ADDIS ABABA UNIVERSITY COLLAGE OF DEVELOPMENT STUDIES CENTER FOR ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

AWARENESS, PRACTICE AND CHALLENGES OF LIQUID WASTE MANAGEMENT: A CASE OF WEREDA-9 GULELE SUB CITY, ADDIS ABABA, ETHIOPIA- 2023

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JUN, 2023

ADDIS ABABA, ETHIOPIA

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COURSE TITLE: MA THESIS (DSESD - 731)

AWARENESS, PRACTICE AND CHALLENGES OF LIQUID WASTE MANAGEMENT: A CASE OF GULELE SUB CITY, ADDIS ABABA, ETHIOPIA

A THESIS SUBMITTED TO ADDIS ABABA UNIVERSITY, COLLEGE OF DEVELOPMENT STUDIES, IN PARTIAL FULFILMENT OF THE REQIREMENT FOR MASTERS OF ARTS IN ENVIRONMENT AND SUSTAINABLE DEVELOPMMENT

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JUN, 2023

ADDIS ABABA, ETHIOPIA

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This is to certify that the thesis work contained by **Gashaw kebede**, entitled **Awareness, practice and challenges of liquid waste management: a case of Gulele sub city, Addis Ababa, Ethiopia** submitted to the college of development studies of Addis Ababa University in partial fulfillment of the requirements for the Degree of Master of Arts in Environment and Development Studies complies with the regulation of the University and meets the accepted standards with respect to originality and quality.

Approved by board of examiners

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DECLARATION

I, the undersigned, declare that this thesis is my original work, that it has not been submitted for any degree at any university, and that all sources utilized are properly credited. The thesis is unique, and it has not been submitted to any university or institution for the award of a degree or diploma.

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ABBRIVATIONS AND ACRONYMS

AACA:	Addis Ababa City Administration
AAEPC:	Addis Ababa Environmental Protection commission
AAWSA:	Addis Ababa water and sewerage Agency
APHA:	American Public Health Association
AU:	African Union
BOD:	Biological oxygen demand
COD:	Chemical oxygen demand
CSA:	Central statistical agency
DAWASA:	Dare Salaam Water and Sewerage Authority
EEPA:	Ethiopian Environmental Protection Authority
EPDRF:	Ethiopian People's Revolutionary Democratic Front
FGD:	Focus group discussion
FOG:	Fats, oils or grease
GHG	Green House Gas
ISWM -	Integrated sustainable waste management
KII:	Key informant interview
LWD	Liquid waste disposal
LWDS	Liquid waste disposal system
LWM	Liquid waste management
MBR:	Membrane bio reactor
NSW:	New South Wales
O & M	Operation and Maintenance
PVC:	Polyvinyl chloride
SPSS:	Statistical procedures in Statistical Package for Social Science
UNDP:	United Nations Development Program
UNECA:	United Nations Economic Commission for Africa
WWDR	World Water Development Report

Acknowledgment

First and foremost, I would like to extend my sincere thanks to Dr. Shemeles Damene, my advisor for his unreserved guidance, comments and support through the whole research processes. I am very grateful for his commitment, suggestions, and constructive feedbacks throughout my entire research activities.

Then, I am pleased to extend my heartfelt gratitude to *Gulele* sub city *wereda* 9 Excutive and environmental officers and NT- Environmental consultant for their willingness and co-operation to provide important information in the data collection process. Finally, I would like to thank my families and friends for their unreserved encouragement and moral support.

Abstract

This study examined LWM awareness, practice, and challenges in Addis Ababa. A household survey, focus groups, key informant interviews, and field observations were used to gather the data. While 2 FGDs were done with 16 community leaders, the 2 KII informants were professionals working in LWM government institutions, 2 environmental health experts and 2 executive officers of the study wereda. About 266 residents were included in the survey who were selected from research wereda sampling sites. Only 16.5 % of the residents responded that they have proper sewage system in place for disposing of liquid waste, while 10.9% of respondents said they used septic tanks, and only 12% discharged to sanitary sewers. In relation to this, 33.8% of the families surveyed took part in LWM training sessions. The Addis Ababa Water and Sewerage Agency (AAWSA) supplies a variety of different sized vehicles to collect liquid waste. Accordingly 24.8% of survey respondents, while 0.8% use, reuse, and recycle liquid waste from flush toilets and 0.4% from urine toilets. With a significance level of $P<0.001$, the study found a significant correlation between age, education, and family size and LWM practice, training, and the use, reuse, and recycling of liquid waste. However, there is no gender biased relationship with having a septic tank, receiving instruction on managing liquid waste, and discharge of waste at the right location. Education level and monthly income have a history of having septic tank and LWM experience, according to the multiple linear regression factors that were provided. Age and educational level have historically had a significant impact on receiving training in LWM practice and proper management of liquid waste from homes to disposal sites. Poor awareness, financial constraints, low motivation and attitude, poor quality sanitary infrastructure and inadequate liquid waste handling equipment lead to poor liquid waste management practice. To increase knowledge, practice and tackle challenges of LWM in general in Addis Ababa city specifically in Gulele-sub city creating awareness, enforcing environmental laws, establishing quality sanitary infrastructures and allocating enough budget should be mandatory.

Key words: Liquid waste, awareness, practice, challenge, liquid Waste Management

CHAPTER ONE

1. Introduction

1.1. Background of the study

As population density rises, so does environmental contamination, which dates back to when people first started farming the land and building towns and villages thousands of years ago (Ara et al., 2003). The first known wastewater management system is located in present day Syria (El Kowm). The Mesopotamian "oasis" in the Fertile Crescent exhibits traces of wastewater control dating back to roughly 6500 BCE. The location is around 120 kilometers northeast of Palmyra. El Kowm featured extensive urban planning focusing on household wastewater drainage (Dornemann, 1986). Following the start of industrialization and the persistent urban growth of big population centers in England, the accumulation of garbage in cities resulted in a rapid degradation in sanitation and the general quality of urban life. Due to a lack of trash clearing laws, the streets got clogged with filth. As early as 1751, calls for the establishment of a municipal authority with garbage management powers were made (Nightingale, 1986).

Environmental degradation, along with associated health risks and ecosystem disruption, is not a recent problem. However, with the industrial revolution and widespread use of technology, man has diverted a significant quantity of the energy and materials that were once moving through natural ecosystems for their benefit. Industries are a significant source of pollution since they release a lot of waste products into the environment, including solids, liquids, gases, heat, noise, etc. Lency (1971).

The definition of liquid waste given by the European Environment Agency (EEA, 2017) is consisting of sewage and domestic wastewater, or processed water, or other liquids, produced by industrial activity, particularly by such industries as pulp and paper production, food processing, and the manufacture of chemicals. Liquid waste is a common problem in both companies and homes. This waste comprises waste detergents, filthy water, organic liquids, wash water, and even rainwater. Point and non-point source liquid waste are two categories for liquid waste. Point source waste includes all manufactured liquid waste. Natural liquid waste is categorized as non-point source trash. Liquid waste is a byproduct of undesirable or dangerous human and animal behavior. Industrial and residential wastes produced by humans harm the environment.

According to Asterioa and Haryanto (2002), education that will be given can advance knowledge, environmental awareness, practical knowledge, and the comprehension of household waste management. Raising people's awareness is essential if separate garbage collection is to become a routine part of life at home, at school, and in the community. Environmental problems are primarily caused by societies with little environmental awareness. Practical education that turns garbage into useful goods helps pupils better comprehend the environment. Waste management should be incorporated into extracurricular and classroom activities on a regular basis to improve students' ecological awareness (Nizaar et al., 2020).

About 80–90% of the world's wastewater is released untreated into the environment, according to Abebaw (2017) and Manderso (2018). The environment and human health would both suffer if the created liquid waste is not effectively managed (Bienfang et al., 2011; Gbadegesin and Akintola, 2020; Jensen et al., 2018). Numerous studies have noted that waste management has been a significant concern worldwide as a result of the WHO reports (WHO, 2008). In addition to sanitation issues, inefficient residential wastewater management (LWM) can cause economic, environmental, and health issues.

According to research (Hounkpe et al., 2014), insufficient LWM has also contributed to the deterioration of air, soil, and water, the growth of insects and vermin, and the loss of attractiveness. Additionally, Funafuti's faulty LWM has a financial toll of almost $500,000 annually, while Tonga spends 5.6 million TOP (Lal et al., 2006). Poor trash collection, treatment, and disposal have a negative influence on the environment and public health in poorer regions of African towns. Sub-Saharan Africa is the region with the highest growth in the world's garbage production, even though high-income nations produce the most rubbish per person. Only 44% of rubbish is collected in sub-Saharan Africa; North Africa has greater collection rates. There are significant differences in collection rates between urban and rural areas as well as within cities.

The collection and treatment of waste water in Addis Ababa is complicated by the lack of sewage networks and treatment facilities. Only 7.5% of the built-up regions are served by a relatively small sewer network (MUDHCo, 2012). About half of houses in the country publicly discharge gray water into neighboring open spaces, roadways, and drainage systems (Manderso, 2018). The environment and human health will suffer if the created liquid waste is not appropriately managed (Bienfang et al., 2011).

1.2. Concepts related with liquid waste management

The terms environment, liquid waste, drains and sewerage, AAWSA, environmental management, liquid waste management, and environmental education were used most frequently in this study. These concepts are helpful because they clarify in depth the meaning of the terminologies used in this work, which aids the reader in comprehending it.

According to the "hazardous waste management and disposal control Proclamation No.1090/2018" environment is as the entirety of all materials, whether in their natural state or modified or changed by humans, their external spaces, and the interactions that affect their quality or quantity and the welfare of living things, including but not limited to land, atmosphere, weather and climate, water, living things, sound, odor, taste, social interactions, and more. The interdependent systems of physical, biological, and cultural components make up the environment. These components are connected in a variety of ways, both individually and collectively. These components are described below (Ahmed and Ismail, 2019).

(1) Physical elements: Space, landscapes, water bodies, climate, soils, rocks, and minerals are examples of physical elements. They determine the erratic nature of the human environment, as well as its possibilities and constraints.

(2) Biological components: The biosphere is made up of biological components like plants, animals, microbes, and people.

(3) Cultural components: The economic, social, and political components that make up culture are fundamentally man-made aspects.

Groundwater, river, and ocean pollution have the power to change the chemical composition of water. A large-scale oil spill can cause it all at once, or it can develop gradually, such as with a steady leak at a chemical processing facility. Aquatic habitats may be disturbed, and drinking water may become contaminated.

The soil may swiftly absorb liquid waste. Animals or people who ingest items produced in contaminated soil can also be harmed by this pollution, as well as plants growing in the soil. Although liquid wastes can also affect air quality, dust, gas, and fine particle pollution are more frequently linked to air pollution. For instance, bad odors are frequently associated with pollution from liquid waste, particularly from sewage systems (EEA, 2017).

The extraction of raw materials, the transformation of raw materials into intermediate and finished products, the consumption of finished products, and other human activities may all result in the production of waste. The place of generation does not include leftovers that are recycled or utilized again. The addition of unwanted or harmful nutrients or compounds to an ecosystem in the form of liquid is known as "liquid waste pollution." Food, water, and other habitat resources in a polluted area deteriorate in quality, sometimes to the point that certain species are forced to leave or go extinct if the pressure is too high (Alemayehu, 2004).

Liquid waste that contain, fats, oils or grease (FOG), used oil, liquids, solids, gases, or sledges and hazardous household liquids. These liquids are hazardous or potentially harmful to human health or the environment. They can also be discarded commercial products classified as “Liquid Industrial Waste” such as cleaning fluids or pesticides, or the by-products of manufacturing processes. Liquid waste is the waste produced in the house hold from washing of cloths, utensils, from kitchen and hand washing activates. It comes from house washing, car washing, latrine and bathroom. Wastes that are created by animal farms, chemical plants, leather factories, hospitals or clinics, storm water, garages, and the like are frequently mixed with water from rivers, rain, homes, businesses, and factories (Olumid et al., 2017). According to (Urbansky, 2001), liquid waste is any waste material that satisfies the definition of a "liquid." According to this, the chemical must "pass through a 0.45 micron filter at a pressure differential of 75 psi".

The infrastructure that transports sewage or surface runoff (storm water, melt water, and rainwater) through sewers is known as drains and sewerage (or sewage system). It includes parts of the combined sewer or sanitary sewer including receiving drains, manholes, pumping stations, storm overflows, and screening chambers (Randell, 2012). The capital city of Ethiopia, Addis Ababa, is served by the AAWSA Addis Ababa Water and Sewage Authority (AAWSA). According to NEC. (2011), environmental management is a topic that integrates economic,

political, and scientific applications. It focuses mostly on finding solutions to the practical issues that people have while interacting with nature, utilizing resources, and producing trash.

Environmental management, in a purely anthropocentric sense, is all about addressing the fundamental problem of how to continuously improve technology while minimizing the extent to which this process modifies the natural environment. As a result, environmental management is intimately related to concerns about maintaining fair and equitable resource distribution, guaranteeing sustainable economic growth, and protecting natural resources for future generations (Paul et al., 2016).

The term "environmentally sound management of wastes" refers to using all reasonable efforts to handle hazardous wastes in a way that safeguards both the environment and human health from any negative impacts. EPDRF, The "Hazardous Waste Management and Disposal Control Proclamation No.1090/2018" is a significant component of environmental management and is devoted to the development of environmental policies to ensure that various human activities do not adversely affect the environment. Government-created environmental laws and regulations establish minimum standards that cannot be surpassed. These standards include maximum permissible pollutant concentrations in soils, air, and water, which are established by in-depth scientific investigation and observation.

Knowledge, sentiments, emotions, attitudes, and values are all relevant to teach people about how natural environments work, particularly how they may control their behavior and ecosystems in order to live sustainably. Its goal is to create informed, responsible people who can take an active role in all environmental issues. According to the Geographical Association's Environmental Education Working Group, 1980, environmental education is studied in two main ways: as interdisciplinary and multidisciplinary but with a shared focus; a variety of processes and activities by which an understanding of the environment is developed and through which caring and committed responses are evolved. According to Parween and Ramanathan (2019), liquid waste management is a systematic administrative activity that ensures correct wastewater collection, handling, treatment, and disposal.

1.3. Statement of the Problem

In most poor countries, including Ethiopia, there is a lack of information, particularly on the understanding, usage, and difficulties of managing liquid wastes, and this needs to be carefully addressed. Although population growth is a key driver of development, when it reaches the threshold levels allowed by the support systems, it becomes a significant contributor to environmental degradation. Population pressure on the environment is linked to environmental pressures such biodiversity loss, air and water pollution, and increased demand on arable land (Mahavidyalaya, 2011). Population effects the environment primarily through the use of natural resources and the creation of waste. The current projection for Addis Ababa's population in 2023 is 5,460,591, about 392,000 people were lived in Addis Ababa in 1950. In the most recent year, Addis Ababa increased by 232,797, or 4.45% annually (UN, 2018).

The generation of both solid and liquid trash has been rising proportionately to the city's population development. Today, all rubbish in Ethiopia is dumped along the sides of the roadways, even in major international cities like Addis Ababa, where it eventually joins smaller streams or rivers and flows downstream, polluting the water. All the trash that is drained into waterways is cleaned up by the winter rains. Even while the harm caused by trash exposure to waste materials depends on a number of conditions, typically liquid wastes are more poisonous than solid wastes since they may be ingested more readily by humans. Sanitary waste, dairy waste, liquid industrial waste, laboratory wastes, and other types of liquid waste are some of the most dangerous ones. *Wereda* 9 LWM is a worry for *Gulele* Sub City, which is a part of Addis Ababa City. Despite the outstanding efforts anticipated in the past, *wereda* 9 environment still requires more attention. Therefore, it is essential to increase knowledge, practice, and minimize obstacles when it comes to handling liquid waste if you want to live in a clean and healthy environment. Liquid waste management includes critical measures for handling and treating liquid waste.

The pace of sanitary development in the city has been slow, which is consistent with a prior Addis Ababa assessment (AAWSA, 2010). So, unfortunately, the general state of poor understanding, poor practice, and excessive challenges burden is still present today. Liquid waste should never be disposed of improperly because it pollutes the air, water, and land. Improper management of effluents waste can also have a negative impact on the general public's health.

This study was carried out in Addis Ababa due to a number of factors, including the city's growing population, which has led to changes in waste composition and volume, as well as the level of ignorance, improper behavior, and extraordinary challenges. It also sought to determine whether people were at risk of exposure to hazardous substances now as well as in the future. According to the FDRE environmental proclamations, the data and results of this study will be used as a baseline for future research, to design laws, rules, and regulations. The proposed study's results will also assist AACA authorities in taking better and more effective action to reduce and control the negative environmental effects of liquid waste.

1.4. General Objective

The general objective of this study is to analyze awareness, practice and challenges of liquid waste management in Addis Ababa.

1.5. Specific Objectives:

i. To analyze the level of societal awareness regarding the handling of liquid waste

ii. To assess the practice of liquid waste management in *Gulele* sub city *wereda* 9

iii. To identify the challenges for the implementation of LWM in the study area

1.6. Research hypothesis Questions

This study has three specific research questions as follows;

i. To what extent is society aware of how to manage liquid waste?

ii. What are the processes used by *Gulele* sub city *wereda* 9 on liquid waste management?

iii. What are the confrontations for the implementations of LWM in the study area

1.7. Significance of the study

This study will help us understand the existing state of knowledge, actual practices, and difficulties associated with managing liquid waste in the wereda 9 Gulele sub-city. As a result, these insights will aid in formulating strategies and reduce costs associated with infrastructure, healthcare, and environmental harm. Furthermore, as members of society, it is our duty to manage liquid waste in a way that improves environmental safety and cleanliness. The researcher thought that this thesis's findings might significantly help stakeholders understand the factors that influence the management of liquid waste. This indicates the existence of determinant factors on the efficiency of liquid waste management, and our study will play a significant part in bridging that imbalance. This study contributes to the sparse body of knowledge concerning sustainable liquid waste management techniques in the city by elaborating on the factors impacting the development of liquid waste management. This study can therefore serve as a starting point or just as inspiration for further extensive research.

Maintaining a clean and fresh environment is waste management's main benefit. As all of the resulting wastes are appropriately disposed of and handled, these waste disposal systems also help to keep the population disease-free. When waste is managed properly, it not only gets rid of the rubbish around it but also lessens the amount of greenhouse gases like methane and carbon monoxide that get released when waste builds up. The collection, transportation, disposal, and treatment of liquid waste properly will reduce the adverse environmental aspects. There are some businesses that pay for trash, such as spent grease and oil that has been burned. The waste is then collected, reprocessed, and recycled, and the finished product is then used appropriately for different things, like base oils or lubricants. Maintaining a clean and fresh environment is waste management's main benefit. As all of the resulting wastes are appropriately disposed of and handled, these waste disposal systems also help to keep the population disease-free.

1.8. Delimitation/ scope of the study

The study examines the issues associated with managing liquid waste in Addis Ababa's *Gulele* Sub-City *wereda* 9. In a study area, the researcher addressed the knowledge, usage, and difficulties caused by liquid waste.

1.9. Limitations of the study

The research was done in the Addis Ababa *Gulele* sub-city *wereda* 9; however, because I am a self-funded student, there time constraints due to juggling a job and the research project.

1.10. Structure of the study

The study is divided into five chapters, the first of which contains an introduction section on the effects of liquid waste on environmental management, the study's background, problem statement, objectives, and research questions, as well as its significance, scope, limitations, and structure. Chapter 2 also discusses the review of the literature that has been produced by various researchers. This chapter offers the definition of essential words and knowledge gaps in addition to general information regarding liquid waste awareness, practice, and difficulties that are related to liquid waste on environmental management. Chapter three also discusses methodologies that the researcher employed in collecting data during the study, the research design used, and sample techniques. Chapter four of this study will discuss and present data from the investigation of the the awareness, practice and challenges of LWM in *Gulele* sub city *wereda* 9. Chapter 5 is the last chapter, where a researcher draws conclusions and offers suggestions on the investigation into the awareness, practice and challenges of LWM on the environment in the *Gulele* sub-city of *Wereda* 9.

CHAPTER TWO

2. REVIEW OF THE LITRATURE

2.1 Theoretical review

2.1.1 Awareness on liquid waste management

It is a proven truth that environmental education for children should be given top priority because it is an efficient waste reduction technique. In order to conserve the environmental resources for future generations, it is anticipated that this will alter students' problem-solving strategies and abilities. Including the circular economy in college and higher education institutions' curricula will be a catalyst for transformation that will result in good change for succeeding generations. (Franke and Remmele, 2022).

The staff members directly working in WM in the public and private sectors must also receive specialized and tailored training. This will provide the technical expertise to enable the adoption of legislation and the efficient application of laws to ensure sustainable WM. Additionally, the training will foster and impart the correct understanding and appreciation of the significance of WM at the political and governmental levels to support effective decision-making on WM-related issues (UNEP, 2012).

The education of young people in the field of environmental protection both in family and in schools is a priority, representing an efficient way to reduce the amount of waste. In this direction, studies have been carried out certifying the importance of education and training in the field of environmental protection, raising public awareness of environmental responsibility, minimally invasive environmental lifestyles based on recycling and waste reduction, essential components for sustainability (Rada et al. 2016), from a worldwide perspective of resource management, education and awareness in the domain of waste and waste management are becoming increasingly crucial. The survival of humans and thousands of other living species, the integrity of the earth and its biodiversity, the security of nations, and the legacy of future generations are all at risk due to local, regional, and global air pollution, the accumulation and distribution of toxic wastes, the destruction and depletion of forests, soil, and water, the ozone layer depletion, and emission of "greenhouse" gases.

Urban communities can be educated and made aware of the waste management process through many channels, according to Fredrick et al. (2018) and Al-Khatib et al. (2015). These channels include public meetings, media use, household head training, NGOs and private firms, active organizations in education, and NGOs. Educational institutions should convey a clear picture of waste characterization, waste strategies including recycling, waste collection, health issues, and other issues while promoting awareness and comprehension of trash. It is feasible to disseminate the waste and recycling message in a fun and engaging way utilizing a variety of media, including TV, radio, posters, displays, pamphlets, websites, public events, and national promotional campaigns (Pushpendra and Avinash, 2020). It is necessary to educate communities on the value of good personal and household hygiene. Usage of pit latrines, hand washing after defections, and proper handling and storage of water for home usage are all examples of this. Pit latrines must be built a minimum of a safe distance away from water sources in urban areas. In metropolitan areas, water wells must be at least 30 meters deep (DAWASA, 2000).

According to Asterioa and Haryanto (2002), the education that will be given on WM can advance knowledge, environmental awareness, practical knowledge, and the comprehension of household waste management. Raising people's awareness is essential if separate garbage collection is to become a routine part of life at home, at school, and in the community, environmental problems are primarily caused by societies with little environmental awareness. Practical education that turns garbage into useful goods helps pupils better comprehend the environment. Waste management should be incorporated into extracurricular and classroom activities on a regular basis to improve students' ecological awareness (Nizaar et al., 2020).

Learning, changing attitudes, and developing skills in the area of resources, particularly waste management, are all accomplished through education. Environmental pollution and diseases linked to trash can be reduced via waste management techniques. It has been demonstrated that public education enhances waste management practices in the city and can also improve the reuse, recycling, and recovery of waste materials (Fredrick et al., 2018). Early education guarantees that future generations will support environmentally friendly waste management techniques (Zainu & Songip, 2017).

According to the WWDR (2017), water reuse plans can fail if planners do not take account for the dynamics of societal acceptance, even if wastewater use projects are technically well constructed, seem financially realizable, and have included acceptable safety precautions. Due to a general lack of knowledge and trust on the risks to human health, the use of wastewater typically meets with substantial public opposition. The most effective methods for removing societal, cultural, and consumer barriers are awareness-raising and education. The target audience for these awareness initiatives must include customers from various ethnic and religious backgrounds. In order to acquire public acceptance and to maximize the advantages of using wastewater while reducing the negative effects, the health hazards connected with water reuse must be examined, handled, monitored, and reported on a regular basis. To develop system trust and get past the "yuck" issue in the case of drinking water (i.e. potable water reuse), substantial communication campaigns are needed.

2.1.2 Liquid waste management practice

There exist no production activities which transform material / energy inputs completely in desirable goods; waste will always be a by-product. This waste can be reduced during the production process by (labour) cost increasing efforts or it can be partly recycled at the “end of the pipe“ by using labour as an input (Fullerton and Kinnaman, 1995). For 2016 it is estimated that only one-third of the generated waste was valorized through recycling and reuse (Kaza et al., 2018). This represents considerable wasted resources. In addition to the depletion of resources as an environmental challenge, the collection, treatment and uncontrolled disposal of waste cause environmental impacts.

The economic and environmental performance of the entire system can be impacted by the way that materials are collected and sorted. In many instances, the collection point will be an interface where waste generators and waste collectors that must be carefully managed if the system is to be effective. Waste generators require waste collection with minimal inconvenience, while collectors must be able to collect waste in a way that is compatible with the planned treatment and processing methods if the waste management system is to be sustainable (McDougall et al., 2001).

According to KNUST (2016), poor sanitation results in substantial expenses for low-income households. This supports (Wang, 2014), who explains that for a technology to be sustainable, it must be applicable, which means that it must be economical for the operators. In order to choose the most appropriate method of application, each of these areas must be evaluated. The facility's management was ineffective under the previous adoption procedure, which involved a system that was accessible internationally. Every manager in sub-Saharan Africa has carried an albatross around the neck of managing LWDS in the sub-region. No leader would be happy to see their people living in an unhealthy atmosphere, thus this is relevant. It became clear that the scenarios were comparable after touring the major cities of two chosen sub-regional nations, namely Nigeria and Ghana, and comparing them to the research on the sub-region's LWDS's reliability. This led one to wonder about the reasons it would be so poorly managed, particularly in the sub-region.

Numerous inquiries occurred, including the following: why do executive leaders not follow successful models in regions where LWDS is effectively managed?, why is this issue given the same level of importance as other governmental-controlled fields like education, agriculture, economic management, mining, and fuel, to name a few? The answers to the two questions above provided a clear picture of the mindset of political decision-makers in the sub-region over the previous few years. Despite being in operation, Accra's main LWDS, which connects the city's most desirable suburbs to the Mudor facility, has long since been broken, allowing liquid waste that hasn't been treated to flow into the Korle Lagoon. The Lavender Hill Fecal Treatment Plant, a second facility, handles septic truck discharges. Although this facility, which was commissioned in 2016, had been in use for five years, there were plans for an outright replacement to expand the system at the time this data was collected because the then capacity of 2000 m3/day did not meet the expected capacity of 6000 m3/day (Joseph and Amervi, 2022).

We can really use fewer natural resources, such as water, oil, energy, fuel, metals, and gas, by recovering, reusing, and recycling materials, objects, and component parts. Significantly, improving a product's waste prevention design is the best strategy to lessen environmental harm. Reducing the use of fresh resources and recycling recovered materials has many benefits. First of all, it helps to conserve natural resources and avoid utilizing virgin items. Second, it makes it easier to reuse recovered components or portions repeatedly. Thirdly, by using less new

resources, it lowers the procurement costs. Fourthly, and most critically, it reduces pollution while also avoiding needless trash and land filling. The environment, economics, and society all contribute to the creation of a sustainable future (Pandey et al., 2018).

Waste management requires effective waste collection. The manner in which resources are gathered and sorted can have an effect on the overall system's economic and environmental performance. If the system is to be successful, the collection site will frequently serve as an interface between waste sources and garbage collectors. If the waste management system is to be sustainable, waste generators must be able to collect trash with the least amount of inconvenience, and collectors must be able to collect garbage in a way that is compatible with the intended treatment and processing procedures (McDougall et al., 2001).

The traditional septic tank and soak away systems are gradually becoming obsolete, especially in commercial structures like shopping malls, multi-story offices, etc. This is due to the fact that having huge septic tanks is not economically feasible given that many visitors are anticipated at specific times of the year due to anniversaries and other events. One may picture typical septic tanks installed at retail centers, regional and district hospitals, market squares, and schools, as well as the results if effluent from these septic tanks overflowed into nearby streams. What transpires under persistent downpours? According to water management organizations in Africa, there is a continuous war on water use as water bodies become less accessible. What transpires in the construction sector, where water is a key component? Sand might be useful for construction. How about the countless design ideas that are now on the market that address the requirement for environmental protection as well as the use of byproducts like biogas for cooking, the creation of power, etc. Knowing that each of these is a by-product that can be recycled to make money will help reduce the costs associated with operation and maintenance (Joseph and Amervi, 2022).

The size and type of collection equipment that is best for any business will rely on a number of variables, including the size of the facility, the volume and weight of the trash being handled, the amount of storage space that is available, and the prices (CCME, 1996). The chosen resources allocated to a waste management framework will be influenced by the desired outcome, i.e., is the objective to maximize recycling and reuse and raise diversion rates, or is the goal to satisfy regulatory requirements? The amount of processing equipment required will depend on the size of the business and the type of trash being generated. Large amounts of materials can be handled

and stored with the use of processing equipment. The volume of liquid waste can be greatly reduced by processing waste items like chemicals. The environmental and health risks associated with trash disposal in streams and bodies of water are also significant. Residents who do not have access to formal waste collection services frequently resort to dumping their waste in nearby bodies of water in cities like Freetown and Kampala, which results in water pollution and urban flooding (Niekerk and Weghmann, 2019). Problems arise even when city administrations collect rubbish since untreated waste frequently builds up in dumpsites, which, depending on the site's location, might result in issues with water pollution.

Trade-related tool washing and cleaning generate liquid waste that must be properly managed, either on- or off-site. This is because the waste may contain toxic liquids, gases, or solids that are hazardous to the environment, human health, and groundwater. Large volumes of silt, chemicals, oils, and greases can all clog pipes, leading to overflows, pungent odors emitted into the environment, and issues in downstream wastewater treatment facilities as well. The effluent from wash bays needs to be properly caught and cleaned of these toxins (Cleana, 2021; Icon, 2020).

2.1.3 Challenges of liquid waste management

Sub saran Africa countries leadership must be encouraged to embrace the circular economy model and fully implement it to protect the environment by building WM infrastructure and committing more financial resources. Sub Saharan African countries need to endorse and enforce environmental sanitation-related regulations and policies and develop the capacity of the personnel involved in WM services. This will help to improve both economic and environmental development. Furthermore, sub saran African leaders must strictly follow the circular economy model to boost products and service design, which will assist in preserving resources from depletion, environmental deprivation, and generating less waste. Since the circular economy provides a framework encouraging development, sub Saharan African countries must adopt it and develop it to ensure environmental sustainability and contribute to achieve the sustainable development goals (Ayelaru, 2020).

The collection and treatment of waste water in Addis Ababa is complicated by the lack of sewage networks and treatment facilities. 7.5% of the built-up regions are served by a relatively small sewer network (MUDHCo, 2012). The city's water supply network and the system for refining liquid waste occasionally overlap, which is being addressed by the current work on the pipelines. However, right of way restrictions present the installation project's biggest hurdle. The city historically lacked adequate liquid waste management pipes (Addis Fortune, 2015). The establishment of a regulatory framework and the adoption and enforcement of pollution control legislation are required. Mechanisms for providing financial and tax incentives to industries for the construction of pollution control facilities must also be investigated. The government must investigate ways to penalize those who pollute the environment (DAWASA, 2000).

The main problems with wastewater management include a lack of stakeholders, a lack of awareness and participation, and excessive mitigation costs. In addition, these are the fundamental problems that various actors in the wastewater industry have recognized. According to MoWIE (2015), water supply is given less priority by the government and actors than liquid waste management infrastructures (sewerage lines, vacuum tracks, public restrooms, disposal sites, and treatment plants), there are multiple implementers who overlap their responsibilities, confusing respected sectors, and there is insufficient coordination between various sector offices. In Ethiopia, there is no clearly defined role or responsibility for an urban sanitation development program that carries out the specified tasks with an adequately organized institutional workforce; liquid waste management requires a significant financial investment for sewer line installation and absorption trench construction; there is a high rate of population growth and incompatibility with services; and there has been a failure to engage the community and make them active participants. Clinical liquid waste collection, transportation, treatment, and disposal present significant issues for Ghana's healthcare facilities. These difficulties are further exacerbated when governmental institutions with the responsibility for ensuring the safe disposal of clinical waste are unable to monitor and assess the conditions of clinical waste prior to their release into the environment because of actual logistical limitations. As a result, there is a risk to the public's health when healthcare officials violate best practices and clinical liquid waste management requirements by discharging untreated liquid waste into untreated natural water bodies Nema et al. (2011).

2.1.4 Integrated strategy for liquid waste management

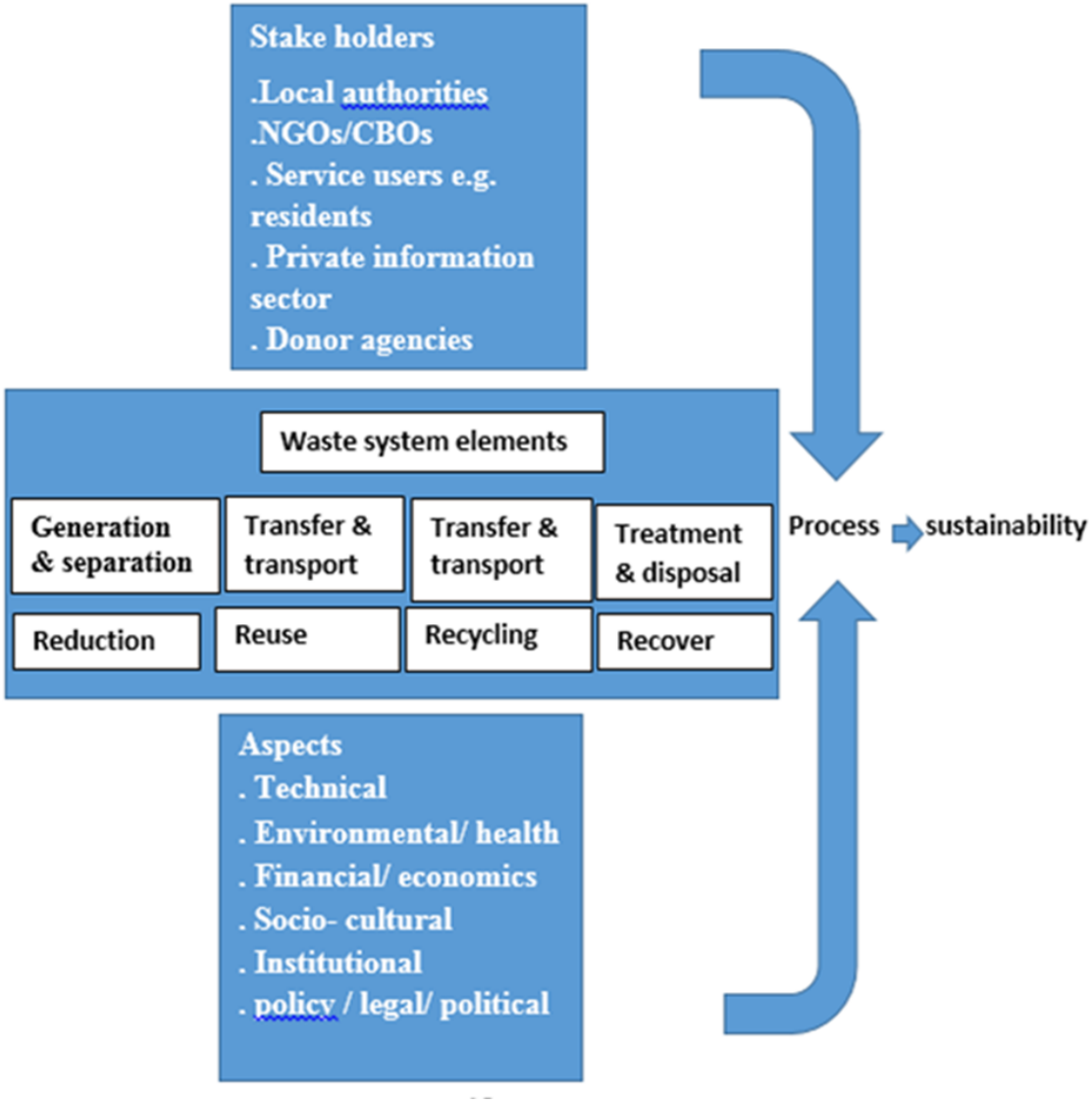
According to the integrated sustainable waste management (ISWM) theory, there are three main elements: the stakeholders who are impacted by or involved in waste management, the technical or operational components of the waste management system, and a variety of 'aspects' that directly influence waste management, such as political, environmental, and cultural factors (et al., 2018). Waste reduction and recycling are essential components of the hierarchy of modern liquid and solid waste management because they simultaneously decrease the amount of waste sent to landfills and the amount of waste that needs to be treated, which lowers the cost of treatment (Hounkpe et al., 2014).

We have now entered a time when efficient resource utilization and lowering consumption levels are increasingly important for maintaining world prosperity. The three R's "reduce, reuse, and recycle" are often become a cornerstone of sustainable trash management initiatives due to rising garbage creation rates, rising processing costs, and shrinking landfill space, these techniques can have a significant positive impact on the environment. They lessen or stop the release of pollutants, save energy, save resources, and lower the need for waste treatment facilities and disposal areas (Tudor, 2011).

Reducing consumption of goods and services is another way to reduce in many situations. Reduction is prioritized at the top of the waste hierarchy because it is the most efficient strategy to reduce waste (USEPA, 2010). Reusing products is an effective way to reduce in many situations. Reusing goods or liquid wastes repeatedly eliminates the need to pay for or purchase new goods, which reduces waste production. Reducing waste through reduction and reuse has a number of benefits, such as lowering costs associated with waste disposal and reducing the need for natural resources to create new products and the wastes produced during the manufacturing process (USEPA, 2010).

It is often possible to divert and recycle this waste to create useful new materials. Recycling products has many advantages over waste reduction efforts, such as reducing the need for new materials, waste generation, and disposal costs, but recycling is less advantageous than reduction and reuse because it requires energy and some new materials, it designed to ensure that waste management procedures are as ecologically friendly as possible (UC Davis, 2008; USEPA, 2010).

Waste management hierarchy is a widely accepted system for managing municipal liquid wastes. Additionally, it prioritizes waste avoidance and waste reduction techniques and initiatives, with treatment and disposal being the least preferred choices. The hierarchy is a practical tool for policymakers to conserve resources, address landfill shortages, reduce air and water pollution, and safeguard public health and safety. Since traditional waste avoidance, reuse, and recycling activities are common in many developing nations, certain elements of this hierarchy are already in place (UNEP, 2012).



Source: Adamoski, 2020

Figure 1. The Integrated Sustainable Waste Management framework

2.1.5 Types and sources of liquid waste

Depending on the source, liquid waste might vary in type and substance. The primary sources in urban areas are homes, businesses, and industry. To create effective waste management methods and mechanisms to handle liquid wastes, we require reliable information on their characteristics. According to the AAWSA, (2000) report, domestic animals, inadequate solid waste management systems, pit latrines and septic tanks, government and private institutions, industries, and factories are the main sources of surface and ground water pollution in Addis Ababa. Other sources include surface runoff, waste water treatment plant effluents, sewage lines, and domestic animals.

Table 1: Liquid waste: Sources, Types and characteristics

Sources	**Typical waste generator**	**Types of liquid waste**
Residential	Domestic dwellings with access to a piped water supply and also from business premises and the various institutions, such as schools and health centers, found in residential areas.	Include those from food preparation, washing, bathing- grey water , toilet usage- black water
Commercial	Business establishments, shops, open market places, restaurants and cafes	Effluent from restaurants and cafes may contain high levels of fats, oils and grease from cooking processes- only human-related activities
Industrial	Chemical industries, tannery, food processing, Agriculture, construction, energy, textile industry	Hazardous chemicals, organic wastes, on-site washing out, Oil and water mixtures, heavy metals
Storm water	Surface run off caused by rainfall	Chemicals, sewage overflow, cooking oil, bacteria from pet waste, used motor oil, fertilizers, paint and construction debris.

Source: Open University, (2023), Liquid waste: Sources, Types and characteristics

2.1.6 Characteristics of liquid wastes

According to their physical, chemical, and biological features, liquid wastes can be classified. Water is never 100 percent pure by nature. The majority of the water sources on earth are replenished. When it rains, water moves over the surface (runoff) and through the soil (infiltration), where it picks up a range of dissolved or suspended pollutants that drastically reduce its utility. Due to its special physical, chemical, and biological characteristics, water is a necessary component of both animal and plant life. The types and distribution of aquatic biota are directly influenced by these traits as well. The features of water quality serve as the foundation for all criteria for the prescribed discharge of wastes into water bodies. Additionally, these qualities play a key role in the improvement of water quality and formulation of regulatory actions. (Pooja, 2017).

Physical characteristics of liquid wastes

***Solids*:** wastewaters may contain solid particles that are carried by the flow. These could be suspended solids or settle able solids. When the flow rate is slowed, as occurs when wastewater is kept in a tank, settle able solids sink to the bottom (settle out). Small particles known as suspended solids stay in suspension in water; they do not disintegrate in wastewater but are transported along with it. By filtering out and weighing the solids in a specific volume of water, the solids content can be calculated. In a lab setting, filter paper is weighed, a specific amount of water is poured through it, the paper is allowed to dry, and then the paper is weighed once more. The mass of solids equals the difference in mass.

***Temperature*:** in general, wastewaters are warmer than the surrounding air. This is due to the possibility that warm or hot water from industrial operations or home tasks like taking a shower could end up in the waste stream. The temperature is stated in Celsius (^{o}C) degrees.

Wastewaters may have an odor, which is often caused by the production of gases during the biodegradation process. The destruction (or breakdown) of organic materials by bacteria and other microorganisms is known as biodegradation. Any material that comes from living things is considered organic matter, including animal and human waste, food scraps, paper, and agricultural waste. Odor detection is frequently an individualized process, yet it is nevertheless possible to quantify it in terms of smell units.

Chemical characteristics of liquid wastes

Organic matter, a frequent source of pollution in surface waters, can be found in wastewaters from a variety of sources. Bacteria and other microorganisms that are naturally found in fresh water will breakdown organic waste if it is thrown into a river or lake, and they will do this by using the dissolved oxygen present in the water. If there is a significant amount of organic matter present, most or all of the dissolved oxygen may be used up, depriving other aquatic life forms of this vital component. The term "oxygen demand" refers to how much oxygen is consumed during the breakdown of organic materials. A measurement known as the biochemical oxygen demand (BOD) can be used to determine this. BOD tests are performed in a lab and entail counting how much oxygen is consumed, often over the course of five days, while the organic matter in the wastewater decomposes. As a result, the wastewater's organic matter is being broken down at a rate measured in milligrams per liter per milligram.

The chemical oxygen demand (COD) test is another chemical technique for estimating the level of organic matter. Compared to the BOD test, this one may be completed in just two hours. Instead of biological decomposition, it depends on chemical oxidation of the organic substance. To oxidize the organic materials, a sample of wastewater is heated with a combination of strong acids and a precise amount of oxidizing agent. At the conclusion of the test, the amount of oxidizing agent left is quantified. The amount that has been consumed is the same as the sample's organic content. Once more, the result is given in milligrams. Because the chemical process may oxidize more material than the biological process, COD typically yields better results than BOD.

Inorganic compounds can be found in wastewater as well. This refers to any material that is not derived from either plants or animals, which covers a wide spectrum of chemicals as well as inert solids like sand and silt. There are many inorganic chemicals dissolved in the water, and while some of them are safe, others are pollutants that can harm fish and other aquatic life as well as other water-dwelling organisms. Ammonia (NH_3), which can be found in both human and animal excrement, is one example. Ammonia is decomposed in the environment by natural processes in a similar way to how organic matter is. When ammonia is released into a river, microorganisms transform it into the less hazardous nitrate (NO_3).

If there is too much ammonia present, the natural conversion of ammonia to nitrate will be limited. Chloride (from salt), phosphates (from chemical fertilizers and from human and animal waste), and metal compounds (from mining activities or metal-plating factories) are further examples of inorganic chemicals found in wastewater.

Biological characteristics of liquid wastes

The bacteria and other microorganisms found in liquid wastes come from a variety of sources, including human waste and other sources. While many of these bacteria are helpful and are in charge of degrading the organic waste components, some of them may also be dangerous. Bacteria are common and anticipated in wastewater, but they become a concern if the waste is not kept away from people or if it contaminates food or clean water. The most important part of sanitation and hygiene is the proper handling and disposal of any waste that contains human excreta, which is necessary to stop the spread of infectious diseases.

Zero waste focuses on reorganizing production and distribution networks to cut waste, rather than just eliminating trash through recycling and reuse (Young et al., 2010). One crucial aspect of the zero waste philosophy is that it is more of an ideal or goal than a concrete objective. Zero waste calls for strong participation from industry and government since they have many advantages over ordinary citizens and the focus of zero waste is on reducing waste from the start. In actuality, industry and the government will need to make major efforts and take action before zero waste can be achieved (Connett and Sheehan, 2001). Design of products and packaging, production procedures, and material choice are all under the control of industry (Townend, 2010). Governments also have the power to create comprehensive waste management strategies that aim to eradicate trash rather than manage it, as well as to form policies and offer subsidies for improved product manufacturing, design, and sale (Snow & Dickinson, 2001).

2.1.7 Liquid waste generation, storage, collection, transportation, treatment and disposal practices

Depending on the kind and composition of the liquid waste, several processing methods are used. Before the liquid waste is stored and collected by a processing facility, the waste generator must classify it. To ensure that the garbage can legitimately be held and/or processed at their facilities, the receiving and processing facilities must make sure the waste has been appropriately categorized. Additionally, it is the duty of the processing facilities to guarantee that the various forms of liquid waste they take can be kept, processed, and treated properly with established standard operating procedures and without the mixing of incompatible wastes (NSW EPA, 2016).

Liquid waste can be produced by industrial processes such as manufacturing and oil and gas exploration and production, or it can be septic or grey water, which is waste generated by sanitary equipment such as portable toilets, comfort stations, or septic tanks.

Storage of liquid waste can be:

a. Dry Toilets: Such toilets are mainly non-flushing toilets or waterless toilets with minimal or no use of water. They are also termed compost toilets as they recycle/compost waste for its reuse.

b. Flush Toilet: Toilet which utilize water for flushing of waste. Flush toilets can be pour flush or cistern flush. Sanitation facilities can be classified as on-site and off-site depending on disposal of waste.

a. On site sanitation: Such system aim to contain wastewater at the point of generation. Septic tank, pit and soak pit toilets and eco-san toilets which do not require sewer/transportation etc. are types of onsite sanitation systems. Seepage in septic tank, however is transported through mechanical means at frequent intervals.

b. Off-site sanitation: Systems which require transportation of wastewater to another location for disposal, treatment or reuse are termed as off-site sanitation systems. Normally, such systems require sewer system or mechanical transportation of waste. The off-site sanitation can be centralized (at single point in town/village) or decentralized (at communal level).

Within many firms, waste is generally handled in one of two ways: custodial collection, or self-haul collection. Custodial collection involves custodial staff collecting and transferring of waste. This typically involves emptying out and maintaining publicly accessible collection bins and transferring them to a larger storage container which is typically located in a centralized area with controlled access. With self-haul collection systems, employees are responsible for ensuring that their waste is managed and sent to a collection point. This essentially means that there are no custodial staff who are responsible for handling waste. Employees are responsible for collecting and handling waste as part of their regular duties. Examples of organizations which may not have dedicated custodial staff include restaurants, supermarkets and convenience stores. With organizations like this, a greater number of people are involved with managing and handling waste. This is an important consideration, particularly with respect to educational efforts. Storage containers and storage areas must have enough room to allow for the easy movement of collection carts, access to the larger storage bins, and compliance with health and safety regulations (CCME, 1996).

The size and type of collection equipment most suitable for any firm will depend on a variety of factors such as: facility size, waste volume and weights, storage space available, characteristics of the waste being handled, and costs (CCME, 1996). The desired outcome will impact the chosen resources devoted to a waste management framework i e: is the goal to increase diversion rates and maximize recycling and reuse; or is the goal to satisfy regulatory requirements?

The sewer line is connected to Kality treatment plant and sludge is transported to Kotebe treatment plant using vacuum trucks that empty septic tanks. The treatment involves circulation of sewer in various ponds for about 30 days in order to make the level of BOD fall below 5 mg/L (Mohammed, 2007). Ministry of Water and Energy (MoWE), Ministry of Health (MoH) and Currently, small vacuum trucks collect material from septic tanks and pit latrines, bring them to a transfer station where the material is loaded onto bigger tankers and from there being transported to the liquid waste treatment plant. The possibility of unloading contents of vacuum trucks into the sewer should be investigated, as it can result in significant cuts in journeys, associated cost, and would free up trucks to provide services to customers. This task does not require any input of external expertise, but can be undertaken using AAWSA's knowledge of the city and its sewer network. It is best to identify locations that are near to the known areas of vacuum truck operations, provide convenient access for site traffic, and are sufficiently set back from

residential areas as to not cause any odour nuisance to residents. To avoid blockages in the sewer pipes the collected waste must be separated and transported in accordance to its quality. Material collected from septic tanks can potentially be offloaded to sewers while this is not possible for material from pit latrines. It is also not advisable to offload sewage from septic tanks mixed with material from pit latrines, as this increases the risk of sedimentation in the sewer and potential blockage. This means that material from pit latrines needs to be transported to the liquid waste treatment plant by road. For offloading material from septic tanks, it is best to choose sewers with base flows capable to prevent settling of sludge.

The management of water supply and sewage disposal is the responsibility of the Addis Ababa Water Supply and Sewerage Authority (AAWSSA). It operates with two wastewater treatment plants namely Kality and Kotebe and a centralized sewerage system. Kality waste water treatment plant contribute about 29% city's waste water treatment coverage. It collects waste water From 7 sub cities except Bole, Yeka and Kality through trunk links using 500 mm and 1500 mm and also use trucks.

Mobile plants being introduced use a biological technology called Membrane Bio Reactor (MBR), a containerized system that refines waste electromagnetically. The treated water will be transferred to underground pools and reused for other purposes. The MBR units will add 20,000 cubic liters of treatment capacity to the existing 7,500 cubic liters. Using stabilizer ponds takes a longer time and is less effective in terms of quality. The MBR refining system is more efficient and meets the standard of the Environmental Protection Authority to release treated liquid waste into rivers, Jemila Mohammed, Sewerage Treatment & Reuse Sub Process head at AWSSA said. The system is well advanced and 100pc effective in purifying, making the end product free from bacteria, and ready for reuse. It is also space efficient, and takes less land, unlike the stabilizer ponds, Jemila says. It also produces no bad smell while in operation.

With the civil works of the stations carried out by a local company named Jemal Ahmed General Contractor, portable liquid waste refinery containers are currently arriving at the Djibouti Port, with delivery to be completed by September 2015. The equipment is supplied in two lots. The first lot for Bole Bulbula, Degnet Kara Qore and Mekanisa Kotari condominium sites, is being supplied by Portuguese company, Manihos Plc, in partnership with a local company, Tsemex Global Enterprise.

• Once the waste is collected in pit, septic tank etc., it further disintegrates and can be termed as follow:

a. Sludge: It is the settled solid matter in semi-solid condition in any collection/storage system. The term sewage sludge is generally used to describe residuals from centralized wastewater treatment, while the term seepage is used to describe the residuals from septic tanks. Solids or settled content in pit latrines and septic tanks are also called fecal sludge.

b. Scum: Impure matter like oil, hair, grease and other light material that float at the surface of the liquid in septic tank.

c. Effluent: Wastewater that flows out of a treatment system. It is partially treated.

• Generally 80 percent of total water supplied is expected to be discharged as wastewater. In urban areas sewers are designed for minimum 100 liters/capita/day discharge (Source: CPHEEO). Thus, it can be assumed that a household (5-6 people) generate approximately 400-500 liters wastewater/day where there is adequate piped water supply.

What is Ecological Sanitation Ecological sanitation is a form of sanitation which involves reuse of human fecal waste/ liquid waste and its nutrient back into local environment, thus avoiding pollution of land, air and water resources. The system involves treatment of human fecal waste and wastewater and reuse of the treated products. The system produces two types of products:

a. Manure for agricultural use.

b. Treated water that can be used in agriculture or gardening, flushing in toilets and aqua culture.

Considerations When Choosing Your Liquid Waste Disposal Method

No single waste disposal technique is most effective for every situation. When you choose a liquid waste disposal method, you'll need to weigh the pros and cons, assess your waste generation patterns and disposal requirements and make a decision that best suits your needs.

2.2 Empirical review

2.2.1 Awareness on liquid waste management

According to certain studies, household trash disposal technique is related to either awareness of at-home safety or understanding of the harmful health effects of garbage (Okechukwu et al., 2012). To prevent direct contamination and exposure to infectious and harmful substances to health from home garbage, for instance, safety behavior is necessary. On the other hand, spreading knowledge can encourage people to adopt safe behaviors and positive attitudes.

In Guinea, there aren't enough initiatives to educate the public about the link between environmental pollution and health, and no plans have been made for a long-term assessment that would allow for an analysis of how effectively the initiatives are reducing problems with environmental health. In order to ensure the long-term safety of the disposal of long-lived waste, research and development in waste management should continue.

The optimization and streamlining of urban waste management have been shown to benefit from public education, according to analysis based on a cross-sectional, multistage survey. However, the analysis also highlights the lack of education in the areas of waste separation and organic waste management, which account for more than 50% of the total amount of waste produced in major cities. Even at an early age, students can learn about garbage recycling, reuse, recovery, and composting in the classroom. As a result, Rada et al. (2016) highlight the need of educating young people about environmental preservation and the example they may set for their families in order to improve household trash management.

The study examined the impact of youth age and activity types for education and information on home waste management behavior throughout educational levels (primary, secondary, and high school). According to research findings, waste output is influenced by the size of the educational institution (measured in terms of the number of students and teachers), the kinds of extracurricular activities engaged in, and the personal habits of the home members. Almasi et al. (2019) discovered that participants had strong knowledge and attitudes concerning source reduction, separation, and recycling, but low levels of right behavior. The majority of participants nearly 50% also expressed dissatisfaction with the rubbish collection services.

2.2.2 Liquid waste management practice

About 80–90% of the world's wastewater is released untreated into the environment, according to Abebaw (2017) and Manderso (2018). The environment and human health would both suffer if the created liquid waste is not effectively managed (Bienfang et al., 2011; Gbadegesin and Akintola, 2020; Jensen et al., 2018).

The average infant mortality rate in the least developed nations is about 10%, compared to less than 1% in the most developed nations. These startling disparities in infant death rates are mostly caused by poor sanitation, a lack of access to healthcare, and an increase in illness incidence (DSST, 2021). The ecosystem is occasionally being negatively impacted by industrial effluents that contain various heavy metals, including chromium, silver, nickel, copper, arsenic, and lead (Bazrafshan et al., 2015; Noreen et al., 2017). By contaminating water bodies, improperly managed garage wastes such old oil, paint, lubricants, cleaning solvent, used batteries, and petroleum products are also contributing to a serious issue (Fayiga et al., 2018).

Approximately 90% of Addis Abeba's companies, according to (UNESCO,2004) national water development report for Ethiopia, have simply dumped their sewage into neighboring bodies of water, streams, and open land without any kind of treatment. Out of 118 industrial establishments evaluated in the city of Addis Abeba, 40 have solid waste discharges, 61 have air pollutant discharges, and 62 have liquid waste that was to be discharged to the surrounding environment. Most government hospitals in Addis Abeba are situated far from existing wastewater systems, according to a report by AAWSA dated 2000. The water quality in Addis Abeba can be harmed by a huge number of hotels, pubs, restaurants, garages, and fuel stations in addition to the city's government buildings, schools, and academic institutions.

About 29% of the city's waste water is treated at the Kality waste water treatment plant. With the exception of Bole, Yeka, and Kality, waste water from seven sub-cities was being collected through trunk links using 500 mm and 1500 mm as well as trucks. Sludge is delivered to Kotebe treatment facility utilizing vacuum trucks that empty septic tanks after the sewage line is connected to Kality treatment plant. In order to reduce the BOD level to below 5 mg/L, wastewater must be circulated in various ponds for roughly 30 days (Mohammed, 2007).

Numerous literatures seem to suggest that the risks associated with clinical waste especially liquid waste are not given the needed attention it deserves (WHO, 2014). This is because the common practices of pouring untreated liquid waste down the sanitary sewer into water bodies and on the bare soil especially in developing countries is viewed by many as a normal practice. Many studies have empirically found that poor management of clinical waste generally at healthcare facilities are highest in developing countries (Abd El-Salam, 2010). Some factors such as financial constraints and lack of skill expertise to manage and reliance on obsolete technology (Coker et al., 2003; Hammond, 2009) are blamed as the cause.

A study conducted in Addis Ababa by the Addis Ababa water and sewerage agency (AAWSA, 2008) reported that the accessibility of the sewer line of the city is less than 10%, which is the same with the study's findings even after ten years. In fact, the total coverage of the city's sewer line is only 6.5%. This is because environmental organizations are weak and focused more on managing solid waste and drinking water than liquid trash. It's also because there isn't readily available, environmentally friendly technology. The vehicles' coverage is 7%. The entire coverage of effluent waste collection is just about 14%, which is insufficient. Environments that are polluted are ideal for the spread and reproduction of various communicable diseases.

2.2.3 Challenges of liquid waste management

On November 15, 2022, the world population surpassed the 8 billion threshold, according to UN estimations. The number of people on the earth has grown by one third, or 2.1 billion, over the previous 25 years. By 2050, it is anticipated that there will be just under 10 billion people on the planet. Nearly all of the growth during the past 25 years has occurred in developing nations, primarily in Africa (an additional 700 million people) and Asia and Oceania (1.2 billion more people). This pattern is anticipated to continue, with a few large nations in Africa and Asia predicted to account for half of the projected growth in global population between now and 2050.

The percentage of people residing in developing nations has increased as the population has increased. This emphasizes the significance of addressing the issues that these countries face, such as hunger, access to clean water and sanitation, health services, and getting people online and linked to affordable, sustainable sources of electricity. Compared to poor nations, high-performing economies produce twice as much garbage per person. Although rapid population expansion in emerging nations is fraught with difficulties, it can also lead to new economic

opportunities, as is the case in Africa, where the proportion of people of working age is rising relative to younger and older generations. The opportunities for the entire planet will likely be overshadowed by the challenges if the world is unable to end the relationship between pollution and prosperity (UNCTAD, 2022).

In a research report published in 2004, Tamiru and his co-researchers found that the major sources of pollution in Addis Ababa are industrial establishments, directly connected sewerages, municipal wastes, fuel stations, garages, and health centers due to the adverse effects of human population growth on surface and groundwater. About 90% of Addis Ababa's companies, according to the national water development report for Ethiopia published in 2004 by UNESCO, have simply dumped their sewage into neighboring bodies of water, streams, and open land without any kind of treatment.

Clinical liquid waste collection, transportation, treatment, and disposal present significant issues for Ghana's healthcare facilities. These difficulties are further exacerbated when governmental institutions with the responsibility for ensuring the safe disposal of clinical waste are unable to monitor and assess the conditions of clinical waste prior to their release into the environment because of actual logistical limitations. As a result, there is a risk to the public's health when healthcare officials violate best practices and CLWM requirements by discharging untreated liquid waste into untreated natural water bodies (Wiafe et al., 2016).

Insufficient infrastructure and subpar O&M were the major conclusions of Wang et al.'s (2014) investigation into the problems with water and wastewater treatment in Africa. Additionally, Nikiema et al. (2017) noted that weak institutional linkages have an impact on management. For instance, the Ghana Institution of Engineering and its affiliated institutions regularly participating in decision-making can greatly aid in knowledge advancement. Additionally, this can raise public awareness and help address issues like low tariff willingness. Since it has been a beneficial technology that has been tried and tested over the years and has surmounted O&M, a significant difficulty with regard to mechanical treatment technologies, Adesogan (2014) urged for the adoption of novel systems in other parts of Nigeria. When land is available, mechanical treatment systems are generally successful, but their high cost of operation and maintenance is due to the need for energy to power the pumps. They also emphasized the challenges of

maintaining sizable septic tanks and cesspools in urban areas during heavy rain. The untreated liquid waste is subsequently released into water bodies, posing a threat to the environment.

For instance, the US research links 22 diseases to insufficient LWM. According to research (Hounkpe et al., 2014), insufficient LWM has also contributed to the deterioration of air, soil, and water, the growth of insects and vermin, and the loss of attractiveness. Additionally, Funafuti's faulty LWM has a financial toll of almost $500,000 annually, while Tonga spends 5.6 million TOP (Lal et al., 2006). Sub-Saharan Africa is the region with the highest growth in the world's garbage production, even though high-income nations produce the most rubbish per person. Only 44% of rubbish is collected in sub-Saharan Africa; North Africa has greater collection rates. There are significant differences in collection rates between urban and rural areas as well as within cities.

A study conducted in Addis Ababa by the Addis Ababa water and sewerage agency (AAWSA, 2008) reported that the accessibility of the sewer line of the city is less than 10%, which is the same with the study's findings even after ten years. In fact, the total coverage of the city's sewer line is only 6.5%. This is because environmental organizations are weak and focused more on managing solid waste and drinking water than liquid trash. It's also because there isn't readily available, environmentally friendly technology. The vehicles' coverage is 7%. The entire coverage of effluent waste collection is just about 14%, which is insufficient. Environments that are polluted are ideal for the spread and reproduction of various communicable diseases.

Human and animal wastes are the primary source of the disease-causing organisms that pollute water and food. Communicable diseases develop as a result of improper management (1). In less developed nations, more than 50% of the populace lacks access to sanitation, and more than 80% of the created liquid waste is directly dumped into surface water bodies (2). Lack of room for the construction of latrines is one of the reasons why Ethiopia still has an unacceptable gap in the coverage of sanitation facilities (3). One of the primary sources of soil and water contamination and, as a result, a cause of many infectious diseases is the practice of disposing of liquid waste in open fields (4). Because of this, improper handling of waste water has major negative effects on human health, the environment, and economic growth.

Due to their accessibility issues and/or residents' inability to pay fees, informal settlements are frequently mostly excluded from waste collection services. Poor trash collection, treatment, and disposal have a negative influence on the environment and public health in poorer regions of African towns. There aren't many formal recycling schemes in use. Even when waste is collected, it frequently finds up in open-field dumpsites that are severely overcrowded. Given Africa's high proportion of organic waste, chances for a circular economy and in particular recycling are receiving more attention than ever (Kumar and Bailey, 2022). The capital Addis Ababa, which is Ethiopia's sociopolitical and industrial hub, is predicted to produce 49Mm3 of total liquid waste annually, of which 4Mm3 is industrial liquid waste (Van Rooijen et al. 2009). According to Amin et al. (2014), liquid waste frequently comprises pathogens, oxygen-demanding waste, water-soluble inorganic chemicals, inorganic nutrients, organic chemicals, sediments, and radioactive waste.

2.3 Conceptual framework

A conceptual framework is what is produced when a number of related concepts are combined to explain and provide a more comprehensive understanding of the topic being studied (Imenda, 2014). The organization of important ideas and central concepts from theories, significant research findings, policy recommendations, and other expert knowledge that serve as the project's compass are represented by the conceptual framework. To establish the study's emphasis and direction, the conceptual framework arranges the essential concepts in the investigation. The key ideas are generated from an examination of pertinent themes and expressions found in literature as well as from the results of literary theories.

Social Factors

The problem of societal acceptance is frequently boiled down to the locals' ignorance or lack of information. Environmental awareness or knowledge, however, may not always convert into strategies for managing liquid waste that are more environmentally friendly, such as waste reduction, recycling, or reusing (Desa et al., 2011).

Contextual Factors

The absence of an efficient framework for enforcing policy and of relevant technological standards poses a significant barrier in organizational and operational issues. These unsustainable waste management methods are only maintained by the general lack of environmental awareness and education of the general population and policymakers regarding the subject of trash management. If genuine progress is to be made in the liquid waste management practices of the poor world, communities will need to adopt a strong participative, culturally integrated, complicated, but adaptive liquid waste management (McAllister, 2015).

Institutional Factors

According to Schübeler (1996), "institutional aspects concern the distribution of functions and responsibilities and correspond to organizational structures, procedures, and methods, institutional capacities, and private sector involvement." Ineffective liquid waste management service is a result of ineffective institutional structure, organizational process, and management capability issues (Farah, 2019). Many of the literature studies covered in the aforementioned (theoretical and empirical review literatures) have their main attention on the global trends in liquid waste management and their effects. However, despite the fact that a single empirical study on liquid waste management was conducted, the segregation practices and difficulties at the household and outdoor level in Addis Ababa are not addressed and studied by various authors as if its value chain impact across the liquid waste management is minimizing a lot of issues. In Addis Ababa, there are also little empirical studies on the institutional, social, and contextual aspects of liquid waste management. The researcher therefore concentrated primarily on this gap, as well as the issues, obstacles, and low institutional, social, and contextual understanding in Addis Ababa City.

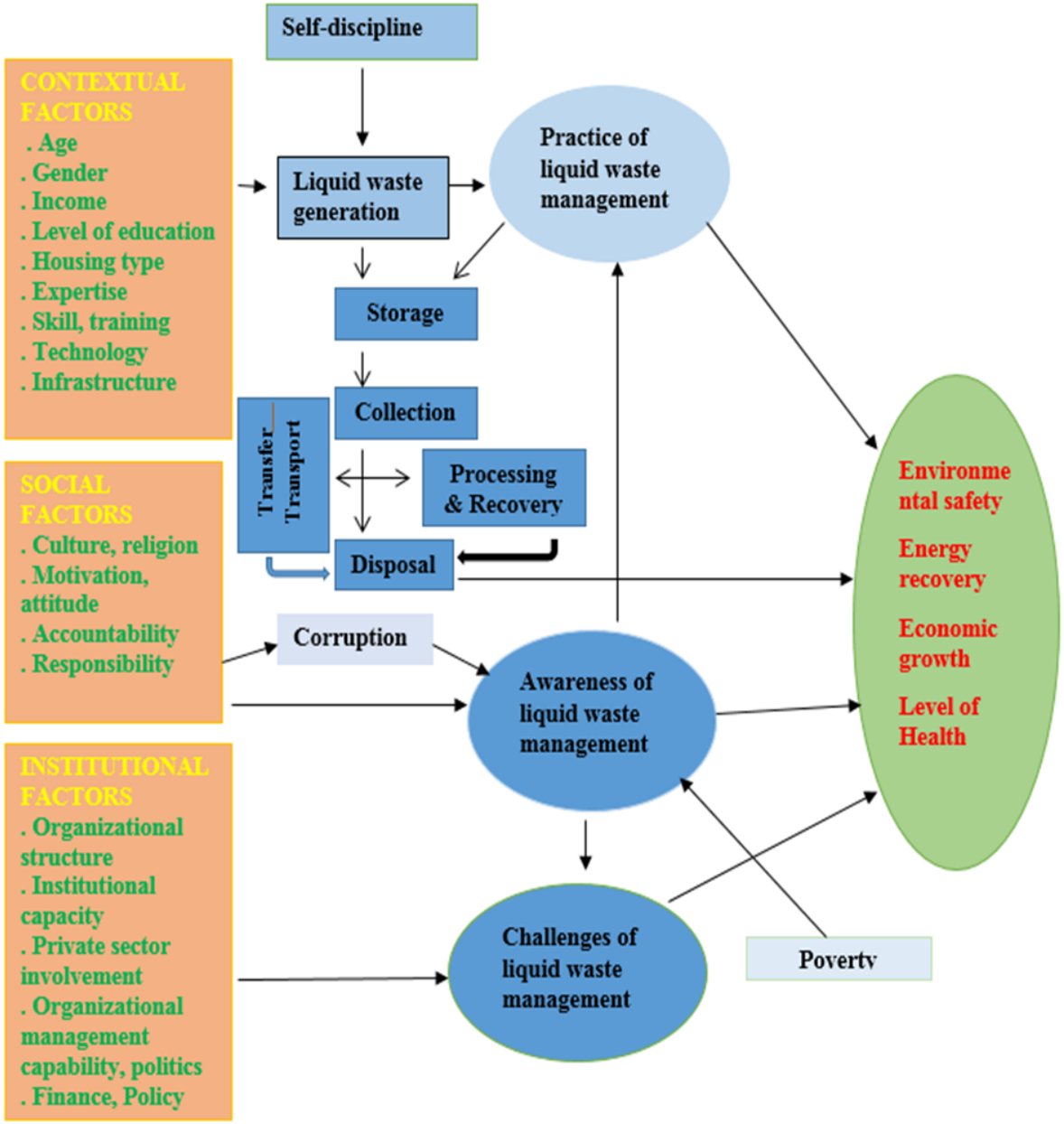


Figure 2: Conceptual framework for liquid waste management

Source: Adopted by the researcher, 2023

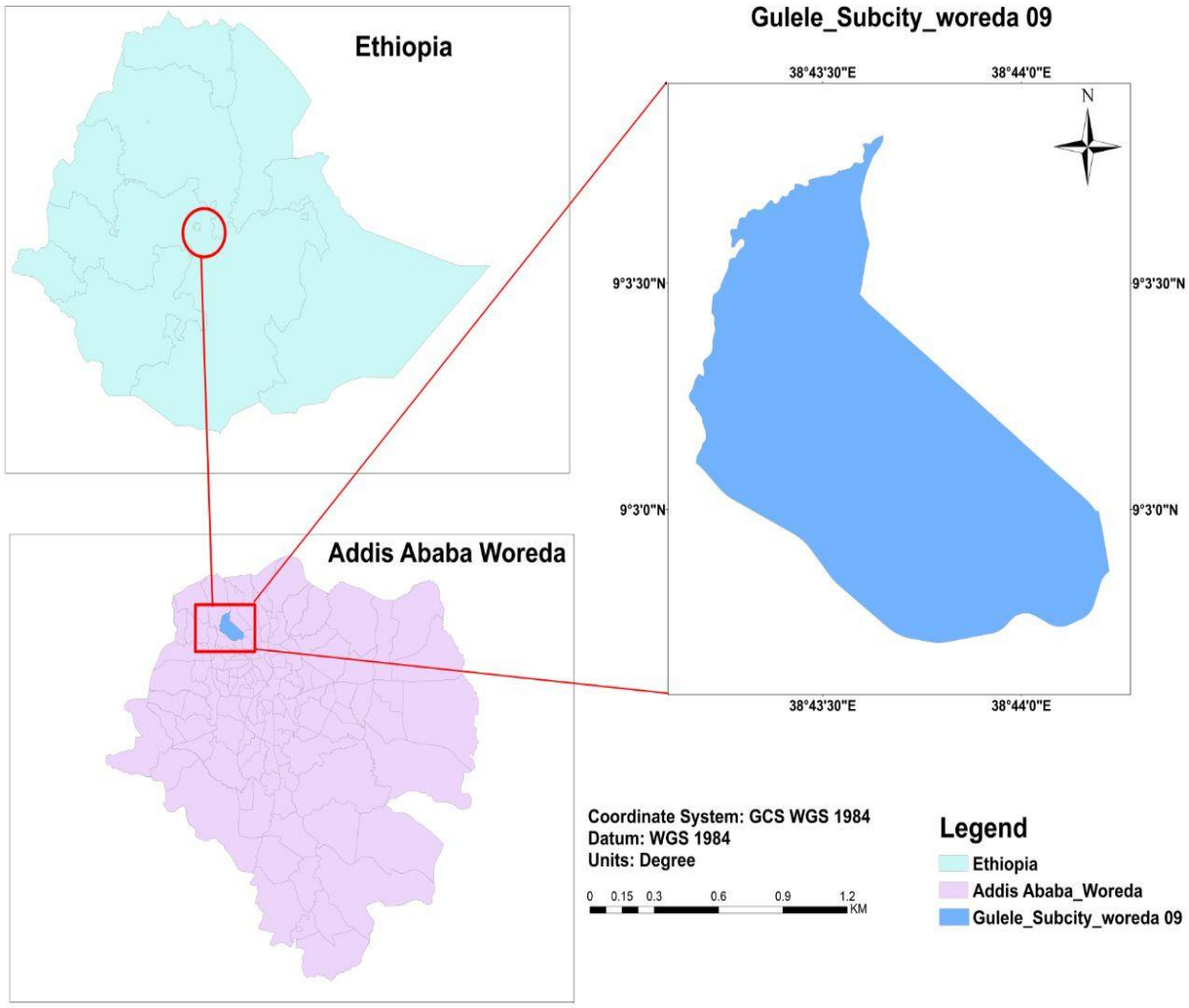
CHAPTER THREE

3. METHDOLOGY

3.1. Description of the study areas

Geographically speaking, Addis Ababa, Ethiopia's political capital as well as its most significant commercial and cultural hub, is situated in the middle of the country between 8°50' and 9°06'N latitude and 38°39' and 38°55'E longitude. It is 2,400 meters above sea level on average, with Entoto Hill to the north having the maximum altitudes of 3,200 meters. As a result, Addis Ababa is one of the world's capital cities with a high elevation. Addis Ababa, a primate city in Ethiopia with an estimated population of over four million people roughly 25% of the nation's total urban population is one of the fastest growing cities in Africa (MoUDHC, 2015). The headquarters of the African Union (AU) and the United Nations Economic Commission for Africa (UNECA) are located in Addis Ababa, which serves as the continent of Africa's diplomatic hub. Many individuals travel to the city in quest of services and career opportunities because of its location and prominence. Its two to four percent annual growth rate, of which about forty percent is attributable to rural-urban migration.

According to the CSA (2013), infant mortality is 50.3 per 1000 live births, with a life expectancy at birth of 65.7 years. A crucial part of awareness, practice, and difficulty evaluation along the *wereda* 9 was sampling and the selection of sampling locations. The study's sample sites were chosen using the following criteria: sites for cattle breeding, factories, and location near rivers, hospitals, schools, neighborhoods with a lot of garages, residential areas, and locations with business activity nearby. And finally, the sampling point must provide a sample that was representative of the awareness, practice and challenges of the society on liquid waste management in the study area.



Source: Data extracted from Arc GIS, 2020

Figure 3: Map of the study area

3.2 Study design

The sort of study being done and the research questions that need to be answered influence the choice of research design. In this study, the relationship between awareness, practice, challenges of liquid waste and environmental management in the *Gulele* sub-city was discovered using a case study research approach. Repeated measurements, independent groups, and matched pairs designs are examples of design types (Kothari, 2004). The researcher must choose how to divide up their sample across the several experimental groups.

3.3 Approaches of the study

This study's focus is on the awareness, practice and challenges of liquid waste management, so a combination of qualitative and quantitative research methods would be the most appropriate approach. According to Kothari (2004), research design is used to restructure the research by demonstrating how the key components of research projects, including the sample or group, collaborate to meet research questions. We gathered both primary and secondary data. The stakeholders who reside in a community were interviewed to assess their level of awareness, level of practice, and level of challenges in order to understand their liquid waste management. The primary data was collected from various aspects of liquid waste management that were on-site observed, evaluated, and collected using a developed checklist. Secondary data were gathered from health center records as well as books, journals, and periodicals.

3.4 Populations and sampling procedures

The *Gulele* sub-city has a total population of 267,624 people, of which *wereda* 09 is populated with 32704 inhabitants, according to the statistics abstract from 2011. Random sampling was used to choose the units of inquiry for the study, with the exception of key informants, due to the ease with which trustworthy information could be easily obtained by ordinary citizens. The planned 266 responses made up the sample size. This was determined using the target population's participation in the study, a confidence level of 95%, a population size of 32,704, and a margin of error of 6%. It depends on the population heterogeneity required for accuracy.

Sample Size $n = N * [Z^2 * p * (1-p)/e^2] / [N - 1 + (Z^2 * p * (1-p)/e^2]$

Population size, N= 32704

Critical value at 95% confidence level, Z=1.96

Sample proportion p= 0.5

Margin of error, e = 6% or 0.06

$n = 32704 * [(1.96)^2 * 0.5 * (1-0.5)/ (0.06)^2] / [32704 - 1 + (1.96)^2 * 0.5 * (1-0.5)/ (0.06)^2]$

Sample size n = 266

Table 2: Random Samples taken from different streets

S. No	**Sample Streets in Wereda-9**	**Total household heads in each street**	**Sample size in each *street***
1.	Street 1902	120	24
2.	Street 2029	150	28
3.	Street 1950	145	25
4.	Street 1961	149	26
5.	Street 1974	110	20
6.	Street 1977	158	32
7.	Street 1979	126	28
8.	Street 2084	134	31
9.	Street 1998	120	24
10.	Street 2000	150	28
	Total	1362	266 households

The sample size of this study involves: 2 experts working in AAWSA, 2 *wereda* environmental health experts, 2 *wereda* executive officers, 16 street leader (chairperson) and 266 households taken from *wereda* 9.

3.5 Data collections

Primary Data Collection

The main data for this study was gathered through the use of

1. Formal questionnaires for 266 households
2. KII's has four experts and two executives, two of whom work for AAWSA, two of whom are environmental health experts, and two of whom are executive officers, respectively.
3. Street leaders organize focus groups that each have two groups of eight people.
4. Methods of observation.

Due to the researcher's access to first-hand data, this strategy was more reliable.

Secondary Data Collection

The appropriate secondary data sources explored to examine the awareness, practice and challenges of liquid waste management were found online, in library books, journals, in environmental declarations, laws, and reports from various liquid waste authorities. After gathering secondary data, we processed, edited, and checked the information for accuracy and consistency.

3.6 Methods of Data Analysis

In order to analyze data, a variety of closely connected tasks must be completed, including categorization, coding, tabulation, and the drawing of statistical conclusions. It is necessary to reduce the bulky data into a few manageable groupings and tables for future examination. As a result, the researcher should divide the raw data into some useful categories (Kothari, 2004).

It was decided that the study that tries to discover using interpretations would make a strong candidate for thematic analysis. It provided data analysis with a methodical element. It made it possible for the researcher to connect a topic's frequency analysis to a text's overall content analysis. It enabled precision, complexity, and improved the overall significance of the research. Understanding and gathering many types of data are necessary for qualitative research. Thematic analysis would provide a chance to comprehend any issue's potential from a wider perspective (Alhojailan, 2012).

The study used version 26 of the Statistical Package for Social Science (SPSS) statistics to conduct a quantitative analysis of the data. The SPSS was significant because it had the extraordinary flexibility and capabilities to analyze large amounts of data quickly and to generate an infinite number of simple and sophisticated statistical results, including simple frequency distribution tables, polygons, graphs, pie charts, percentages, cumulative frequencies, and other distributions as much as required in computing field data. In order to make recommendations about awareness, practice, and challenges of liquid waste on environmental management in the *Gulele* sub-city, quantitative data will be coded, examined for integrity, analyzed, and presented in useful outputs like figures. Calculations were performed using descriptive analysis.

The researcher used a variety of statistical tools to test the multiple linear regression factors and correlation models applied to determine the relationship and influence between independent variables (gender, age, educational attainment, marital status, monthly income, occupation, family size, and home residence type). The quality of services offered by the Sewerage Authority in your premises, the form of service delivery for discharge of liquid waste used in an area, and the transportation of liquid waste, use, reuse, or recycling of liquid waste at the household level, proper discharge of liquid waste, sewerage systems prepared to discharge liquid waste in the area, the presence of septic tanks, the cause of those improper practices of managing liquid waste, experience managing liquid waste properly from your household to disposal sites, training on liquid waste management, availability of various sized vehicles to collect liquid waste materials from the government, and appropriate and standard practices all are the dependent variables. This section must demonstrate the survey data outputs, the narrations to implement descriptive statistics outputs, and the descriptive statistics results. Since some of the determinant factors are qualitative such as liquid waste management practice, liquid waste use, reuse, recycle, presence of septic tank and training on liquid waste management, observed *wereda's* sample sewerage status, documents from health center, motivation, attitude, responsibility and finance were discussed or analyzed qualitatively, correlation and regression are analyzed quantitatively.

3.7 Ethical considerations

The ethics committee of the College of Development Studies at Addis Ababa University's Center for Environment and Sustainable Development granted ethical clearance and approval. Before beginning data collection, legal permission was obtained with better support from the College of Development Studies at Addis Ababa University. It was then given to *wereda* 9 executives along with a clear explanation of the study's purpose to the respondents, and consent was obtained from each format by inquiring about privacy. The significance of the study was discussed with study participants, and written agreement was acquired.

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1 Socio economic demographic characteristics of respondents

As seen in Table 3 below, there were 47% and 53% of men and women, respectively. In FGDs, there were 11 men and 5 women participants, and in the key informant interview, there were 4 men and 2 women. 24.8% of survey respondents were between the ages of 18 and 25; 22.6% were between the ages of 26 and 33; and 17.3% were between the ages of 31 and 41. 12.4% of the population was between the ages of 42 and 49, 10.2% between the ages of 50 and 57, 7.1% between the ages of 58 and 65, and 5.6% were age 66 or over. According to the study's findings, the majority of participants were between the ages of 18 and 25, then 26 to 33, as indicated in table 2. According to Isabela et al. (2015), gender and age structure have an impact on the amount of waste produced. The findings revealed that the greater percentage of women in society contributes to higher waste production, with the greatest amount of waste produced by women falling in the age range of 14 to 64, or so-called "working age." Most respondents (24.1%) have 1-3 families, while 22.9% have 7–10 families, making up the majority of the resident 38.3% family, who on average has 4-6 families in their home. Few respondents (14.7%) on average have above 10 families. All of this demonstrates how many individuals reside in one housing unit and how problems may spread to the extended family, which is difficult to manage. Large numbers of households generated a lot of grey and black liquid waste from cleaning, washing, and using the restroom.

Table 3: Socio demographic characteristics and respondents background

No	Variables	Measurements of variables	Frequency (#)	Percent (%)
1	Gender	Male	125	47.0
		Female	141	53.0
		Total	266	100.0
2	Age	18-25	66	24.8
		26-33	60	22.6
		34-41	46	17.3
		42-49	33	12.4
		50-57	27	10.2
		58-65	19	7.1
		66 and above	15	5.6
		Total	266	100.0
3	Family size	1-3	64	24.1
		4-6	102	38.3
		7-10	61	22.9
		Above 10	39	14.7

Figure 4 below demonstrates that, out of the 266 participants, the study area's educational level is relatively high. 15.04% of participants were educated from grades 5-8, 14.29% had diplomas, 19.5% earned university degrees, 19.5% had completed certificate programs, and 4.14% were illiterate. The low level of education demonstrates limited exposure to the range of application choices for wastewater management, including, among others, the production of biogas from black wastewater, reuse and recycling of grey water, treatment of wood, and car washing. The issue has been made more difficult by a lack of environmental education in the form of lessons on waste management and ignorance of the negative consequences on people and the environment. As a result, waste management emerges as a crucial issue of environmental justice (Verma and Prakash, 2020).

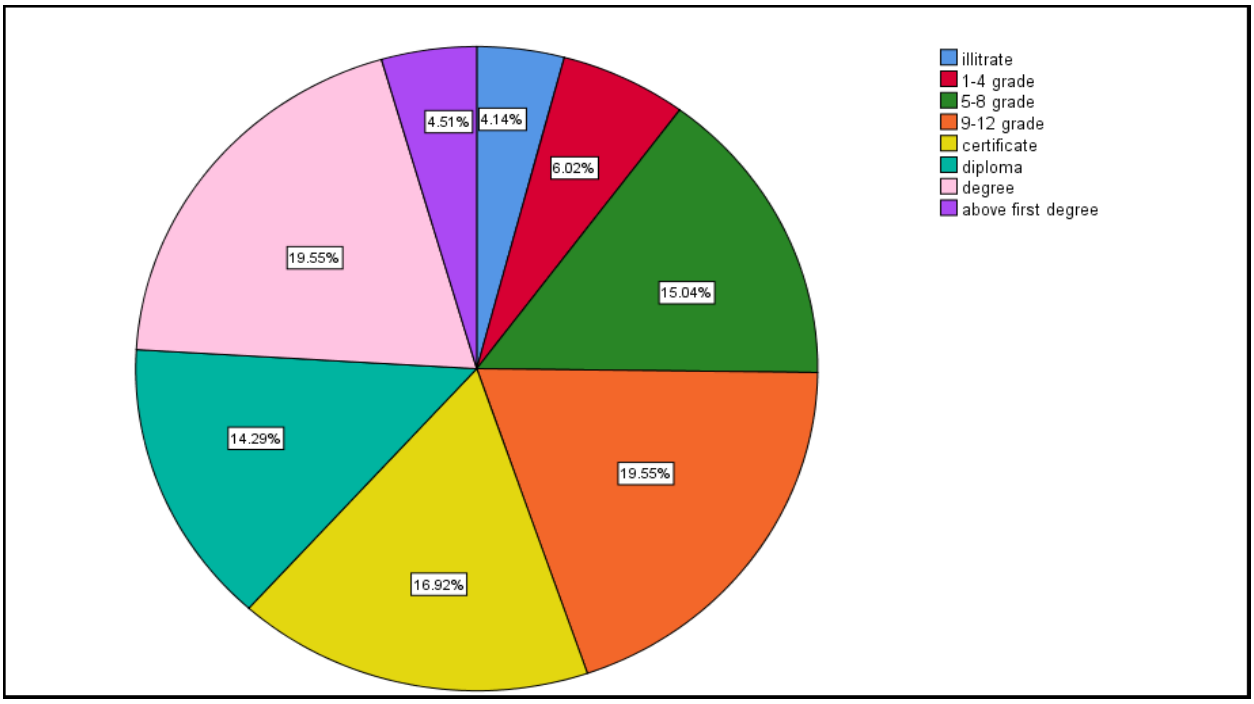


Figure 4: Pie chart of educational level

The purpose of the study was to determine the participants' gross monthly income. As can be seen in Figure 5 below, a sizable 26.32% of respondents have a monthly income of between 250 and 4000 birr, followed by 23.7% of 4001 to 5500 birr, 15.8% of 1001 to 1500 birr, 15% of 5501 to 7000 birr, and only 9.0% of less than 1000 birr. More than half of the respondents have low incomes. According to (World Bank, 2017) estimates, the new extreme poverty threshold is $2.15 per person per day based on 2017 purchasing power parities. As a result, if people receive less than $2.15 per day their fundamental human needs won't be satisfied. Those who are poor lack access to adequate housing, clean water, wholesome food, and medical care. Which may be the reason they are unable to build ordinary latrines, have trouble getting enough clean water for drinking, cleaning, and washing, and are unable to afford the costs associated with disposing of liquid waste. Similarly, between 2004 and 2009, in Sub-Saharan Africa, the poorest quintile had only 42% of the access to improved sanitation compared to the richest quintile's 91% (JMP 2012). According to research by (Foday et al., 2012), a rise in household income can alter their consumption habits, which alters the types and amounts of garbage they produce. Due to their greater exposure to and less resilience to social, environmental, and economic risks, the poor, the disadvantaged, the marginalized, and the vulnerable can be particularly negatively disproportionately affected by pollution.

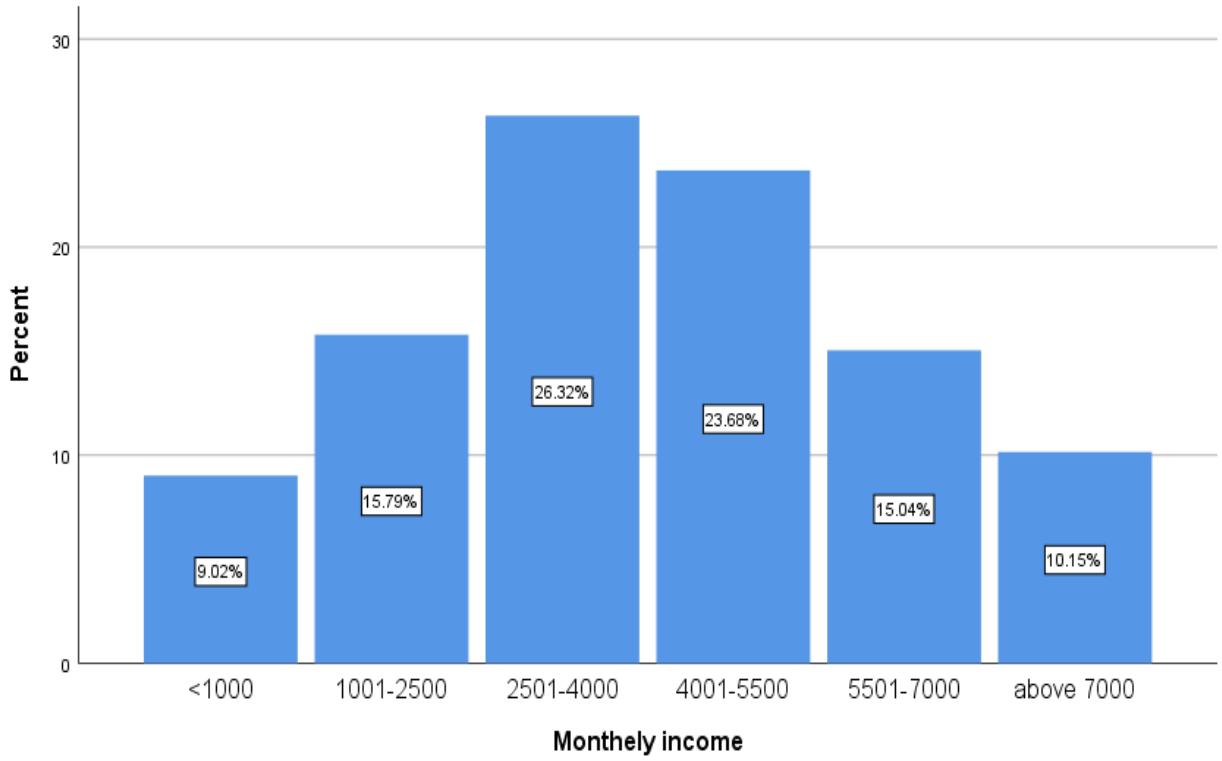


Figure 5: Simple bar graph of monthly income

4.2. Awareness building ways of the respondents on liquid waste management

As shown on the table 4 below, the respondents answer regarding the liquid waste management awareness building ways about liquid waste management revealed that only few 27.8% respondents indicated that they discussed in social organizations about LWM, but the majority 72.2 % does not have such discussion. High number of population didn't discuss about liquid waste management which can be the cause for the improper liquid waste management. The respondents were also asked about existence of guidelines prepared by *woreda* administration on liquid waste management, where majority 74.1% respondents reported that the *wereda* administration didn't prepared guidelines to implement LWM.

The other issue assessed in relation to LWM, training given by experts on liquid waste management. Accordingly, 33.8% of respondents answered that they properly participated, 49.2% of responded that sometimes participated, 10.5% was not invited at all and 6.4% respondents were not sure conserving their participation on training on LWM. Low level focus by *wereda* administration on environmental management guidelines could result lack of clear commitments from the person taking the action on how those impacts can be avoided, minimized and managed and the consistent training could affect the sustainability of knowledge.

The respondents answer regarding the level of knowledge and skill of experts revealed that 36.5% and 42.9% respondents indicated that they have excellent and very good respectively, while the remaining 9% and 11.7% respondents indicated that they have good and satisfactory knowledge and skill respectively. The other issue assessed in relation to managing liquid waste properly from house hold. Accordingly 39.1% of respondents answered that they dispose properly, while 35.3% that sometimes properly dispose, and 19.5% don't properly dispose at all and 6% didn't sure the modality of the disposal. It is well known that improper management of liquid waste could cause groundwater pollution, soil contamination, air pollution, greenhouse gases, economic consequences, health risks. Public awareness and participation is a key element of any waste management program (Hasan, 2004) although many factors could be attributed to inadequate (WWM), it is essential to emphasize the role of the community, their attitudes, practices, and interactions (Okechukwu et al., 2012).

Table 4: Awareness building ways of respondents on liquid waste management

No	Variables/Items/questions	Characteristics	Frequency	Percent
1.	Discussion on the social organization about liquid waste management	Yes	74	27.8
		No	192	72.2
2	Guidelines prepared by woreda administration on liquid waste management	Yes	69	25.9
		No	197	74.1
3	Training by experts on liquid waste management	Yes, where my household was properly participated	90	33.8
		yes, sometimes my household was participated	131	49.2
		No, my household was not invited at all	28	10.5
		Not sure	17	6.4
4	Level of knowledge and skill of experts	Excellent	97	36.5
		V. good	114	42.9
		Good	24	9.0
		Satisfactory	31	11.7
5	Experience of managing liquid waste properly from your house hold to disposing cite	yes, I dispose properly	104	39.1
		yes, I dispose sometimes	94	35.3
		No, I don't dispose at all	52	19.5
		I am not sure	16	6.0

Source: Own survey (2022)

According to *wereda's* key informant interviews (KIIs) involved in qualitative data generation indicated that people have awareness deficiency in terms of discriminately dumping of liquid waste as they dispose all types of liquid wastes like gray, black, recyclable and hazardous waste together. Majority of people in the *wereda* were not aware of liquid waste as recyclable material. Dladla et al. (2016) identified factors associated with indiscriminate dumping of waste in open spaces, streets, storm water drains, rivers, and streams are among improper liquid waste management practices which have been resulting environmental health problem in eleven African countries and found institutional weaknesses and lack of awareness as key starting points to the problem.

KII respondents from AAWSA underlined that some community have awareness to manage liquid waste to keep the community clean and healthy but most local people have very limited understanding views in the liquid waste management. In relation to this study indicated that institutional weaknesses may occur in the form of ambiguity of waste management policy and legislation since liquid waste management activities effect the core infrastructural framework of a municipality and its residents. Hence, increasing awareness of inhabitants may have a positive impact on attitude as well as perception towards the environment. Training by experts on liquid waste management is shown in table 4 above indicated that almost half (49.2 %) respondents respond that sometimes in such awareness creation sessions. In relation to this, FGD revealed that some of the society have basic awareness on liquid waste management, they know how to use water properly to reduce production of excess liquid waste e.g. for flash latrine and room cleaning. Also participants pointed out mostly little attention has given to social institutions to discuss such issues as a result, liquid waste management remained persistent problem among the community. Similarly, McAllister, (2015) indicated that the participation of the community in the production and use of scientific knowledge is considered the best approach for environmental and waste management. They also understand as urine should be collected in to the latrine even if access of latrine in these *wereda* is deficient. Perception of domestic waste disposal in terms of community attitude about and perception of sanitation, interlinked with waste management concerns (Yoada et al., 2014). In this regard, *wereda's* KII respondents underlined that even though training by experts on liquid waste management program to be conducted reputedly with residents, the training were not implemented effectively due to financial constraints and low level of motivation by the society. In addition, the AAWSA KII´s confirmed that trainers were given for sub-city and *woreda* team leaders including other stakeholders so as to address liquid waste issues for the community in different budget years. From this perspective in general, key informants from AAWSA at *woreda* level and Addis Ababa city administration Cleansing Management Agency reported that training and other material support for the community and waste collectors (partnerships) or associations were not delivered as required due to lack of budget and other factors.

4.2.1 Correlation analysis on Liquid waste management awareness

As the findings suggest below in the Table 5, there is moderate positive relationship with age concerning with discussion on social organizations (r= 0.663**, P< 0.001). The findings suggest that there is positive relationship with educational level, with getting training on liquid waste management (r= .843** and P < 0.001) it also has high correlation, with discussion on social organizations about liquid waste management r= .767**, P< 0.001 and high relationship with discussion on social organization about liquid waste management. The analysis revealed there was positive relationship with households monthly income with getting training (r=.661**, p< 0.001) and family size with discussion in social organization (r=.720**, p< 0.001). In connection to this Lee and Paik (2011) examined Korean household recycling policy and waste management behavior, results showed that waste management attitudes, age and income affected recycling and waste management behaviors significantly. Similarly Kumar et al. (2015) pointed that trainings of healthcare workers are essential to improve their behavior towards hospital waste management. Without environmental education, more time and resources could be wasted on waste management, hence there should be a greater emphasis on this issue.

Waste management strategies should not only be economical and socially acceptable, but also environmentally sustainable (Verma, 2019). Another study by Mohd et al. (2002) revealed a favorable association between waste creation and family size and eating habits. From a worldwide perspective of resource management, education and awareness in the domain of waste management are becoming increasingly crucial. The survival of people and thousands of other living species, the integrity of the earth and its biodiversity, the security of nations, and the legacy of future generations are all at risk due to local, regional, and global air pollution, accumulation and distribution of toxic wastes, destruction and depletion of forests, soil, and water, ozone layer depletion, and emission of "greenhouse" gases (Pushpendra and Avinash, 2020). Additionally, a statistically significant association between monthly income and the aforementioned characteristics was found by our investigation. This led to the conclusion that Addis Ababa's handling of liquid waste is influenced by its financial resources.

The majority (51%) of those surveyed reported having a monthly income of less than 4001 birr (less than $2 a day). Technology must develop to improve the operation and monitoring of the treatment of wastewater and sewage in order to reduce the negative impacts of pollution caused by the uncontrolled release of industrial sewage and wastewater (Jing Zhao et al., 2016). This intern also needs better pay. The outcome shows that, at r= -0.20 and r= -.013, respectively, there is no gender-biased link between receiving training in liquid waste management and engaging in debate about LWM in social organizations. This led to the conclusion that financial resources have influence on liquid waste management in Addis Ababa. To curb the adverse effects of pollution induced by the uncontrolled release of industrial sewage and wastewater, technology must be advanced to improve the operation and monitoring of the treatment of wastewater and sewage, this intern needs better income (Jing Zhao et al., 2016). The result reveals that there is no gender biased correlation in attaining training on liquid waste management and discussion in the social organization on LWM at r= -0.20 and r= -.013 respectively.

Table 5: Correlation analysis on Liquid waste management awareness

Correlations	**Gender**	**Age**	**Education**	**Marital status**	**Monthly income**	**Family size**
Training on liquid waste management	-.020	.887**	.843**	.837**	.661**	.871**
Discussion in the social organization about LWM	-.013	.663**	.767**	.544**	.575**	.720**

**. Correlation is significant at the 0.01 level (2-tailed).

4.2.2 Regression on Predictors that influence training on liquid waste management

The study was done to find out if different Predictors can affect training on liquid waste management, as the results in Table 6 below show. The analysis of multiple regressions was used. The two predictors may explain 81.9 % of the variance in receiving training in liquid waste management, according to the results, $F(2, 263) = 595.5$ ($p < 0.001$). Educational level ($B= -0.042$, $t= -0.551$, $p= 0.582$) and age ($B= 0.944$, $t= 12.512$, $p= 0.000$). This implies that acquiring training on liquid waste management has historically been influenced by age. Certification of the significance of environmental protection education and training, public awareness-building regarding environmental responsibility, minimally intrusive environmental lifestyles based on recycling and waste reduction, and key elements of sustainability. In developing nations, a favorable attitude toward environmental education and training might lessen the waste management gap between young and old Rada et al. (2016).

Table 6: Regression analysis on Predictors that influence training on liquid waste management

Model	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
	B	Std. Error	Beta	t	Sig.	Lower bound	Upper bound
(Constant)	.672	.080		8.400	.000	.515	.830
Age	.432	.034	.944	12.512	.000	.364	.500
Educational level	-.019	.034	-.042	-.551	.582	-.087	.049

a. Dependent Variable: Training on liquid waste management from your *wereda* administration by delegating relevant experts

b. Predictors: (Constant), Gender of respondent, age of respondents, educational level of respondents

According to the *wereda* expert responses, the training was specifically focused on better sanitation practices, which include the safe collection, storage/disposal, and recycling/reuse of domestic wastewater. Domestic liquid waste and human excreta contain certain nutrients that can be converted into organic manure, bio gas, and other products. Organic manure can be used in agriculture, while bio gas can be used in other applications.

4.3 Practice of the society on liquid waste management

According to the data in table 7 below, when asked how they manage liquid waste, respondents stated using a car-truck system (65.8%), a sewer line (16.5%), a septic tank system (5.6%), and no system at all (12%). Similar to this, the Addis Ababa city's garbage disposal system performs poorly despite the volume of waste created increasing (WHO, 2010). The respondents were also questioned on the transportation of liquid waste; 72.2% of them agreed that liquid waste should be transported without causing environmental pollution, while 27.8% disagreed. Septic tank systems should be employed in addition to automobile and truck systems in places like Addis Ababa that are not connected to the sewage system until the sewerage system is well established. The availability of acceptable and standard roads for cars and trucks to merge into to collect liquid waste was the other LWM-related issue evaluated. Accordingly, (35%) of respondents say that there is a standard and acceptable road; (56.8% say that there is a standard and suitable road, but only partially; and (8.3% say that there is no such road). Accordingly, 38% of respondents said that the sewerage authority's services in their community were good, while (62%) said that they were not. Without a standard and adequate route, the liquid waste collection vehicle may not be able to collect liquid waste, which could lead to environmental contamination and health risks. The collection and treatment of waste water in Addis Ababa is complicated by the lack of sewage networks and treatment facilities. 7.5% of the built-up regions are served by a relatively small sewer network (MUDHCo, 2012). From the clinics surveyed, 9.4% covered their waste containers during transportation, 1.8% had different transporting materials for different categories of waste, 0.7% were connected to the sewerage systems, and overall, 85.6%, 63.3%, and 61.9% of clinics had poor waste transporting, storage, and treatment practices (Berhanu et al., 2022).

Table 7: Responses by residents about road and AAWSA liquid waste management practices

No	Variables/Items/questions	Characteristics	Frequency	Percent
1.	The mode of service delivery for discharge of liquid waste used in an area	Sewage disposal	44	16.5
		Tank system	15	5.6
		Car truck system	175	65.8
		None of them	32	12.0
2	Liquid waste collection and transportation without environmental pollution	Yes	192	72.2
		No	74	27.8
3	Is their suitable and standard road for vehicles to inter to collect liquid waste?	yes, there is standard and suitable road	93	35.0
		yes, there is road but not standard and suitable	151	56.8
		No, there is no standard and suitable road	22	8.3
4	Are services provided by the Sewerage Authority in your premises satisfactory?	yes	101	38.0
		no	165	62.0

Source: Own survey (2022)

Liquid waste management can be boiled down to social, institutional, and contextual aspects that are directly connected to service delivery for discharge of liquid waste used in a region from the findings of the KII, FGD, field observation, and survey (Table 7) stated above. Therefore, 5.6% of the community has used a tank system and 62% of respondents noted that the services offered by the Sewerage Authority in premises was not adequate from the standpoint of the social element in implementing liquid waste management practices at the household or outdoor level. Similar to this, there were few different-sized car trucks at the institutional level, and the majority of the roads weren't designed to be used by car trucks in a variety of conditions to collect liquid waste. Due to a lack of desire and financial limitations, the gap connected to managing liquid waste at the household or outdoor level would be inefficient from a contextual perspective. This demonstrates the lack of attention given to improving municipal practices for managing liquid waste.

As shown in Table 8 below, when asked how to reduce the production of liquid waste, respondents gave the following responses: 32.7% reused waste water, 22.2% reduced waste water at the source, 21.4% applied none of them, 17.3% dumped liquid in landfills, 3% recycled liquid waste, and 3.4% used energy recovery. Whenever practicable, end-of-pipe treatment should be replaced with water pollution control strategies that prioritize wastewater prevention and minimization. According to WWDR. (2017), these strategies include banning or restricting the use of specific contaminants to prevent or reduce their entry into wastewater streams by regulatory, technical, and/or other measures. The other issue assessed in relation to liquid waste use, reuse or recycle at house hold level in which 50.8% reuse from bath, washing clothes, 0.8% from flush toilet, 0.4% from urine toilet, 36.1% from kitchen and 12% don't practice any. The respondents were also asked about place to discharge liquid waste in which, 12% discharged to sewers, 12.8% discharged to public area, 10.9% discharged to septic tank, 62.4% discharged to ditch and 1.9% discharged to other areas. Similarly liquid waste is important source of pollution in Addis Ababa city, only 7.2% of the liquid waste is disposed in appropriate way and the remaining 92.8% is disposed inappropriately in to rivers and rainwater channels (AWASA, 2010). The lack of sanitation facility coverage in Ethiopia is still unacceptable, and one of the problems is the lack of collecting and emptying systems.

At the household level, liquid waste is very poorly managed. About half of the houses dispose of their grey water (domestic liquid waste) in any publicly accessible areas like roadways, drainage systems, and neighboring open spaces. The use of sewer lines is not widely known in the nation (Temesgen, 2018). Organic waste pollution might also significantly affect you. It may result in the water in streams, reservoirs, boreholes, and wells being inappropriate for applications including irrigation of crops and the provision of drinking water for people and animals. Youcai Zhao (2018). Liquid contaminated waste (such as human tissue, blood, feces, urine, and other body fluids) requires specific handling since it may present an infectious danger to community healthcare professionals who come into touch with or handle the waste, according to Esayas et al. (2004).

Table 8: Liquid waste management practices by the society

No	Variables/Items/questions	Characteristics	Frequency	Percent
1	How do you reduce liquid waste production	reducing waste water at the source	59	22.2
		reuse of waste water	87	32.7
		recycling waste water	8	3.0
		energy recovery	9	3.4
		land fill liquid	46	17.3
		none of them	57	21.4
2.	Liquid waste use, reuse or recycle at house hold level	from bath, washing clothes	135	50.8
		from flush toilet	2	.8
		from urine toilet	1	.4
		from kitchen	96	36.1
		I don't practice any	32	12.0
3	Place to discharge liquid waste	sewers	32	12.0
		public area	34	12.8
		septic tank	29	10.9
		ditch	166	62.4
		other	5	1.9

Source: Own survey (2022)

The survey revealed a decrease in the output of liquid waste. According to table 8 above, which examines different areas of liquid waste minimization, just 3% and 3.4% of respondents said that liquid waste was recycled and recovered, respectively. The outcome demonstrated that the majority of Addis Ababa's population was not and is currently not provided with any practical recycling and recovering operations. This low number of people who rarely recycle and recover indicates that there is a lot of liquid waste in Addis Ababa. Poor burnt oil collection procedures from automobiles were observed during a field observation at St. Paul Hospital, as depicted in Figure 7. The majority of the oils were spilled on the ground, and improperly built storage containers and locations for them worsened the environment and increased the likelihood that they would spread to water bodies, where they would contaminate and negatively impact the environment and the quality of the water.

Participants in the FGD made the point that, in regard to this, minimizing liquid waste at the source is more important than recycling and recovering. The recovered objects save money and prevent unintended environmental pollution. In this regard, *wereda* KII respondents emphasized that while some residents use, reuse, and recycle liquid waste from the bathroom and while washing clothing, very few inhabitants use, reuse, and recycle septic tank flush and urine waste. Additionally, respondents to the AAWSA KII claimed that septic tank and sewer systems were rarely used.

4.3.1 Correlation analysis on liquid waste management practice

The results as shown in Table 9 below imply that there is a good association between age and the correct disposal of liquid waste (r= 0.721, P < 0.001), which shows a moderate correlation, and the use, reuse, and recycling of liquid waste (r= 0.885**, P<0.001), which shows a high relationship. There is a significant link between educational attainment and properly disposing of liquid waste (r= 0.851**, P<0.001). Korean household recycling policies and waste management practices were researched by Lee and Paik (2011). The findings indicated that waste management attitudes, age, and income had a significant impact on recycling and trash management behaviors. Septic tank presence is correlated with the use, reuse, and recycling of liquid waste (r=0.617**, P<0.001), discussion of liquid waste management in social organizations (r=.767**, P<0.001), and presence of septic tanks (r= 0.617**, P<0.001). The results indicate a positive correlation between monthly income and the presence of a septic tank (r= 0.447**, P<0.001), which indicates a moderate correlation, and between the usage, reuse, and recycling of liquid waste (r=.654**, P<0.001), which indicates a high correlation. These results demonstrated a statistically significant association between monthly income and the aforementioned characteristics.

According to the findings, there is a strong association between family size and the usage, reuse, and recycling of liquid waste (r=.837**, P<0.001). The amount of garbage that households produce is greatly influenced by factors including household size, income, and the age and educational level of the family members (Afroz et al., 2011). The outcome demonstrates that

there is no gender-biased link in achieving proper discharge of liquid waste, presence of septic tank, and r=.035, P= 0.571, respectively. While a study by Willetts et al. (2016) in Indonesia (13% women), Timor-Leste (0% women), and Vietnam (40% women) confirmed the male predominance of the sanitation sector, the authors also demonstrated the significant regional variation.

Table 9: Correlation analysis on liquid waste management practice

Correlations	**Gender**	**Age**	**Education**	**Marital status**	**Monthly income**	**Family size**
Proper discharge of liquid waste	-.098	.721**	.851**	.856**	.651**	.767**
Presence/ using of septic tank	-.012	.424**	.617**	.330**	.447**	.488**
Liquid waste use, reuse, recycle	.387	0.885**	0.859**	.799**	.654**	.837**

**. Correlation is significant at the 0.01 level (2-tailed).

Recent studies have shown that an individual's age may have an impact on how they manage their waste, and that these affects are distinct from those of ageing. Older people have emphasized that prevention, reuse, and recycling are aspects that relate to attitudes, norms, and behavior in different ways. Behaviors in the context of waste management are influenced in part by attitudes, experience, and circumstance rather than just wealth (Pickerin & Shaw, 2015).

According to Struk and soukopoval (2016), waste-related behaviour varies significantly depending on age group. We have found that people under 30 tend to produce the least amount of residual waste per capita while also being the best at waste separation and management, whereas people aged 50 to 79 seem to be generating the most residual waste while not doing as well at waste separation and management but generally producing the least amount of waste overall. According to Handayani et al. (2019), households with more educated and wealthy members who live in metropolitan areas are more likely to produce more garbage, but they are also more likely to manage their waste production. This shows that factors such as age, education, gender, and income have a history of impacting how well liquid waste is managed at home before it is disposed of.

4.4 Challenges for the implementation of liquid waste management

As shown in Table 12 below, there were a number of obstacles to the implementation of LWM in residents, including low motivation and attitude (23.3%), accountability (18.8%), insufficient funding (18.4%), lack of commitment and political will (13.5%), a lack of innovation and new technologies (12.0%), limited qualification (9.8%), and lack of policy (4.1%). The growing difficulties are a result of a lack of funding for urban sanitation and a lack of city-wide legislation governing sanitation. The lack of adequate space for cleaning and washing purposes was cited as a barrier to liquid waste management by 16.2% of respondents, 18.4% of respondents, and 65.4% of respondents, respectively, as well as poor awareness of LWM and sewer system blockage. Lack of knowledge among locals, officials, and professionals may be the cause of the inefficient waste management method. The wastewater management infrastructures (sewerage lines, vacuum tracks, public restrooms, disposal sites, and treatment facilities) are allegedly inadequate, and there are no standards, guidelines, or manuals to support their implementation.

Table 10: Challenges of respondents on liquid waste management

No	Variables/Items/questions	Characteristics	Frequency	Percent
1	Barrier for the implementation of LWM in your resident	Limited qualified waste professionals	26	9.8
		Lack of accountability	50	18.8
		Insufficient budget	49	18.4
		Inhibited innovation and new technologies	32	12.0
		Low motivation and attitudes	62	23.3
		Absence of policies and regulations	11	4.1
		Lack of commitment and political will	36	13.5
2	Barrier for liquid waste management in your home	Lack of enough space for latrine and washing purposes	43	16.2
		Poor awareness of LWM	174	65.4
		Blockage of sewerage system	49	18.4

In this regard, *wereda* KII respondents emphasized that the common barriers to liquid waste management in this *wereda* include a lack of environmental consultants at the *wereda* or sub-city level, poor awareness, a lack of social responsibility, poor and insufficient infrastructure, poor engineering, a poor sewerage system, a lack of mitigation tools, the unrestricted disposal of several tons of industrial effluents, poor investment decisions, and discharges of untreated or undiluted pesticides. Residents failed to dispose of liquid waste from indiscriminate household solid wastes such as coffee grounds, plastic bottles, ceramics, wooden materials, etc. to the sewerage system, which blocked the channels used to transport liquid waste and led to flooding, backwater, and various diseases in the neighborhood.

The AAWSA KII's further confirmed that the main obstacles to effective liquid waste management are a lack of sewerage lines connecting to the main akaki treatment system, a lack of trained and experienced liquid waste workers, illegal or unplanned housing, an unsustainable poor quality sewerage system, a lack of construction knowledge, and financial constraints. Similarly, information from FGD confirmed that there are physical challenges, such as a large volume of liquid waste, as well as a lack of strong control and implementation of pollution control proclamations, concerned bodies that are unwilling to solve the issue instead delegate their responsibilities to other bodies, irregular waste collection, inadequate waste collection vehicles, limited access to septic tanks, and a lack of alternatives to final waste disposal and facilities.

As indicated in the Table 13 below, according to the researcher survey of the status of sewerage system in the wereda's sample streets, 57% poorly built and polluted. *Assessment of overall status of sewer system: the majority of sewer system at wereda 9 are poorly built and polluted*.

Table 11: Observed wereda's sample sewerage Status

No	**Wereda 9 Streets**	**Sewer Status for each Stree**
1.	Street 1902	There is complete and poor sewer system, high pollution
2.	Street 2029	There is complete and good sewer system and low pollution
3.	Street 1931	There is complete but poor sewer system and low pollution
4.	Street 1950	There is complete but poor sewer system and high pollution
5.	Street 1961	There is complete and good sewer system, low pollution
6.	Street 1974	There is complete and poor sewer system, low pollution
7.	Street 1976	There is complete and poor sewer system, low pollution
8.	Street 1977	There is partial and good sewer system, high pollution
9.	Street 1978	There is complete and good sewer system, low pollution
10.	Street 1979	There is complete but poor sewer system and low pollution
11.	Street 2084	There is partial and poor sewer system and high pollution
12.	Street 2086	There is partial and poor sewer system but low pollution
13.	Street 1998	There is complete and good sewer system, low pollution
14.	Street 2000	There is complete and good sewer system and low pollution

Sources: own survey (2023)

According to Table 14 below, there were 2223 patients admitted for urinary tract infections in 2022, 1684 patients were admitted for typhus fever, 834 patients were admitted for amoebiasis, 379 patients were admitted for intestinal helmentis, and 218 patients were admitted for typhoid fever. A particular form of bacteria known as E. coli is the root cause of 80 to 90 percent of UTIs. These bacteria mostly reside in your intestines, but they can occasionally enter the urinary tract through liquid waste and spread there. Other infections that affect both children and adults, such schistosomiasis, typhoid, hookworm, and round worms, are spread by contaminated water that has been contaminated with human excreta.

Where stools were not properly disposed of, the risk of infection increased by 30 to 50% when there was severe diarrhea EPHTI, (2002). Although amebiasis can occur anywhere, it is most common in underdeveloped nations due to poor sanitation and increasing fecal contamination of water supplies. Amebiasis is an ailment that affects over 50 million people worldwide, and it is reported to be responsible for over 100,000 annual fatalities. Ingestion of water or food contaminated by feces with E. histolytica cysts is the main cause of infection (Saidin et al., 2019). Only 14% of the urban population in Ethiopia has access to better sanitation facilities, which are capable of preventing feco-oral routes of illness transmission, according to the 2014 Ethiopian Demographic and Health Survey (EDHS). Resident wastewater may have both favorable and unfavorable effects on ecosystems, soil resources, public health, and crop output. Because wastewater may contain microorganisms or chemical pollutants that can negatively affect the health of those working on wastewater farms, consumers of vegetables produced using wastewater, and neighboring communities, often leading to gastrointestinal disease, it poses potential health risks like diarrhea, skin diseases, and hepatitis.

Table 12: Level of infectious diseases from wereda 9 Selam health center

No	**Diseases**	**Amount**
1.	Urinary tract infection	2223
2.	Typhus fever unspecified	1684
3.	Amoebiasis	834
4.	Intestinal helminthiasis	379
5.	Typhoid fever	218
6.	Gastroenteritis and colitis	151
7.	Gastritis	152
8.	Giardiasis	53
9.	Duodenitis	41
10.	Shigellosis	4

Source: Data from Selam health center *wereda* 9, 2022

The challenges associated with liquid waste management can be summarized in terms of social, institutional, and contextual aspects, which are directly related to the overall liquid waste management practice and instructions of the issues, according to findings from KII, field observation, and documentary analysis indicated in the aforementioned tables (Tables 12, 13, and 14), respectively. As a result, the community has demonstrated low motivation and attitude when it comes to addressing the liquid waste management challenge at the household or outdoor level. Similar issues were found at the institutional level, including a lack of funding for infrastructure construction, inadequate allocation of land for community or association latrine construction, and a lack of knowledge and expertise among *wereda* experts assigned to provide door-to-door awareness and waste management services. Due to the lack of environmental consultants and the closure of the environmental office at the *woreda* level, the gap connected to the management of liquid waste at the household or outdoor level would be inefficient from a contextual standpoint. This demonstrates the lack of focus on issues related to the management of liquid waste at the municipal level. Although onsite sanitation as a whole is not addressed, the 2002 Wastewater Master Plan, an update of the 1993 Master Plan (AAWSA 2002), takes both sewage and fecal sludge management (i.e., collection, treatment, and disposal of sludge from latrines and septic tanks) into account. One million people should be served by sewers, 1.4 million by septic tanks, and 1.4 million by pit latrines by the year 2020, according to the planning horizon. However, the plan's goal will not be met until 2023. The majority of the remaining urban area uses pit latrines to dispose of its wastewater in the storm water drainage network, whereas less than 10% of the urban area had sewer system (AAWSSA, 2008). The highly engineering-based design of the city sewage system, according to the WWDR (2017), failed due to a lack of public awareness regarding the proper understanding of the importance and implementation of the service. The main cause of sewer obstructions including non-degradable and floating un-flushable items, such as sanitary napkins, diapers, various sizes of polythene, cooking oil, and food, is the irresponsible personal and societal attitude toward the city sewage system.

UNIT FIVE

5. CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The overall awareness and practice are not satisfactory and there were multiple challenges of liquid waste management in *Gulele* sub city, specifically in *wereda* 9. Since the focus for awareness creation, trainings and discussions on liquid waste management was very low.

Insufficient access and high cost for liquid waste transfer and transportation to the final disposal due to costs, currently sludge fee is about 500 birr by AAWSSA and in private it costs 3000 birr. There were low use of septic tank and sewer systems, practically there were low level of liquid waste recycled and recovered. There were low motivation and attitude, society are not responsible enough towards liquid waste management, and financial constraints are also undeniable challenges.

The study reflected strong correlation among age with practice of liquid waste management, getting training and liquid waste use, reuse and recycle. There were Strong correlation among education with practice of liquid waste management, getting training, discussion on social organizations and with liquid waste use, reuse, recycle. Similarly strong correlation shown between marital status with practice of liquid waste management and liquid waste use, reuse, recycle. But here is no gender biased in attaining discharging liquid waste at proper place, to get training, having septic tank and discussion in the social organization on LWM.

Educational level and monthly income have a history of influencing using septic tank to discharge liquid wastes and experience of managing liquid waste properly from house hold to disposing cite. Educational level and age have a history of influencing getting training on liquid waste management and experience of managing liquid waste properly from house hold to disposing cite.

Significant fecal contamination of water sources from both livestock and human waste occurred in the study area. Municipal sewage canals that are blocked and do not empty into waterways. Liquid waste and other rubbish are thrown into rivers by people who live close to water sources and by those who go farther. The discharges of industrial sewage and household effluent are highly polluted in terms of biological, physical and chemical content. According to the researcher survey of the status of sewerage systems in the wereda 9 main streets, 57% poorly built and polluted.

Particularly the high level of UTI (urinary tract infection) indicated that, influence of improper management of resident's liquid waste because of most microorganisms from domestic liquid wastes posed a threat to anyone who consumes these waste water sources without some forms of physical and chemical treatments.

5.2 RECOMMENDATION

The following suggestions are made in light of the findings and conclusions of this study:

- To raise public awareness and alter the culture of discarding and pouring liquid waste into any open area, road, river, or other site not intended for such reasons, a significant information distribution effort on liquid waste management should be carried out by wereda 9 environmental health experts. It's important to stop individuals from defecating and urinating close to water sources. Before visiting aquatic bodies, follow all applicable and legal rules for proper treatment of domestic discharge. AAWSA and private sectors should increase the number of sludge treatment facilities to decrease the volume of sludge transported.
- Construct a regular sewer system in areas of wereda 9 don't have one at all. Practice proper liquid waste disposal at home and at work; avoid pouring chemicals into drains or on the ground; check underground fuel oil tanks for leaks; if possible, replace them above ground; store all chemicals and fuels safely; use as little chemically as possible; have onsite septic systems pumped and inspected every five years; check onsite wells and surrounding land areas; test wells as frequently as pollution risk requires.
- AAWSA should made the cost of collecting liquid waste excessively low or zero. Wereda 9 administration should try to improve society's level of education, start job development to boost income, and encourage more senior citizens to participate in liquid waste management activities.

- Reducing the amount of fecal contamination of water sources by livestock and human wastes will significantly lessen water source pollution in the research area. Municipal sewage canals that do not drain into the river could be built to achieve this. Therefore, it is essential to refrain from throwing trash and rubbish into rivers.
- Used oil transporters and buyers in Addis Ababa should be authorized and accredited. The nation should put into effect bylaws that specify how waste water and oil produced by the nation's car washes should be handled, stored, and disposed of. Ethiopia should adopt the gentleman's agreement style of pollution reduction where local government and local businesses agree to follow stronger standards than those set by the national government. Local governments monitored and oversaw local industries in an effort to improve environmental conditions. Additionally, the business had to produce regular survey report submissions.
- In the future, EIA and EMP should be implemented because, in terms of cost, effort, and effectiveness, it is much preferable to include pollution controls during the initial planning stage rather than trying to come up with containment plans after the fact. This is because these controls are based on studies of anticipated environmental effects. Due to poor infrastructure engineering and subpar sewerage systems, there is excessive liquid waste pollution in most areas of Addis Ababa city during the summer. This needs to be cleaned up continuously, starting with workers from the safety net liquid waste channel cleaner enterprise, and should continue until the majority of the sewerage infrastructures are rebuilt and new systems are created.
- To facilitate recycling and reuse created liquid waste must be separated. In order to prevent environmental contamination in wereda 9, the sub city must consider using liquid waste to make fresh water for reuse. By encouraging more private sectors to handle liquid waste, AAWSA must enhance their current transportation strategies. Different sized trucks in an appropriate and sufficient amount should be provided depending on the width of the roadways. This will guarantee that more liquid waste created is collected and transported. The government of the city of Addis Ababa should develop a long-term, all-encompassing plan for managing liquid waste that would inspire the population to support it.

- AAWSA shall offer free bins and containers in a range of sizes to accommodate the volume of waste produced for efficient removal of liquid waste. Put them in a location that is convenient for keeping such rubbish on your property. Then, complimentary containers will be delivered; make sure to fill them with the proper kinds of liquid waste. At a predetermined time and date when they are full, licensed waste carriers arrive and remove them; you only have to pay for the collection. Make sure the containers are placed in a location that is easy for trucks to access.
- Make sure that waste water discharge connections are in place, avoid using floor drains wherever possible, utilize and maintain onsite septic systems properly, and seal and cover waste dumpers. Methods of collecting and transporting liquid waste need to be improved, some locals who handle and store hazardous materials safely need to be monitored, disconnect drains from storage and loading sites, keep chemicals and garbage away from rain, and protect storm water.
- Sanitation systems need a paradigm shift that supports decentralized systems that cut down on expensive infrastructure, promotes safe sanitation practices without harming the environment, and views trash as a resource through appropriate recycling and reuse. Investments that are misleading should be avoided.
- Permeable Cess-pits (similar to soak pits) should be used by society in places with a shortage of latrines. Wastewater settling (grey water and black water), anaerobic sludge digestion, and liquid percolation into the subsurface where microbial action breaks down some of the organic portion are the treatment processes used in permeable cesspits. Faecal organisms are eliminated as the effluent migrates across the unsaturated soil matrix and leaches from the porous cesspit.

5.2.1 Recommendation for further research

- Future research is encouraged in order to expand the sample size and coverage to additional sub cities where there are differences in infrastructure, economic capacity, educational attainment, and other factors. Additionally, more research should be done to determine how managing liquid waste affects the environment. However, more study is necessary to ascertain whether factors including environmental impacts, habits, and problems in various years can contribute.

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Annex A

Survey Questionnaire

ADDIS ABABA UNIVERSITY

COLLAGE OF DEVELOPMENT STUDIES

CENTER OF ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

Survey Questionnaire

Dear Respondents,

I am Gashaw kebede, a student of the Addis Ababa University Master's Degree of Arts in Environment and sustainable development. Currently I am doing my research on **Environmental Impacts of liquid waste management: a case of Gulele sub city, Addis Ababa, Ethiopia.** Therefore, your response for this questionnaire is very important for the success of the study because all information that you provide determines the analysis and conclusion of the research. Hence, I kindly ask you to respond to the questions, but if you have an issue you can ask clarification or withdraw at any time.

I would like to thank you in advance

Address: - EMAIL: gashawkebede322@gmail.com

Mobile phone: 0910351149

Part One: Demographic Characteristics and Respondent's Background

Choose an appropriate answer and put it in the bracket or write on the space provided

1.Gender of respondent 1) Male 2) Female ( )

2.Age of respondent ----------

3.Educational level of respondent

1) Illutrate 2) 1-4 grade 3) 5-8 grade 4) 9-12 grade

5) certeficate 6) Diploma 7) Degree 8) Above first degree ( )

4.Merital Status of respondent

1) Single 2) Married 3) Divorsed ( )

5.Monthly Income

1. <1000, 2. 1001-2500, 3. 2501-4000,

4. 4001-5500, 5. 5501-7000, 6. above 7000

6.Occupation of the houshold heads (bread winers)

1) Self-employed 4) Civil servant 7) others

2) Private sector 5) Retiree

3) Housewife 6) Student( )

7.Family size

1. 1-3 2. 4-6 3. 7-10 4. Above 10

8.Home residence type

1) Governmental house rent 2) Private house rent 3) Private owned 4. Other ( )

Part Two: Liquid waste management practice - Questions to Ordinary Citizens

Choose an appropriate answer and put it in the bracket

1. Is the liquid waste transported from informal settlements to the main sewerage system without environmental pollution?

a) Yes b)No ( )

2. The mode of service delivery for discharge of liquid waste used in an area

1) Sewerage disposal

2) Tank system (chamber)

3) Car truck system?

4) None of them ( )

3. Mechanism to reduce liquid waste production?

1) Reducing waste water at the source

2) Reuse of waste water

3) Recycling waste water

4) Energy recovery

5) Land fill liquid

6) None of them ( )

4. Are services provided by the Sewerage Authority in your premises satisfactory?

a) Yes b) No ( )

5. Which liquid waste do you use to reuse or recycle for liquid wastes at house hold level?

1) From bath, washing clothes

2) From flush toilet

3) From urine toilet

4) From kitchen

5) I do not practice any ( )

6. Where do you discharge your liquid waste produced in your house?

1) Sewers

2) Public area

3) Septic tank

4) Ditch

5) Other ( )

7. In your residence area, is there any sewerage system prepared to discharge liquid waste?

1) Yes 2) No ( )

8. Did you prepared septic tank to discharge liquid wastes?

1) Yes 2) No ( )

9. What do you think the reason for those improper practices of managing liquid waste?

1) No facilities to dispose

2) No need to dispose to proper place, it is wastage of time

3) I am not aware, no information

5) My household produce very small amount of liquid wastes ( )

10. Does your household have the experience of managing liquid waste properly from your household to disposing cite?

1) Yes ,I dispose properly

2) Yes, I dispose sometimes

3) No, I do not dispose at all

4) I am not sure ( )

Part Three: Liquid waste management awareness

11. Do you get any awareness/training on liquid waste management from your *woreda* administration by delegating relevant experts?

1) Yes ,where my household was properly participated
2) Yes, sometimes my household was participated
3) No, my household was not invited at all
4) Not sure ( )

12. If the answer is yes to question No 16 above, how do you evaluate the knowledge and skill of experts who are delegated in your *woreda* administration liquid waste management while they are delivering technical support to you?

1) Excellent
2) v. good
3) good
4) satisfactory ( )

13. Is there any supply of different sized vehicles to collecting liquid waste materials from the government?

1) Yes, there is sufficient supply of liquid waste collecting vehicles
2) Yes, but small amount
3) No, there is no sufficient supply of liquid waste collecting vehicles
4) I am not sure ( )

14. Is there a suitable and standard road for vehicles to inter to collect liquid waste?

1) Yes, there is standard and suitable road
2) Yes, but not standard and suitable road
3) No, there is no standard and suitable road ( )

15. Is there a directive (guideline) prepared by *woreda* administration to implement rules and regulation of liquid waste management

1) Yes 2) No ( )

16. Have you ever been discussed on the social organization (like *Idir, Ikub*) about cleaning your environment based on liquid waste management?

1) Yes 2) No ( )

THANK YOU!

Part Four: Interview for street leaders

Focus group Discussion

Sub-city/*Woreda* Name ----------

1. Define liquid waste
2. Discuss your awareness about liquid waste management?
3. What are the most successful aspects of liquid waste management in this wereda?
4. How do you manage liquid waste in your locality?
5. What are your experiences of liquid waste management according to the 3 R principle- Reduce, Reuse and Recycle
6. Explain your opinion, on the main challenges or worst aspects of liquid waste management in residential area?
7. How is the support of *woreda* administration on liquid waste management at residential level?
8. What improvements need to overcome liquid waste management problems?

THANK YOU!

Part Five: Key Informant Interview Questions for Wereda Experts

Organization Name----------

Name of Expert----------

Job Title----------

1. Explain liquid waste treatment techniques applied in this wereda

2. How do you consider the awareness of resident on liquid waste management?

3. What kinds of training programs given regarding liquid waste management for the community?

4. What are your opinions on the environmental and health impacts of residents due to improper management of liquid waste around the residents?

5. How do you consider the implementation of rules and regulation/ Proclamations with respect to liquid waste management?

6. How do you consider the linkage of liquid waste collectors AAWSA and private collectors with recycling industries?

7. Discuss the effectiveness of liquid waste collecting privet and governmental organizations in collecting, transporting, treating and disposing or recycling liquid waste materials?

8. Explain about the residents' practice of protecting ground water pollution that could exist due to improper liquid waste management?

THANK YOU!

Part Six: Interview Questions for wereda Executive officers

Organization Name----------

Name of Excutive officers----------

Job Title----------

1. What kinds of liquid waste management services does your locality provide?
2. Discuss the type of liquid waste materials that are recycled in your wereda
3. Why people discharge liquid waste produced in their houses and industries to public areas and rivers?
5. Describe common barriers to implementing effective liquid waste management system?
7. Explain the status of sewerage system in this wereda that is used to drain liquid waste?
8. What are the current wereda executive orders on liquid waste management?
9. How do you control and improve liquid waste management practices in this wereda as an executive officer?

THANK YOU!

Part Seven: Interview Questions for experts working in liquid waste management institution

Organization Name----------
Name of Expert----------
Job Title----------

1. Discuss the quality and quantity of workers and materials that are used to collect, transport, treat and dispose liquid waste.
2. Explain the awareness of the AAWSSA workers and the community in the liquid waste management practices
3. How do you understand the community liquid waste management practices in their resident
4. Discuss the challenges for the implementation of liquid waste management practices in AAWSA
5. Explain your effectiveness in the liquid waste management practice in terms of collecting in time, transporting without environmental pollution
6. What look like competencies involve developing and implementing waste management plans
7. Which area of liquid waste management practice (human, animal or industrial waste) applied by the community
8. Discuss the integration of the different liquid waste managing institutions for the proper disposal of liquid waste management

THANK YOU!

Annex B

Field observation Photograph

Figure 6: Road in Tsion *industrial park* wereda *9, 2022*

Figure 7: Garage area in Public Health Institute, 2022

Figure 8: Road side small hotel hand washing area near down to Mastem hotel, 2022

Figure 9: The status of residential sewerage system near to Ethiopian Science academy, 2022