month

c. What kind of problem do the school face regarding to the municipality's solid waste management system?

- Not having a good system for disposal of waste
- Irregular service
- High cost
- Lack of depots/waste containers around the area
- Others

d. How do the school evaluate the status of the existing solid waste collection system?

- Fair
- Satisfactory
- Unsatisfactory
- Other
.....

8. How frequently do the school dispose of its solid wastes?

- Daily
- Once a week
- Twice a week
- Thrice a week
- Other

.....

9. Do the school use different trash bins for waste collection?

4. Yes 2. No

If No, why?

.....
.....

10. Which of the following 4R's principles do the school use?

- Reuse
- Recycle
- Reduce
- Recover
- Other

11. Are there any public waste containers/depots near the school area?

4. Yes 2. No

If yes,

a. Do the school have access to it?

2. Yes 2. No

b. How do you describe the state of the containers near your area?

1. Rotting/Rusting
2. Not in a good condition
3. In a very good condition

c. How often do the containers emptied?

1. Once a week
2. Twice a week
3. Thrice a week
4. Every week
5. Don't know
6. Other

12. Do your students dump their waste in to the waste containers/litter bins in the school compound?

- c. Yes 2. No 3. Other

13. Do you believe that your students properly collect and dispose of solid waste while they are outside the school?

1. Yes 2. No 3. Other

14. Do you think the waste disposal and collection method is a problem in your school?

4. Yes 2. No

15. What is your school practice regarding to these issues?

No.	Practices	Never	Seldom	Sometimes	Often	Always
	Proper solid waste collection					
	Proper solid waste disposal					
	Dispose solid waste to waste collectors					
	Dispose solid waste in to municipality waste containers					
	Throwing solid waste to open drainages					
	Dispose solid waste in open field					
	Dumping solid wastes alongside the waste containers/depots instead of putting it inside the containers					

Section D: Awareness on Solid Waste Management related questions.

16. Have your school attended any awareness programs conducted by local authority regarding solid waste management?

3. Yes 2. No 3. Other

17. Has the school ever conducted any educational programs related to solid waste management?

1. Yes 2. No 3. Other

18. Do you think there is enough information available about the impact of solid waste mismanagement in the city?

5. Yes 2. No 3. Other

19. Does the school have any cleanup activity programs?

4. Yes 2. No 3. Other

20. Have you ever done a cleaning program outside the school premises?

2. Yes 2. No 3. Other

21. Do you think a regular solid waste management program for the school is important?

32. Yes 2. No 3. Other

22. Do you think that solid waste management committees are important for the school?

2. Yes 2. No 3. Other

23. In your opinion which of these mass media components are more effective in generating public awareness for your students?

- Radio
- Television
- Newspaper
- Social media
- Mini medias

24. What do you suggest Adama city municipality council to resolve solid waste management problems?

.....
.....

Thank you for your time!

Appendix 7

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY
SCHOOL OF CIVIL ENGINEERING AND ARCHITECTURE



DEPARTMENT OF URBAN PLANNING AND DESIGN

MSC PROGRAM

Municipality and SME Questioner

The goal of this questionnaire is to gather preliminary information for the assessment of the current situation for solid waste management practice in Adama City. The information collected by this questionnaire will be used to evaluate the status of the solid waste management practice in the city. To enable an accurate assessment, it is important that all information requested in the questionnaire should be provided as completely and accurately as possible.

- Participation in the study is completely voluntary.
- All information collected through this questionnaire will only be used for academic purposes.

Thanks a lot for your highly appreciated support.

Sincerely

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Section A: Personal information

Name of Respondent:

Position:

Date:

1. How many service providers are there, for

- Household solid waste collection.....
- Commercial solid waste collection.....
- city solid waste collection.....
- construction solid waste collection.....

2. What kind of solid waste does the city generate the most of?

.....
.....
.....

3. Where did you usually dispose of the collected solid wastes from the city?

.....
.....
.....

4. What kind of problem do you face regarding to the solid waste management/collection system?

.....
.....
.....
.....

5. Do you think the public bins and containers are enough for the city?

.....
.....

6. How do you describe the state of the containers and litter bins in the city?

.....
.....

7. How often do the containers and litter bins emptied?

8. How many land fill sites and compost plants are there?

.....
.....

9. What do you think about these compost plants and landfill sites?
 - Are they adequate?
 - Is their location appropriate?
 - What is the people's reaction about the landfills?
10. Do you think the waste collection and disposal system of the city is appropriate?
11. What problems do you think exist in the city as for solid waste management?
12. Are there any policies regarding to solid waste management?
13. How do you evaluate the application of these policies?
14. Have you ever prepared any program to teach the people about solid waste management?
15. Do you think there is enough information available about the impact of solid waste mismanagement in the city?
16. Does the city have any city cleanup activity programs where the residents may become involved?

Section B: Only for MSE

1. How long have you stayed in this sector?
2. How often do you give the collection service?
 - For household
 - For hotels

- For commercial centers
- For market centers
- Other

3. How much do you charge per month?

- For household.....
- For hotels
- For commercial centers
- For market centers

4. What kind of problem do you face regarding to the solid waste management/collection system?

.....

5. What challenge do you face most frequently at work?

.....

6. How much do you believe the community accepts you?

.....

7. Before beginning the work, did you take any courses that are related to solid waste management?

.....

8. How do you feel about the money you make? Is it fair enough?

.....

9. What in your opinion, ought to be fixed for the future?

.....

10. Have you ever had issues with individuals over the collection and disposal of solid waste?

.....

11. What are the major problems for your organization regarding to solid waste management?

.....
.....
.....

12. How do you evaluate the state of solid waste management awareness in the city?
.....
.....

Thank you for your time!

Appendix 8

Planning Documents Reviewed and Analyzed in this Research

No.	Planning Documents	Year
1	Public Health Protection Proclamation	1995
2	Federal Democratic Republic of Ethiopia constitution	1995
3	Solid Waste Management Proclamation	1995
4	Adama City master plan	2004
5	Adama city Solid Waste Management Standard	2014
6	Population and Housing Census of Ethiopia	2012
7		