MEKELLE UNIVERSITY
COLLEGE OF BUSINESS AND ECONOMICS

DEPARTMENT OF MANAGEMENT

ASSESSMENT OF SOLID WASTE MANAGEMENT PRACTICIES IN MEKELLE CITY, THE CASE OF KEDAMAY WEYANE DISTRICT

BY

SAMRAWIT BIRHANU

A THESIS

SUBMITTED TO THE DEPARTMENT OF MANAGEMENT, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF ARTS DEGREE IN MA PROGRAM IN DEVELOPMENT STUDIES

ADVISOR: ASSEFA SHAMIE (ASST.PROF)

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MEKELLE, ETHIOPIA

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Approved by Board of examiners:

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Chairperson	Signature
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(Advisor)	Signature
_____	_____
(Internal examiner)	Signature
_____	_____
(External examiner)	Signature

Statement of Declaration

I here, declare that the thesis entitled “assessment of solid waste management practices in Mekelle city, : the case of Kedamay Weyane district Tigray regional state” is my own original work and has never been presented **by** anyone for any degree in any university. All sources of materials used for this thesis have duly acknowledged.

Name: Samrawit Birhanu

Signature: _____

Date: _____

Statement of Certification

We certify that this thesis entitled “assessment of solid waste management practices in Mekelle city, the case of Kedamay Weyane district Tigray regional state” is work of Ms. Samrawit Birhanu who carried out the research under my guidance.

Principal Advisor: Assefa Shamie

Signature: _____

Date: _____

Signature: _____

Date: _____

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Abbreviations / Acronyms

CSA: Central Statistical Agency

DSWGR: Daily Solid Waste Generation Rate

ISWM: Integrated Solid Waste Management

MSW: Municipal Solid Waste

MMPD: Mekelle Master Plan Document

NEMA: National Environmental Management Authority

PCPDSWGR: Per Capita per Day Solid Waste Generation Rate

NNNPR: South Nation Nationality Peoples Regions

SW: Solid Waste

SWM: Solid Waste Management

SPSS: Statistical package for the social science

MSBPDD: Mekelle Sanitation Beatification and Parks Development Department

WASET: World Academy of Science, Engineering and Technology WHO World Health Organization

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Abstract

Municipal solid waste causes substantial harm to the environment and human health if mismanaged. With a rapidly expanding human population and growing trend of urbanization, problems related to the management of municipal solid waste have become of considerable importance in Ethiopia from both environment and human safety. This urges for better understanding of the existing practices and problems of solid waste management in emerging towns of Ethiopia. This study therefore assessed the existing solid waste management practices and problems in Mekelle city. Samples were selected using probabilistic and non- probabilistic techniques. The primary data were collected via questionnaires, interview, and field observations. Whereas the secondary data were extracted from different published and unpublished materials. A total of 95 respondents were used in the study. The findings of the study revealed that the main types of solid wast in Mekelle are peels of vegetables, ash and dust, plastic, paper and cardboard, leaf and the physical composition of MSW in the city is composed from both biodegradable and non-degradable components, the current SWM practice of City is weak and also there is a problem on solid waste reduction strategy: separation, reuse, recycle, and resource recovery. According to the results different main factors that aggravate the existing poor status of SWM practice in the city. These are: socio-cultural, technical and institutional factors. To alleviate the problems the study suggests that, the current study showed that the solid waste production rate of Mekelle city at the household level is 8,380.869 kg/day, 58,666kg/weak, 251,426kg/month and 3,0590,28.5 kg/year with 41,696 population of Mekelle city. The per capital solid waste generation rate is 0.201kg/cap/day/25 households. The study employed binary logistic regression model to identify the factors that determine households decision to practice solid waste management in the study revealed that family size, education status, households perception towards SWM, and distance were the main factors that determine households decision to practice solid waste management in the study area. Poor municipal solid waste management is practiced in the town. Therefore, it is recommended that the municipal should develop good infrastructure, and prepare appropriate disposal sites where solid wastes can be disposed. Awareness raising among the inhabitants and also organizing the youth groups in small and micro enterprises in solid waste management activities is found to be important. Normal monitoring of the functionality of the system is also essential

Keywords: *Households, Management practices, Solid waste composition, Mekelle city*

CHAPTER ONE: INTRODUCTION

1.1. Background of the Study

Waste management is one of the greatest environmental challenges confronting cities in developing countries. It is one of the most pervasive environmental problems which constantly engage the attention of policymakers, city administrators, and academia. According to a report commissioned by the World Bank, by 2050, 3.40 billion tons of waste will be generated around the world annually, increasing drastically from today's 2.01 billion tons (Kaza, et.al, 2018). The cost of managing tons of waste generated on a daily basis in cities, coupled with the scarcity of landfill sites has been a major cause for concern.

Wastes that are often discharged from residential, commercial, and institutional activities make up the majority of municipal solid wastes (MSW). Food waste, paper, plastic, glass, textile scrap material, wood, and other materials are examples of these wastes. Such materials cannot decay naturally and take a longer time to deteriorate, necessitating the urgent need to find another method to alleviate such an issue (Ashani et al., 2020; Wang et al., 2017).

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

A door-to-door collection system is widespread in most industrialized countries. But municipalities in underdeveloped countries can only provide this service to a small fraction of the population due to budgetary and administrative constraints (Bezama and Agamuthu, 2019). Un planned placement of communal bins or garbage sites could endanger water resources, especially water sources like rivers and streams. In time, other groundwater sources including hand-dug wells and boreholes will also be impacted (Odonkor et al., 2020). Many urban

residents in developing countries lack access to sewerage systems and efficient municipal waste disposal, which severely pollutes their surroundings (Solgi et al., 2018). In addition, many city dwellers improperly manage and handle their waste products, whether on purpose or accidently aggravating soil and water pollution.

According to the studies, significant proportions of solid waste disposal in Ethiopia are not collected and hence wind up in open places and sewers. Both human life and the ecosystem are threatened by the consequences of this occurrence. Solid waste disposal is a severe issue because, when burned, it can increase air pollution, and, when thrown in the open, it can contaminate the land, and water in the surrounding areas (Jerin et al., 2022). The management of solid waste in Ethiopia faces a variety of challenges, such as a lack of finance and resources, technical challenges, a lack of public awareness, and a lack of coordination between various government agencies and the public and private sectors (Ashikuzzaman and Howlader, 2020).

Several researchers have looked into the health and environmental effects of waste disposal, and they've discovered that waste and health are inextricably linked (Habib and Sarkar, 2017). As a result of the findings of these investigations, scientists have been increasingly interested in the study of environmental contamination and its impact on microorganisms. Only a small number of studies, however (Mekonnen et al., 2020), have examined the environmental and health effects of solid waste on residents who live close to garbage dumps.

Solid waste management systems in the Mekelle city continued to be in appropriate and problematic. However, no one was willing to do the research. Municipal solid waste management has previously served the city, but has not been able to solve the problem due to rapid urbanization and population growth. Water and other liquid packaging plastics are widely disposed of in the city. As a result, the researchers decided to carry out this sociological study to solve the problems of improper solid waste management practice, which in turn encourages researchers and organizations to look for the Mekelle city in the future.

1.2. Statement of the problem

The organization of waste in urban areas of Ethiopia is the accountability of the town municipality. However, due to lack of sufficient technology, human capital, institutional set up and financial constraints the sector has been mistreated. Collecting and managing solid and human waste is a challenge for countries across the world. The implementation of effective waste management practices has been identified as necessary for economic growth in low- income countries in particular (Scheinberg, 2011).

The population growth rate of urban population in Ethiopia, according to (Abraham, 2018), estimated in most urban areas especially small urban centers is doubling every 15-25 years. In line with this, Birhanu, and Berisa, (2015) described that with economic development and population growth in urban areas results in increased solid waste generation, which demands municipalities in Ethiopia to be prepared for such challenges. Getahun et al, (2012) stated that poor solid waste management is a threat on sustainable development posing urban growth, which results in environmental pollution. Similarly, Feleke (2015) also noted that poor management of solid waste have a devastating impact up on the environment.

The research conducted by Kibralem (2017) stated that lack of infrastructure for collection, transportation, treatment and disposal of solid waste, proper solid waste management planning, insufficient financial resources, technical expertise and public attitude have made the situation exasperating due to which several environmental and health related problems are increasing.

Mekelle city is characterized by fast population growth and urbanization. Such rapid raise in population coupled with rapid development of the town has created increasing solid wastes generation rate. Moreover, the amount and type of solid wastes generated is now a day increased time to time. Solid waste management practice of the Mekelle city is weakly organized and implemented because of factors such as lack of adequate infrastructure, skilled manpower, financial constraints and absence of institutional arrangements and also no research was conducted. So far regarding its solid waste generation rate, composition and separation practice at household level is limited (Mekelle city health sector and municipal office 2017). Thus, to fill in the gap, this study was focus to quantify solid waste generation rate, composition and separation practices at household level within Mekelle city.

1.3. Objectives of the study

1.3.1. General objective

The general objective of the study is to assess solid waste management practices and quantification of solid waste generation rate in Mekelle city

1.3.2. Specific objectives

These specific objectives were incorporate as follows:

1. To evaluate household solid waste generation rate through quantification,
2. To assess the practices of household solid waste management experience in Mekelle city
3. To assess the impact of inappropriate solid waste management in the study area;
4. To identify the factors of solid waste management practices in the city;

1.4. Research Questions

1. What is daily rate of solid waste generation at household level in Mekelle City?
2. What is the experience of solid waste management practice in Mekelle City?
3. What is the impact of inappropriate solid waste management of the study area?
4. What are the factors of the solid waste management practices in the town?

1.5. Significance of the study

This study is expected to be useful in different main points. First, the study could contribute to a better theoretical understanding of the overall features of solid waste and problems faced in the process of solid waste management. Second, it give some guideline information to policy makers, public administrators, solid waste managers, municipal leaders, researchers and environmental protection agencies who seek to improve existing solid waste management and to minimize related problems and also to see the practices in the study area. The study also important in putting baseline information to the next work as a springboard for researchers who would like to conduct detailed and comprehensive studies either in the city or another study area.

According to the study area (Mekelle city health sector and municipal office 2017) lack of information on solid waste generation rate, its composition and association practice at household level and the existing status of household solid waste management practice is one of the main factors that was leads to improper waste management. In this respect, this study would be provides baseline data on solid waste generation rate, physical composition and sorting practices of solid waste at household level and the existing status of household solid waste management practice of Mekelle city. Furthermore, it may provide as a starting point for further study and also could provide as a document for future use.

1.6. Scope and Limitation of the Study

1.6.1. Scope of the Study

Solid waste management activities significantly vary from place to place. Regardless of scale, variation in SWM activities is related to the increasing socio-economic, financial and legal variables. The scope of this study was to assess the SWM system with the special focus of practices and challenges at local level that is Mekelle city. The study has confined to small geographical area due to financial and time constraints. The scope of the research has conceptually confined to the specific objectives of the research in terms of evaluating household solid waste generation rate through quantification, the practices of household solid waste management experience in the study area, the impact of inappropriate solid waste management in the study area and the factors of solid waste management practices in the city. In respect to methodology descriptive research method has applied for this study. Moreover, although both liquid waste and solid waste are demanding subject to study, this study has dealt only Solid Waste Management Practices of Mekelle city Administration of Tigrai regional state of Ethiopia.

1.6.2. Limitation of the study

The first limitation of the study was its coverage of only the solid waste management practices and quantification of solid waste generation rate in Mekelle city which would not incorporated liquid waste management.

Moreover, in the study area there are seven municipalities but the researcher studies only one municipalities due to the university's academic Calendar, time and resource constraints. In

addition, some municipality employees and service users of the city were not willing to provide the necessary information by formal interviews and questionnaires

Besides, the other limitation of the study was shortage of secondary data sources regarding to solid waste management practices and quantification of solid waste generation rate in Mekelle city. But the researcher was tried to minimize these problems and come up with reasonable findings.

1.7. Organization of the Study

The study was organized in to five chapters. The first chapter has consists the introductory part which includes the background of the study, statement of the problem, research questions of the study, objective of the study, significance, scope, limitation and organization of the study. The second chapter was presented the review of literature relevant to the research. The third chapter has discussed about research design and methodology and chapter four was deals about results and discussion. The last chapter has presented conclusion and recommendations of the study.

CHAPTER TWO:

REVIEW OF LITERATURE

2.1. Solid Waste Concept

Solid waste technically, any solid material disposed of as no longer useful in common usage the term has somewhat more limited meaning of solid materials thrown out by house holders those materials referred to by engineers as municipal solid waste. Solid (nonhazardous) waste is defined as any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semi liquid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations and from community activities, but does not include solid or dissolved material in domestic sewage (Benny, 2005). Solid wastes are wastes arise from human and animal activities, including the heterogeneous mass of garbage from the urban community as well as more homogenous accumulation comprising of countless different materials such as food wastes, packaging material such as paper, metals, plastic, glass, construction wastes, pathological wastes and hazardous wastes. Rapid population growth and urbanization in developing countries have led to the generation of enormous quantities of solid wastes and consequently environmental degradation.

Wastes are materials that are not prime products (that is products produced for the market) for which the initial user has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose. Wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, and other human activities. Residuals recycled or reused at the place of generation are excluded" (Abrhame, 2018).

2.2. Solid Waste Management Practices from Global Perspectives

Ten years ago there were 2.9 billion urban residents who generated about 0.4 kg of MSW per person per day, and 0.68 billion tons per year (Chertow, 1998).In the United Kingdom, in contrast, land contaminated by waste solid is less likely to be seen as a hazard, and the government appears to have taken a less careful approach (WASET, 2014). Germany, which is backing away from nuclear power by announcing it will shut down all nuclear reactors in the

country by 2020, identified a massive underground salt chamber for storage in 1977, but research there was stopped in 2000 because of political challenges (Cointreau et al., 2000). Solid Waste management practices differ between developed and developing countries, between urban and rural areas, and between residential and industrial producers (Mugambwa, 2009). Solid Waste management in most of the Africa counters has two problems: lack of accurate data on waste generation and characterization and a corresponding lack of information about waste collection, processing, and disposal (Tchobanoglous et al., 2002).A July 2002 report by the African Development Bank has found, for instance, that no country has specific waste management legislation, although some statutes are being drafted, and virtually no integrated waste management programs are being implemented (UNEP, 2009). A lack of information has also been major contributory factors to poor solid waste management in many African countries (Ayotamuno et al., 2004).

2.3. Solid Waste Management Practices in Ethiopia

In Ethiopia, according to the Federal Democratic Republic of Ethiopia Proclamation No. 513/2007, Solid Waste Management Proclamation, "Solid Waste" means anything that is neither liquid not gas and is discarded as unwanted. The ever increasing amount of solid waste generated which is exacerbated by lack of proper waste management system is of growing environmental and public health concern worldwide and in major towns and cities of Ethiopia (Goa, and Sota, 2017).

Collecting and managing solid waste is an important challenge for countries across the world. This problem is often magnified in cities where a dense concentration of people leads to a substantial amount of waste generation (Contireau, 1994). In developing countries like Ethiopia, this problem is increased by an influx of people moving to urban centers (Dereje, 2001). Densely populated areas are more susceptible to health risks as disease can be spread quickly (Chertow, 2007). The implementation of effective waste management practices has been identified as essential for economic development in low income countries in particular (Scheinberg, 2010).

Urban centers are usually the hardest hit as efforts to develop and grow lead to an influx of economic opportunities and people. In the middle ages the Bubonic Plague swept through cities as solid waste was improperly disposed of in the roads (Awetash, 2003). Given the tragic

consequences of the past, it is vital that improving waste management practices in the growing cities of Ethiopia be a top priority (Kuma, 2004). Waste management in Ethiopia is important because only a small percentage of the country's inhabitants have access to safe drinking water that is 21% in rural areas, 84% in urban areas and 30% in countrywide. Additionally, only 7% of populations in rural areas, 68% in urban areas, and 15% of people countrywide have adequate access to latrines or other improved human waste disposal options. Access to latrines is a critical aspect of waste management, especially since the practice of open defecation is prevalent in the country, which can contaminate ground water and lead to disease (WHO. 2006).

Most of them tend to focus on the technical dimensions of the municipal waste management, such as estimating the amount of solid waste composition (that is 89.4%around in Adama city) (Lemma, 2007). Systems that should be put in place (e.g. new sanitary landfill, transfer stations, composting sites, new trucks and containers, data on waste generation, and waste composition) in order to improve the capacity of the management in the city (Dereje, 2001). The city's suffers from poor solid waste management and refer to lack of data on waste generation, of recycling activities, lack of proper transport schedules, a poor sanitary landfill, and a low level of awareness among the citizens as the main obstacles (KBRALEM, 2017).

2.4. Source and Types of Solid Wastes

Tchobanoglous et al., 1993 classified types of solid waste in relation to the source of generation, generation facilities or activities, and locations. However, (Charlotte, 2009) Classified solid waste types based on their origin as food waste (60%), rubbish (5%), ashes and residues (25%), demolition and construction (7%), and agriculture waste (3%). On the other hand, Cheremisinoff (2003) classified solid waste based on their biological characteristics as biodegradable (80%) and the other (20%) is non- biodegradable wastes. Solid wastes could also be classified based on the risk potentials associated with the waste as hazardous waste (16%) and non-hazardous waste (84%) (Zurbrugg, 2003). Household items that are frequently separated include newspapers, magazines, scrap paper, boxboard, plastic bags, food and drink cans and containers, and in some cases, organic wastes and bulky goods (Simoes, 2012). A review (Barr, 2004) on recycling and

recovery routes of plastic solid waste: about (87%) emphasize that sorting is the most important step in the recycling loop irrespective of how efficient a recycling scheme might be.

Source	Typical waste generators	Types of solid wastes
Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g. bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous wastes
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plant	Housekeeping wastes, packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, special wastes
Commercial	Stores, hotels, restaurants, markets, office buildings, etc.	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Institutional	Schools, hospitals, prisons, government centers	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, dirt, etc.
Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants	Street sweepings, landscape and tree trimmings, general wastes from parks, beaches, and other recreational area, sludge
Process	Heavy and light manufacturing, refineries, chemical plants, power plants, mineral extraction and processing	Industrial process wastes, scrap materials, off specification products, slag, tailings
Agriculture	Crops, orchards, vineyards, dairies, feedlots, farms	Spoiled food wastes, agricultural wastes, hazardous wastes (e.g. pesticides)

Source: (Hoornweg and Bhada, 2012)

2.5. Solid Waste Generation, Characteristics and Compositions

For effective and efficient management of solid waste generated in a particular city is (i.e. 2.9%/day in Teppi Town) adequate knowledge and data about the characteristics of solid waste is essential (Abyot Aseres, 2014). In order to decide or determine types of facilities required for solid waste management, best disposal options, and projecting future needs requires precise information about quantities, compositions, densities, moisture content and calorific value of solid waste produced in a city (Rush,1999). Information on the composition of solid wastes is important in evaluating alternative equipment needs, systems and management programs and plans. For example if the daily solid waste generated rate 2.27% per daily around Yeki Town. At the commercial facility consists of only paper products, the use of special processing equipment such as shredders and balers, may be appropriate (Seada, 2011).

Municipal solid waste is produced as the result of economic productivity and increase in consumption pattern of the people in low income countries, there is relatively less commercial and industrial activity, as the result there is lower waste generation rate (Cointreau, 1994). The implication of this growth is that pollution issues such as solid waste management and the provision of adequate safe water alongside acceptable levels of sanitation coverage will need closer attention (Memon, 2010). In general, solid Wastes which are generated in low-income countries are less than solid waste which is generated in high-income countries (Cointreau, 1994).

2.6 Factor Influencing Solid Waste Management

The poor management structure and institutional inefficiency in Ethiopia has resulted in weak work coordination, insufficient controlling, and monitoring and evaluation system and aggravated the existing obstacles. Community participation in solid waste management must start at home, with house being involved in separation of waste at source and being responsible for strict control over storage hygiene (Gebreamanuel, 1994). For further understanding some of these factors are discussed below.

2.7 Management Factors

According to some authors for example (Joardar, 2000), poor management of local authority who are responsible for the handling. In addition, municipal waste management is key factor to

consider inadequate provision of facilities for waste management (kuma, 2004). Low skill workers; Inadequate of sensitivity and consciousness to understand the needs of the public are also important factors for weak management of municipal wastes (Ayotamuno et al, 2004). The garbage collection process is not systematic and practically ineffective for disposal (Staniskis, 2005). In many countries, particularly in developing countries there is also no approach to monitoring and supervision of all activities associated with the waste management (Ayotamuno et al, 2004)s.

2.8. Lack of skills, knowledge and equipment in solid waste management

Ineffective management system, absence of reasonable and systematic method adopted the weaknesses in the provision of equipment for the implementation of services, poor infrastructure (Chaturvedi, 2007). Lacks of awareness restrictions of the technical work in solid waste management are other important factors to hinder the effective management of solid waste (Coffey, 2010). Limitation of knowledge in the waste management organization including weakness of action policies from government are important to mention and to act up on to improvement (Hazra and Goel, 2009).

2.9. Lack of Policy Enforcement and Responsibility

Often it is not the environmental legislation itself that is at the heart of the problem and also lack of enforcement that is the real challenge to sustainable waste management in Ethiopia (Kassa, 2009). This lack of enforcement of policies and laws is a major institutional issue that greatly contributes to the mismanagement of solid waste. An example of this can be seen in Addis Ababa; although there is insufficient legislation covering waste management, local authorities lack the capacity to implement them(Abebaw, 2008). Immoral scattering habits and attitudes of people, lack of awareness among communities, support and public interest in the solid waste management (Ali and Snes, 2006).

2.10. Risks and problems associated with solid waste

It is fact that, if solid wastes are not managed properly there are many negative impacts on aesthetic, human health and environment (NEMA, 2007). Therefore, in order to control the management activity in a good manner and have a proactive measure for such negative

impact, one must have a good understanding about (85%) the effects and risks that may arise from improperly managed solid wastes (WHO, 1996).

2.11. Impacts of improper solid Waste

2.11.1. Management Environmental Health Risks

Uncollected waste in settlements often accumulates in open drains, in river gullies, on empty plots, or at the roadsides. During storm events drains are blocked by solid waste. Then, a mix of storm-water, wastewater and waste overflows the drains and floods the neighborhood creating an unhygienic environment and exposing residents to pathogenic and chemical substances.

Solid waste dumped indiscriminately into empty plots, drains or rivers also offers ideal breeding grounds for disease-transmitting vectors. When rainwater accumulates in waste (such as discarded tires) or when waste blocks drains and channels creating stagnant puddles, these are ideal breeding sites are created for the mosquitos Aedes aegypti and Aedes albopictus both of which are major vectors of dengue which is basically an urban disease (Dutta and Mahanta, 2006). Furthermore, the malaria transmitting mosquito Anopheles was found to breed in similarly polluted, stagnant waters (Awolola et al., 2007). Awolola et al (2007) have shown that Anopheles gambiae is able to adapt to a large range of water quality conditions present in urban areas. This has serious consequences on urban malaria. Biodegradable waste also attracts insects, rodents and other animals that feed on waste; the animals then proliferate and when in contact with humans, transmit disease. In Europe between the 14th and 17th century, the historically most devastating pandemics of plague was caused by fleas carried by ground rodents, and is attributed to roads and neighborhoods covered in garbage and excrements which provided ideal breeding grounds for the rodents.

A well-documented case in modern times is from the city of Surat in the state of Gujarat India, where the rapid growth of slums, uncollected waste and indiscriminate dumping led to a proliferation of rats and then, as a consequence to the outbreak of pneumonic plague in September 1994 leaving 56 people dead. This event created global panic and severely affected the city of Surat and the national economy of India. About 60% of the Surat population left the city for fear of falling ill. The industry suffered an estimated loss of about 214 Million USD, although the disease was controlled within a week. Inadequate waste collection and disposal was

mentioned most frequently as main cause of the outbreak. Authorities however, argued that it was the non-cooperation and non-compliance of the public and a lack of awareness about cleanliness that led to the outbreak. This again shows the complexity of providing good solid waste services that are based on an intricate link between stakeholders with different roles and responsibilities (van Beukering et al., 1999). Surveys further show that when waste is not collected regularly, the incidence of diarrhea is twice as high as in areas with frequent waste collection. Also, acute respiratory infections are six times higher in areas with deficient waste collection services (Scheinberg et al., 2010).

Waste in contact with water causes leachate. Chemical substances in waste, usually from household cleaners and industrial solvents, may leach from waste with water in an undiluted or diluted form. If left uncontrolled and untreated, this leachate can pollute groundwater or surface water, creating an environment hazard or threatening health of downstream water users. Similarly, decomposition of organic waste will generate a leachate with high organic loads. If left untreated and then discharged into the environment such leachate may cause severe eutrophication (Cointreau, 1994).

At a global level, greenhouse gas (GHG) emissions from municipal solid waste are considered to contribute up to 5% (1,460 t CO2e) of annual total global greenhouse gas emissions. Methane released into the atmosphere is a product of anaerobic organic waste decomposition in landfills. It represents approximately 12% of the total global methane emissions (EPA, 2006). For the municipal waste sector, landfills are the source of about half of the methane emitted in 2010 (Bogner et al., 2008). In developing countries disposal is most often uncontrolled and haphazard in open dumps. Often, at the dump site waste is set on fire to reduce waste volume, thus creating a health risk from smoke in the neighborhood. In the low-income countries of Asia between 80 and 100 % of the waste ends up in open dumps (UNESCAP, 2000). In open dumps, without a concise tipping face, waste is spread out in thinner layers than in an engineered landfill. Thus, open dumps tend to emit less methane as compared to sanitary landfills as waste degrades under aerobic condition (Gyalpo, 2008). The Intergovernmental Panel on Climate Change (IPCC) considers a reduction of methane emissions from shallow (< 5m) open dumps by 60% (Gyalpo, 2008). Improvements on landfill management in the near future might therefore even increase the generation of landfill methane emissions (Bogner et al., 2008)

2.11.2. Occupational Health Risks

Commonly reported health and injury issues linked to occupational aspects in solid waste management are described in Cointreau, These include: i) injuries as a results of lifting heavy loads, ii) respiratory illness resulting from burning of waste when particulates, bio-aerosols, and volatile organics are generated; iii) injury such as puncture wounds or animal and rodent bites and subsequent infections or, iv) injuries by fires, waste slides or accidents with waste handling equipment. Many occupational health and injury problems can be minimized by better trained staff, simple safety procedures which are systematically followed and protective gear, particularly shoes, gloves and face masks. The dirty nature of solid waste handling also necessitates the provision of water for washing, sanitation, and hygiene facilities to allow workers to maintain personal hygienic conditions (Cointreau, 1994).

A study at open dumpsites in Mumbai, India showed that from 95 solid waste workers surveyed 80% had eye problems, 90% had decreased visual perception, 73% had respiratory ailments, 51% had gastrointestinal ailments, 40% had skin infections or allergies, and 22% hadorthopedic ailments. Clinical examination further showed that 27% had skin lesions, of which 30% were occupation related (Cointreau, 1994). In Addis Ababa a study shows a clear relationship between workplace exposure and health impacts on waste workers specifically related to open wounds and infections as well as musculoskeletal burdens and fatigue from heavy lifting (Gyalpo, 2008). The same study also indicates that the exposure of workers may have an even higher impact as they belong to the poor population and are thus subject to overall unfavorable hygienic conditions which also contributes to a basic poor state of worker's health.

2.11.3. Economic Risks

Uncollected waste has an economic cost for a city and for a nation. A visibly unpleasant and dirty city with severe health risks for the population within will make it difficult to attract businesses and/or tourism. Scheinberg et al. (2010) cites three examples of such economic impacts. The first example is from Tangier, Morocco, where beach pollution by solid wastes led to a tourism decline that cost hotels of the area 23 million USD per year in lost revenues. In addition, in Costa Rica, the utility company responsible for the hydro dams started financing plastics recycling schemes in the water shed to mitigate the high costs of turbine failure from plastic waste damage. A last example is taken from a World Bank report

where the environment cost of water contamination from improper waste disposal is estimated at 86 million USD annually with the lives of about 40 million Nigerians at risk (Scheinberg et al., 2010). Just as pollution from waste inflicts serious damage on the environment it endangers ecosystem services. Restoring these services are for instance providing unpolluted, safe drinking water, ensuring fish habitat, clean air, etc. will come at a cost, and will impact the national economy. The social perception of pollution has shown to result in the devaluation of capital. In the USA landfills although well managed impact on property values, which decrease as closer the property is to the disposal site (Thayer et al., 1992). A similar situation, probably even more pronounced, can be expected in low-income countries with open dump locations. However systematic scientific studies are not yet available to confirm this.

2.11.4. Components of Good Solid Waste Management System

Solid waste consists of many different materials. Some are combustible others are noncombustible (2%), recyclable (1%), and non-recyclable (2%), biodegradable (94%) and non-biodegradable 1% around in Debre Markos Town (Kassa, 2012). The combustible materials that may be included in a waste stream include paper, plastics, yard debris, food waste, wood, textiles, disposable diapers, and other organics are (89.6%) and the non- combustibles materials also include glass, metal, bones, leather and aluminum (10.2%) in Adama city (Lemma, 2007).

2.11.5. Waste Recycling and Reuse

In developing countries, it is acknowledged that (85%) the recovery of materials such as iron, steel, copper, lead, paper plastic and glass will decrease the investment in importing these materials and save energy (MELAKU, 2008). The formal sector has concentrated on the collection and final disposal; although (10.4%) recycling is viewed as an option, its application is very weak. In the same way, the attitude of the formal waste management sector towards informal recycling often is very negative regarding it as backward, unhygienic and generally incompatible with modern waste management systems in Addis Ababa city (KumaTadesse, 2004). Materials are converted into new products for local use; some examples are the smelting of aluminum cans (45%) and scrap metals (23%) into household utensils, and paper and plasticresidues (21.2%) into products for to surists, but a number of strong problems at household ((Fesseha, 2005). For example, in Kenya, Cameroon, Nigeria, Botswana, etc

recycling has gained importance due to the increasing costs of raw materials. Initially (65%) it was carried out informally by poor people, but it is now emerging at an industrial level (Zurbrugg and Vaccari, 2004).

2.11.6. Composting

High organic content of the waste streams of developing countries is ideal for composting, but municipal services operators do not have enough and adequate information only (17%) used for compost in Addis Ababa (Gebreamanuel, 1994). Even though they may be familiar with the application of composting in agriculture (83%) is not considered as a way to solve their urban wastes generated at household problem (Arroyo, 1998). Composting is a widely utilized practice in Western countries, in Chongqing, one of the four largest municipalities in China, it is rarely used due to reasons such as the low application of source separation, low acceptance of compost by farmers, limited usefulness of compost in comparison with chemical fertilizers and strict regulations, monitoring and quality standards of the product (Zhuang, 2008).

In India, composting is a tradition mainly in rural areas; utilization of large scale about (83-89%) and centralized composting plants during the 1970´s had not been economically feasible. Studies have determined that composites difficult to use because the waste arrives mixed and with high quantities or inorganic materials (Suttibak, and Nitivattananon., 2008). The use in agriculture, as soil conditioner or fertilizer, is one of the most usual ways to take advantage of the compost obtained with the processing of MSW; however, the quality of the product is subordinated to variables such as the design of the composting facility, type and proportions of feed stock used, composting procedure and maturation period (Joardar, 2000.).

2.11.7. Incineration

Waste Incineration is an approach in the waste management hierarchy, about (S72.8%) which is majorly used in European and American countries, instead of disposing the waste in the landfill (Kassa, 2009). The residue after burning the waste is used to extract some of the non-combustible materials like glass (4%), metals (12%) and rest of the fly ash is used as a mixture for engineering purposes (20%) (Kassa, 2010). The advantages of incineration are it majorly minimizes (76-79%) the volume of waste being dumped in the landfill, produce energy with the heat produced during combustion (Mugambwa, 2009). The volume of solid waste is reduced to more manageable level there by reducing transportation cost to ultimate disposal site. It also

reduces the land requirement at least by 30% of the residue after incineration is free from degradable materials and hence no longer source of pollution (UNCHS, 1995).

2.11.8. Land filling

The most commonly used method of solid waste treatment and disposal is land filling in developing cities. It is relatively cheap when we compare with other solid waste disposal methods and reduce road damages (Yongsheng, 2014). Because of these, many countries in the world prefers and commonly used land filling method. In this method generated wastes are dumped beneath the soil in an isolated manner and are commonly used methods for the disposal of waste (Coad, 2005).It is more appropriate in large urban centers of Ethiopia where significant number of solid wastes may be generated within a day (Tchobanoglous, 1993).

2.11.9. Disposal

This is final functional element in SWM system. Disposal activities are associated with final dump of solid wastes directly to a landfill site. Today disposal of wastes by land filling or land spreading is the ultimate fate of all solid wastes whether they are residential wastes, or residual materials from materials recovery facilities. “However, in most developed countries this method is officially banned allowing only sanitary landfill for final disposal. Because sanitary landfill is not a dump it is an engineered facility used for disposing of solid wastes on land without creating nuisances or hazards to public health and environment” (Tchobanoglous, 2002). Nevertheless, it is the most common technology around the world, conventional and environmental unfriendly methods such as open-burning, open-dumping, and non-sanitary landfill can still be used as disposal method” (UNEP, 2009).

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Description and Site Selection of the Study Area

This research was conducted in Mekelle City Administration. Mekelle, the capital city of Tigray, is one of the ancient cities in Ethiopia. It was founded by Emperor Yohannes 4th in 1860s (Mekelle City Administration, 2006). It is located between 130 32' north latitude and 390 28' east longitudes with an elevation of 2,000 to 2,270 meters above sea level. Mekelle had a total land area of 16 km2 in 1984; whereas, in 1994, the size of the city reached to 23.04 km^2. The city showed a dramatic increase in land mass and reached 74-km^2 area in 2004 by engulfing the vast agricultural lands, neighboring villages and towns (Mekelle City Administration, 2005). Generally, Mekelle covers an area of 7,500 hectares (Mekelle City Administration, 2017). The economic base of the people of Mekelle is trade and employment. There are many reasons why Mekelle city is chosen. Mekelle, as a capital city of Tigray National Regional State, is growing very fast in land size and population. As a result, urban agriculture is becoming an alternative of employment creation and food supply for the city.

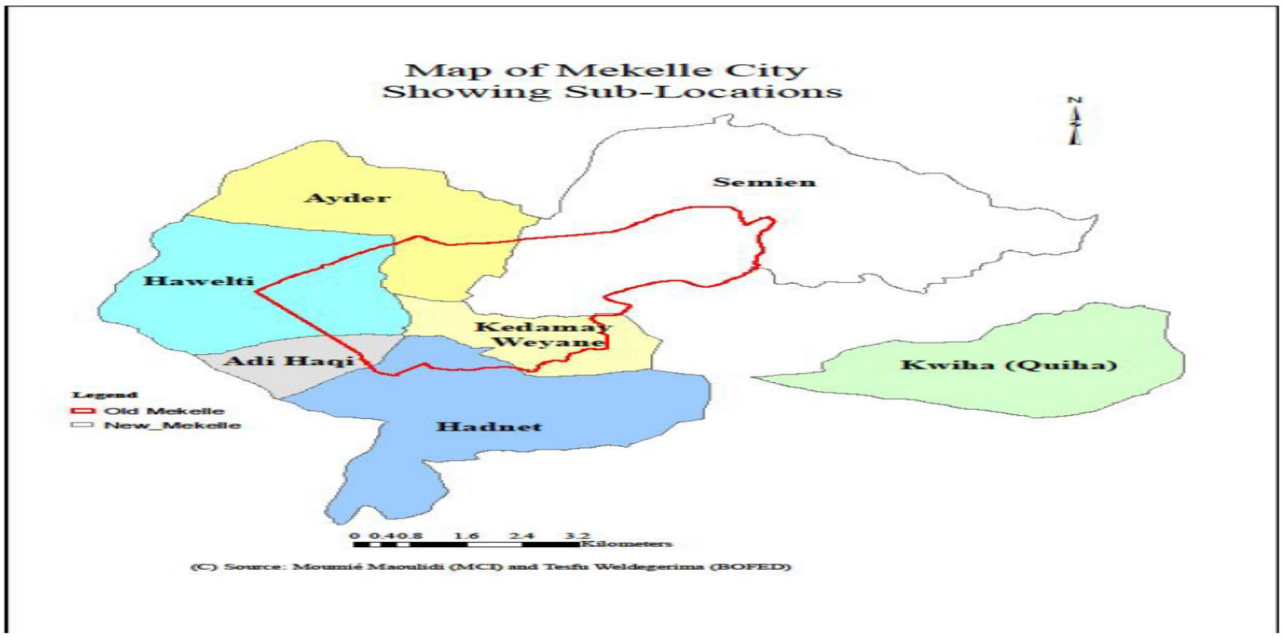
3.1.1. Population

Mekelle from the time of its establishment, as regional capital city of Tigray, the population is increasing from time to time. The major components of the city inhabitants are small scale merchants, civil servants and daily laborers. Mekelle is one of the highly populated cities in Ethiopia. According to the Tigray region statistics agency (2019), the total population of Mekelle city in 2019 was 433,081 i.e. males 219,649 and females 213,432 with total household 131,237 i.e.70, 737 males and 60,500 females. The reason for the growth of the population of Mekelle mostly it is migration of people (Tigray BoFED, GIS Department, 2019). The population increment of Mekelle city is five percent per annum. Residential houses and social and economic infrastructure development is also increasing with population growth. Moreover, Mekelle is expected to be the center of politics and administration, trade and industry and path way and destination to different areas (Mekelle City Plan Preparation Project 2019).

Figure 3:1 Map of Ethiopia

Sources: Mekelle city **bureau of plan and finance, 2015**

Figure 3:2 Map of the Study Area



Sources: Mekelle city **bureau of plan and finance, 2015**

1.1.2. Unemployment

There is high rate of unemployment in Mekelle city. According to the survey conducted by the Tigray Region Statistics agency (2019), the rate of unemployment in Mekelle is 22.40 percent. Of which 35 percent are male and 65 percent are female. Moreover, the agency stated the

poverty index of the study area city has 12% of which women comprised 20.3% (Tigray Region Statistics agency, 2019).

3.1.3. Infrastructure and Transport services

I. Road versus Transport

The total length of asphalt road currently within the city is about 40 km. This represents only 31.25 percent of the total 128 km required. The remaining road of the city constitutes gravel where it has poor shape and poorly maintained (Tigray BoFED, GIS Department, 2006). Mekelle, capital city of the region, is the center of transportation service. According to report of the office of transport, Mekelle is the departure to about 21 different parts of the country. It is a center of small, medium and big buses. These buses are providing transportation service to an estimated number of about 3,000 persons a day on average. Taxi transport service is started in Mekelle in 1995. At that time there were 7 taxis that provide service. Nowadays there are a lot of taxis and carts. According to the report of office of transport, the existing coverage of transport reached 61 percent (Tigray BoFED, GIS department 2006).

II. Water

The city's water supply at present is totally dependent on underground water sources. But, due to persistent drought, the underground water is getting decreased from time to time. As a result, the city's water supply is at risk. Especially, during the dry season, the water supply office is forced to ration water on a shift basis. The current water coverage of the city is estimated to be 67 percent (Tigray BoFED, GIS department, 2006.)

III. Telecommunication

The city is currently getting a digital telecommunications service. Cellular telephone service has also been introduced recently. At present, everyone who needs cell phone can get easily from the bureau of Ethiopian telecommunication (Tigray BoFED, GIS department, 2006).

IV. Electricity

Mekelle city has become the beneficiary of electric power using generator since 1966. But towards the end of 1996, the city has become the beneficiary of hydro-electric power, at large with reserves of two diesel generators. Although the city has been consuming around 12 MWA, it has a transformer which can produce to the extent of 46 MWA. This actually covers

including 180 km street light (30 km sodium, 60 km florescent and 60 km incandescent). But there are still many streets which are out of electric light and some needs serious maintenance. In addition, from the available 6 squares, only two of them have traffic lights (Tigray BoFED, GIS Department 2006).

VI. Market

Currently there are 9 general and one special market which is cattle market. Although Mekelle's market was expected to accommodate more than 3,000 societies, the actual beneficiaries are only 540 (28 percent). The main problems observed in the market areas are narrowness of the plot, unavailability of open markets for the rural, narrowness of the channels, lack of public latrines, muddy and windy in the summer and winter seasons (Tigray BoFED, GIS Department 2006)

3.1.4. Social Service

Education

Educational institutions in Tigray, particularly in Mekelle, are being expanding at a faster rate. There are 15 kindergartens, 21 primary schools, and 9 secondary schools in the city. Furthermore, there are 2 technical schools, 1 university and five colleges giving training /education to middle high level professionals. The increment of educational institutions at all level is encouraging. However, the quality of the education provided is questionable and requires attention (Tigray BoFED, GIS Department 2006).

3.1.5. Economic Activities of the City

The city's economic activity is largely dependent on micro and small enterprises. The majority of the inhabitants (65 percent) livelihood depends on the informal business. According to Tigray region Agency of Macro and Small Enterprise (2019), there are a total of 26,269 licensed enterprises in the town. Out of these 12,444 (47.37 percent) are retail trade, 7094 (27 percent) service, 3200 (12.18 percent) urban agriculture, 2246 (8.55 percent) manufacturing industries and 1,285 (5 percent) are construction sectors. In addition, there are also around 2337 micro and small business in the town operating without licenses but only undertake registration. Out of these, 806 are male operators and the remaining 1531 are females. In terms of the sectors the majority are engaged in petty trade and services activities (census study report Agency Macro and Small Enterprise, 2019).

3.1.6. Materials

The material that was used in the research study includes; sack or madaberiya was used to sit the generated house hold solid wastes, glove was used to protect myself, 50 kg pocket balance was used to measure or quantify generated house hold solid wastes and Digital Camera: was used for photographing of field data collection.

3.2. Methods of Sampling Design

Descriptive type of research method was used to assess solid waste management practice in the study area. Descriptive approach was applied because it enables to describe the existing situations of the solid waste and the management practices as it exists broadly SWM. The research proposal was designed to use a household-based cross-sectional survey which in turn was based on multi-stage sampling procedure was used method for the selection of kebeles and households.

3.2.1. Study Site

To select the study site, purposive sampling was employed. Purposive sampling was used as the study site is convenient as solid waste management practice of the study area city is weakly organized and implemented as well as no adequate research was conducted. It was help to reduce time and costs that were spend and to have a better understanding about the existing problem in the city related to the study area.

3.2.2. Sample Size

Mekelle city was purposively selected for the assessment of solid waste management practices. Mekelle city has seven sub cities of which Kedamay Weyane sub city of the study area was selected. Besides, the selected sub city has four Tabiyas of which Tabiya Selam, Tabiya Hariya, Tabiya Walta and Tabiya Z-Selassie. But the researcher was purposively selected two Tabiyas from four tabiyas that is Tabiya Selam and TabiyaWalta. In order to select respondents among four Tabiyas of the study area, the sample Tabiyas were selected using purposive sampling technique based on population density and commercial activity. As a result, Tabiya Selam (commercial center) and Tabiya Walta (heavily populated) were selected. With regard to the sample households a total of 161 respondents were selected proportionally using stratified random sampling. Based on questionnaire results, solid waste generation rate and its physical

composition data was grouped into three categories income level, family size, and education level. Each category was divided to their respective class's income level: family size and education level.

A sample size (n) of households who participated in the study was determined using the formula developed by pagos *et al* 1981 formula as follows:

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

where

n=sample size
N= Population
e= error margin

Assuming 95% of confidence level, the sample size for this study is calculated as:

$$\text{Sample size} = \frac{12547}{1+12547(0.1)^2}$$

$$= \frac{12547}{1+12547(0.01)}$$

$$= \frac{12547}{1+125.47}$$

$$= \frac{12547}{126.47} = 99$$

Therefore,99 sample respondents will be the final sample size for the study and it will be proportionally distributed to the selected districts of the study area.

Therefore, 99 sample respondents was the final sample size for the study and it is proportionally distributed to the selected study area.

Table 3.1: Distribution of Sample Size

No.	Tabiyas	Total no of HHs in Tabiya	No. of sample HHs	Percent (%)
1	TabiyaWalta	7347	58	58

2	TabiyaSelam	5200	41	42
	Totall	12547	99	100

3.3. Data Collection Instruments

In this study both primary and secondary sources were used to collected data for this study. These sources were used to collect necessary information that addresses the research questions and objectives of the study. Primary data was collected from sample respondents of each sample Tabiya. To collect secondary data resources such as books, journal articles, government documents and websites were consulted.

3.3.1. Questionnaires

Questionnaires were prepared in English but later translated in to Tigrigna to making it easier for respondents to collect data from households. Questionnaires (closed and open-ended) was designed carefully to obtain all the necessary information such as sex of householder, family size, and family's income, household waste handling system, disposal practices and impact of improper solid waste management of the town.

3.3.2. Sampling procedure for quantification purpose

During this period field observation was employed to determine spatial distribution of households' solid waste handling practices, solid waste collection, separation, and disposal site. At household level, measurement was carried out to examine households' solid waste generation rate and physical composition and separation by distributing plastic bags to the selected 25 households divided in to three groups. Each household was given three plastic bags label with yellow color for non-biodegradable, pink color for hazardous, black color for biodegradable for one week. And these processes were continuing for 21 days. Among these selected households survey were randomly selected based on income categories, that is low income, high income and middle income. It measured solid waste from the selected households for the 7 consecutive days. Finally generation and components of the waste were separate into major components and recorded.

3.3.3. Focus Group Discussion

The researcher gathered information about the level of community participation and the impact of improper solid waste management to obtain qualitative data. The individuals in focus was selected from each of the surrounding kebeles. Therefore, four focus discussion groups were organized. The discussion issue was directed by predetermined set of questions which were prepared by the investigator. The number of participants in each group was determined by depending on the number of concerned with, local leaders, kebeles managers, municipal manager, municipal chief workers, health officers and chairpersons or representatives of Mekelle city in each representative group. The discussions were held with each group at different times per a weak with convenient for the participants of the group.

3.3.4. Interview

To supplement the data collected through questionnaire the researcher also conduct structured interview with MBPDD head, head of Mekelle city health sector and MBPDD employee. The objective of this interview was to solicit ideas which will not be cover by the questioner and for the purpose of triangulation.

3.3.5. Data collection Procedures

First questioners were adopted from related previous works done by Solomon, A.O. (Solomon, A.O., 2011), Ashenafi, H. (Ashenafi, H., 2011), and Daniel, S.A. (Daniel, S.A., 2017). Secondly, the questionnaires adopted in English language were translated in to Tigrigna version to make easily understandable by respondents. Thirdly, the pilot test were conducted to test the validity and reliability of the questionnaire by distributing to 10 respondents that were not be included in the actual data collection and amendments is made based on the response during the pilot test. Finally, the actual data collection were made through data enumerates employed on temporary basis. Data enumerators were properly train and also, they know Tigrigna. For households the purpose of the study was briefly explained and encouraged to cooperate.

On the other hand, interviews were conducted with interviewees on the basis of appointment. Data from secondary sources was obtained by getting permission from concerned officials.

3.4. Data Analysis Methods

3.4.1 Descriptive analysis

This section deal with presentation, analysis and interpretation of data gathered from households and Mekelle city MBPDD office as well as field observation. Both qualitative and quantitative methods were used to analyze the data. Quantitative method was used for close ended questions and qualitative methods for open ended questions and interviews. Quantitative methods include percentages, tabular analysis and frequency distribution. Qualitative techniques were cause and effect relationships, inductive and deductive.

Questionnaires analyses were using quantitative methods i.e. Tables have been widely used to present the collected data by using SPSS version 26 computer software that is used to analyze the data.

3.4.2. Econometric Analysis

The research employed binary logistic regression to identify the factors that affect household solid waste management practice in the study area.

3.4.3. Binary Logistic Regression Model

Logistic regression is a statistical technique used to predict the relationship between predictors (the independent variables) and a predicted variable (the dependent variable) where the dependent variable is non-metric. The binary logistic model in the form of regression is used when the dependent variable is dichotomous and the explanatory variable may be of any type.

A logistic regression model is preferable to other dichotomous outcome variable analyses because it is extremely flexible and easily employs a model from a mathematical standpoint while also interpreting the results in a meaningful manner. The logit model is a way of estimating the probability that an event will occur or not by predicting a binary dependent outcome from a set of explanatory variables (Gujarati, 2004). It was employed to explore the relationship between the dependent variable and the independent variable. When the dependent variable in the regression is binary, the analysis could be conducted by using a liner probability model. But the result of a linear probability model may generate a predicted value out of the range between zero and one, which violates the basic principle of probability ($0 \leq E(yi/xi) \leq 1$).

The logit and probit model guarantee that the dependent variable is dichotomous or estimated probability lie between the logical limit of zero and one. These two models assume that the binary outcome has an S-shaped relationship between the independent variable and the probability of an event which address the problem with in the linear probability model(Verbeek, 2017). The logit model assume normal logistic probability distribution, whereas the probit model is associated with cumulative normal probability function are very close to each other, except at the tails, actually, we are not likely to expect very different result using probit or logit model. Therefore, given the similarity between the two models, it is possible to use the logit model for analysis of the factors that affect household's solid waste management practice.

Model specification

The maximum likelihood estimation method is appropriate for estimating logistic regression model parameters. Mathematically, the logit model specified as,

$$Pi = \text{prob}(yi = 1/x) = \frac{1}{1+e^{-2}} \quad (1)$$

$$1-Pi = \text{prob}(yi = 0/x) = \frac{1}{1+e^{-2}} \quad (2)$$

$$Zi = Xi\beta = \beta 0 + \beta 1\, X1i + \beta 2X2i \ldots\ldots + \beta nXni + \varepsilon i \quad (3)$$

$$\frac{p}{1-1} = \frac{1+e^{-2}}{1+e^{2}} = e^{z}$$ is the odd ratio (4)

Taking the natural logarithm of equation (4)

$$Yi = \ln\left(\frac{p}{1-1}\right) = \beta 0 + \beta 1\, X1i + \beta 2X2i \ldots\ldots\ldots\ldots + \beta nXni + \varepsilon i \quad (5)$$

Then

$$Yi = \ln\left(\frac{p}{1-1}\right) = \beta 0 + \beta 1\, SEXi + \beta 2AGEi + \beta 3EDUCSi + \beta 4\, MRSi + \beta 5FSi + \beta 6HINCi + \beta 7HPSWMi + \beta 8DISi + \varepsilon i \quad (6)$$

Where, Yi is the dependent variable used in this study which is the household solid waste management practice status. More specifically:-

Yi = '1' if households are practiced SWM '0; if households are not practiced SWM)

1. Pi = is the probability that the household being practice SWM, 1-Pi is the probability of the household belongs to not practiced SWMP.
2. Xi = vector of explanatory variable representing the household head characteristics
3. β's = a vector of regression coefficients to be estimated using Maximum Likelihood Estimation
4. Ɛi = the error (disturbance) term, and e = the base of natural logarithm

Evaluation of binary logit model

First of all, the overall model should be evaluated. The goodness of fit of a model measures how well the model describes the response variable. Secondly, the significance of each explanatory variable also needs to be assessed

Likelihood–Ratio test

The Likelihood-Ratio (chi-square (X2)) test is the test statistic commonly used for the loglikelihood ratio test. It is based on (-2* times log-likelihood). The overall fit of the model, as determined by the hypothesis test. H0: the model is not a good fitting model (the predictors do not have a significant effect on the dependent variable). H1: the model is a good-fitting model (the predictors have a significant effect on the dependent variable). The likelihood ratio test is a chi-squared distribution with a degree of freedom equal to the number of predictors; i.e. X2 = -2 log) = -2 [log (l0-log (l1)] X2 = -2 log) = -2 [log (l0-log (l1)] Where log l0 is the log-likelihood value of the model which has the intercept term only and l1 is the log-likelihood value of the full model. If the p-value is less than 5% level of significance, it leads to the rejection of the null hypothesis that the predictors have no significant effect on the response variable.

Hosmer - Lemeshow test

The Hosmer - Lemeshow test is used to check the overall fit of the model and allows for any number of independent variables, which may be continuous or categorical (Bewick et al., 2005).

The test divides the subjects into groups of g (usually 10) based on the predicted probabilities, and then computes a chi-square from the observed and expected frequencies. The hypothesis to be tested is:

H0: The model fit the data

H1: The model does not fit the data.

If the p-value is greater than 5% level of significance, it leads to a failure to reject the null hypothesis that the model fits the data (Hosmer & Lemeshow, 2000).

Diagnostic checking

Multicollinearity

Before estimating the model, testing the severity of multicollinearity among explanatory variables is an important diagnostic test to check the appropriateness of the model. Because two or more explanatory variables giving the same piece of information may be included, that may have redundant information. In this study, to test multicollinearity variance inflation factor was used. Following Wooldridge et al. (2016), the VIFi is given as follows.

VIFi =, where Ri2 is the squared multiple correlation coefficient that results when the explanatory variable xi is regressed against all other explanatory variables. VIF shows how the variance of an estimator is inflated in the presence of multicollinearity. As Ri2 increases and approaches unity, when the correlation between an i^{th} explanatory variable and the other regressors increases, the VIF also increases to infinity. If there is no collinearity between the explanatory variables, the VIF will be 1. The large value of VIFi is the more collinear between the explanatory variables. As a rule of thumb, if the VIF of an explanatory variable exceeds 10, then the variable is said to be highly collinear.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Rate of Response by Respondents

Concerning respondents' questionnaires returned response rate, the findings of the research study are presented in relation to the rate of response by respondents:

Table 4.1: Rate of Responses of the Sample Respondents

No	Respondents type	Questionnaires	Respondents	Percentage
1	Participants of Solid waste Management of the Study Area	Returned	95	96%
		Not returned	4	4%
		Total distributed	99	100%

Source: Researcher's own survey, 2025

As shown in table 4.1 above, 99 questionnaires were administered to participants of solid waste management practice of the study area in Mekelle city. Out of the 99 questionnaires that were distributed 95 (96 %) returned and 66 (4%) of questionnaires were not returned. The return rate indicates that there was somewhat acceptable rate of response from the respondents.

4.2. Character of the Respondents

4.2.1. Demographic Characteristics of the Respondents

Table of 4.2 below shows from a total of 95 household respondents, 36 HHs (37.9 %) were male-headed and the remaining 59 HHs (62.1 %) were female-headed. This was due to the fact that most of the time females stay and work inside their house rather than working outside. Such dominance of women is respected and essential for this research since women have better understanding than men about their residence solid waste property and its management(Solomon, A.O., 2011.). Beside this, out of the total respondents 53 HHs (55.8 %)

of sample respondents are belongs to adult age group (31 – 45 ages). This is also contributed for the accuracy of the information gathered from such respondents. Furthermore, with respect to marital status 43 (45.3 %) of the respondents were married; 23 (24.2 %) were single; 21 (22.1%) were divorced and the remaining 8 (8.4 %) were widowed (table 4.1).

Table 4.2: Respondents Sex, Age and Marital status

No	Item	Alternatives	F	%
1	Sex	Male	36	37.9
		Female	59	62.1
		Total	95	100
2	Age	18-30	8	8.4
		31-45	53	55.8
		45-65	26	27.4
		>65	8	8.4
		Total	95	100
3	Marital status	Married	43	45.3
		Single	23	24.2
		Divorced	21	22.1
		Widowed	8	8.4
		Total	95	100

Source; computed based on own survey, 2025; Note: 'F' refers to frequency and % refers to percentage

4.2.2. Socio-economic condition of the Respondents

As table of 4.3 below shows that respondents with no formal education, those who attended grade 1-8, those who attended grade 9-12 and those who attended college and university account for 11.6%, 17.9%, 30.5% and 40.0% respectively. On the other hand, the survey on the profession of sample households shows that 35.8% were government employees; 16.8% were engaged in private sector employees; 16.8% were self-employed; about 20.0% were merchants.

Regarding the family size Majority, (50.5%), of the respondent reported 3-4 family members; (26.3%) respondent reported 1-2 family members; (14.7%) respondent reported 5-9 family members and (8.4%) respondents reported greater than or equal to10 family members are found in the HH. concerning monthly income, 15.8% of respondents have a monthly income of below1500 birr; 38.9% of respondents receive about 1500-3500 birr;21.1% of respondents receive about 3500-5000 and 24.2 % of respondents were average income of >5000 birr(Table 4.3).

Table 4.3: Respondents Educational level, profession, Family size and Monthly income

No	**Item**	**Alternatives**	**F**	**%**
1	Educational level	No formal education	11	11.6
		1-8 Grade complete	17	17.9
		9-12 Grade complete	29	30.5
		College / University	38	40
		Total	95	100
2	Occupation	Government Employee	34	35.8
		Private sector Employee	16	16.8
		Merchant	19	20
		Self-employed	16	16.8
		Others	10	10.5
		Total	95	100
3	family size	1-2	25	26.3
		3-4	48	50.5
		5-9	14	14.7
		>= 10	8	8.4
		Total	95	100
4	Average monthly income (in birr	,<1500	15	15.8
		1500-3500	37	38.9
		3500-5000	20	21.1
		>5000	23	24.2

		Total	95	100

Source; computed based on own survey, 2025; Note: 'F' refers to frequency and % refers to percentage

4.3. Characteristics of Solid Waste

4.3.1. Solid waste generated and source of solid waste in Mekelle city

Below the table of 4.4 indicates the major of 46 HHs (48.4%) source of solid wastes is households, 20HHs (21.1%) source of solid wastes is commercial institutions, 15 HHs (15.8%) source of solid wastes is industries,8 HHs (8.4%) source of solid wastes is hotels and the remaining 6 HHs (6.3%) source of solid wastes is hospital (Table 4.3).

Table 4.4: Source of solid waste in Mekelle city

Source of Solid Waste	Frequency	Percentage (%)
Household	46	48.4
Commercial Institutions	20	21.1
Industries	15	15.8
Hotels	8	8.4
Hospitals	6	6.3
Total	95	100.0

Source: Researcher's own survey, 2025

The current study showed that the solid waste production rate of Mekelle city at the household level is 8,380.869 kg/day, 58,666kg/weak, 251,426kg/month and 3,0590,28.5 kg/year or 8.38 ton/day, 58.67 ton /weak, 251.43 ton/month and 3,059 ton/year with 41,696 population of Mekelle city. The per capital solid waste generation rate is 0.201 kg/cap/day/25 households.

Household data investigation showed that high income household waste production rate is significantly higher than the lower income household. This finding agrees with kibralem

(2017), income level and solid waste generation rate have a direct relationship. Income level is the most important factor influencing the kind and amount of waste generation rate at household level. When family size increases waste generation rate also increases. The main reason for this relationship might be the increase in household members' causes to increase in resource consumption resulting increase in waste generation at their houses.

Income Group	No. of Households	No. of Family Members	Solid Waste / Household / Week (kg)	Solid Waste / Household / Day (kg)	Solid Waste / Capita / Day (kg)
High Income	6	36	61.3	8.76	0.243
Middle Income	9	57	96.6	13.8	0.242
Low Income	10	80	84.1	12.0	0.150
Total	25	173	243.0	34.7	0.201

Table 4.5: Solid Waste Generation in Mekelle city

4.3.2. Composition of solid waste in Mekelle City

Composition of urban waste can be divided in to two major components called biodegradable and non-biodegradable. The biodegradable part of urban solid waste constitutes organic waste such as food waste, garden waste, agricultural waste which undergoes biological degradation under controlled conditions and can be turned in to compost or organic fertilizer. While non- biodegradable wastes include inorganic materials which cannot be decomposed and degraded like plastic, glass, metal and etc. Mekelle city physical composition of solid waste is also composed from both biodegradable and non-degradable components. But the result shows in Mekelle city biodegradable or organic solid waste types, agricultural wastes and animal residue is the highest.

Figure 4.1: Composition of Solid Waste in Mekelle city

4.4. Solid waste Treatment Activities of Mekelle city

4.4.1. Solid Waste Storage Facility and Its Management

Solid waste storage facilities and their handling have significant impact for betterment of municipal solid waste management activity. This is from the point of identification of type and quantity of storage material to be used, appropriate location (sitting) of it, deciding the collection method to be used, and avoidance of health, environment and aesthetics impacts of storage materials (Staniskis, 2005).

. Primary solid waste storage facility and its handling

The current study result showed that, 77 (81.1%) of sample respondents have temporary solid waste storage material while the remaining 18(18.9%) of sample respondents do not have temporary solid waste storage material. The main problem of the respondents is not have temporary solid waste storage material but the main problem of the respondents is dumping of solid wastes at everywhere or at open space. The result has shown that majority (62.3%) of sample respondents were used sacks local name of "*Madaberiya*". This is highly related to the least cost of sack, easily availability in the market, its suitability for holding large amount of solid wastes and simply delivered by MSEs of the City and

plastic container („festal") about (31.2%) and while the remaining (6.5%) used other storage material (Table 4.6).

Table 4.6: Type of Solid waste storage material used by sample households

No	Items	Alternatives	Frequency	Percentage (%)
1	**Ownership of Storage Facility**	Yes	77	81.1
		No	18	18.9
		Total	**95**	**100.0**
2	**Type of Storage Material**	Sack (Madaberia)	**48**	**62.3**
		Festal	**24**	**31.2**
		Other	**5**	**6.5**
		Total	**77**	**100**

Source: Researcher's own survey, 2025

Secondary solid waste storage facilities and their management

Secondary storage facilities refer to different kinds of solid waste containers which provides keeping solid waste generated from different households at a common or central point from where collection vehicles can pick it and transport to final disposal site(Zebenay, 2010). These facilities are provided by municipality which is responsible for management of the city solid waste. According to the data gained from Mekelle city MBPDD the department was not put solid waste storage containers. But this service is highly available around commercial centers and institutions.

According to the data gained from head of Mekelle city MBPD two solid waste MSEs are organized permanently. From this 22 are females and 8 are males. By road and river cleaning in the city two MSEs are organized temporary. From this 15 are females and 8 are males. Currently these solid waste MSEs cannot give services because of the communities are not properly paid payments for this service and the municipality of the city cannot support by different mechanisms. By this condition currently the majority of households can dispose solid wastes by human. These human services dispose solid wastes inside the city of open spaces. These problems coming the main issue this created dirty environment of the city. So highly awareness and power is needed.

4.4.2. Solid Waste Separation, Processing and improvement Activities

In this study solid waste separation, processing and recovery activities at source and by municipality refer all activities or efforts of separation of recyclable, reusable, compostable wastes to sell or to recover resources by themselves. Practicing these types of activities is very important to waste generators as well as municipality since it minimizes cost of disposal, generates revenue, and prolongs life span of disposal site. This is one of the reasons why solid waste managers in many parts of the world are now exploring ways to reduce flow of biodegradable and recyclable materials to landfill sites (Solomon, 2011).

Solid Waste decreasing activities of households

Among those who responded to this question, 26 HHs (27.4%) stated that they do separate solid wastes for different purposes and majority of 69 HHs (72.6%) stated that they do not separation.

As we observed from households" solid waste separation activities in the city, solid wastes that are sold to "*Quraleos*", exchangeable to "*Liwach*" are separated. Response of sample households also showed that about 11 HHs (42.3%) of them are separately store solid wastes which are sold to "Quraleos" and exchangeable with "Liwach," 5HHs(19.2%) of them are separately store solid wastes which are sold to reuse like plastics and highlands for recreation, prepare flower and different values, 8 HHs(30.8%) of them are separately store solid wastes to compost and 2HHs(7.7%) of them are separately store solid wastes to others. Based on the question, respondents gave their respective answers as 38(55.1%) told that they lack of enough knowledge

about waste separation practice; 27(39.1%) told that they do lack of understanding the importance of solid waste separation and 4 (5.8%) believe that others (Table 4.7).

Table 4.7: Applying of Households waste separation practice in the city

1. Applying Solid Waste Separation Practice at Household Level		
Response	**Frequency**	**Percentage (%)**
Yes	26	27.4
No	69	72.6
Total	**95**	**100.0**
2. Reasons for Separating Solid Waste at Household Level (Among Those Who Separate)		
Reason	**Frequency**	**Percentage (%)**
To reuse	5	19.2
To sell / exchange	11	42.3
To compost	8	30.8
Other	2	7.7
Total	**26**	**100.0**
3. Reasons for Not Separating Solid Waste (Among Those Who Don't Separate**)**		
Reason	**Frequency**	
Lack of enough knowledge about waste separation practice	38	55.1
Lack of understanding the importance of waste separation	27	39.1
Other	4	5.8
Total	**69**	**100.0**

Source: Researcher's own survey, 2025

Solid waste separation, processing and recovery practices by MBPDD

In Mekelle city the rapid increasing of urbanization and parallel increment of its solid waste volume are adding burden to MBPDD of Mekelle city, Mekelle city MBPDD is not apply different type of solid waste management practices like composting, recycling, and reusing activities. But privately by the households this solid waste management practices can apply but not enough. This is attributed to lack of commitment, finance, material, and manpower resource.

4.4.3. Solid Waste Gathering and Transportation Systems

This study shows in the city 37 HHs (38.9%) of respondents is disposed by vehicle (car) and majority of 58(61.1%) of respondents is disposed by human because of 42(72.4%) this service is low cost and 16(27.6%) this service is gaining accesses day to day. These human services dispose solid wastes near to home and inside the city of open spaces. This is a major issue of the city this can affect the community, created dirty environments of the city and increases different diseases (Table 4.8).

Table 4.8: Solid Waste Transportation System in Mekelle city

1. Solid Waste Transportation System		
Mode of Transportation	**Frequency**	**Percentage (%)**
By vehicle (car)	37	38.9
By human	58	61.1
Total	**95**	**100.0**
2. Reasons for Using Human-Based Transportation		
Reason	**Frequency**	**Percentage (%)**
It is low cost	42	72.4
It gains access day to day	16	27.6
Total	**58**	**100.0**

Source: Researcher's own survey, 2025

About 37 (38.9%) of the respondents were customers of solid waste collection service rendered by the MSEs and 58 (61.1%) of the respondents were found to be non-user of the service provided by MSEs. Respondents who have not been served by designated MSEs, they were practiced indiscriminately dump their waste in open spaces, ditches and roads. Therefore, the result indicated that 29.7% reported that MSEs collect solid wastes on a weekly, 56.8% indicated that MSEs collect solid waste twice in a month and13.5% indicated that MSEs collect sold wastes on Monthly basis.

As shown, 18 (48.6%) of the respondents replied that the coverage of service delivered by MSEs is enough accesses whereas 19 (51.4%) mentioned that the current number of MSEs is not enough accesses. Referring to Table 4.8, 10 (27.0%) of responded 5 birr / Twice month ; 12 (32.4%) responded 10 birr / Twice month 11 (29.7%) responded 20 birr /Twice a month and the rest 4 (10.8%) respondent responded 30 birr / Twice a month were paid for the service provided by to MSEs (Table 4.9).

Table 4.9: Households that get service from the city of MSEs

1. Access to Door-to-Door Waste Collection from MSEs		
Access	**Frequency**	**Percentage (%)**
Yes	37	38.9
No	58	61.1
Total	**95**	**100**
2. Sufficiency of Access (Among Those with Access		
Sufficiency Level	**Frequency**	**Percentage (%)**
Enough access	18	48.6
Not enough access	19	51.4
Total	**37**	**100**
3. Frequency of MSE Collection per Month (Among Those with Access)		
Collection Frequency	**Frequency**	**Percentage (%)**
Weekly	11	29.7
Twice a month	21	56.8

Monthly	5	13.5
Total	**37**	**100**
4. Quantity of Payment for MSE Service (Twice a Month)		
Payment Amount (Birr)	**Frequency**	**Percentage (%)**
5 birrs	10	27.0
10 birrs	12	32.4
20 birrs	11	29.7
30 birrs	4	10.8
Total	**37**	**100**

Source: Researcher's own survey, 2025

From this most households (44.2%) of solid wastes are disposed on open space, (38.9%) of solid wastes are disposed on proper disposal site, (10.3%) of solid wastes are disposed on near to road and (6.3%) of solid wastes are disposed on the others. From this one can understand that most households who do not use the service of private waste collectors often prefer to dispose their wastes in illegal places or in open spaces inside the city, at the time of early night and early morning, which is out of official working hours. This condition created a dirty environment in the city and increased different dangerous diseases.

4.4.4. Solid Waste removal activities in Mekelle city

4.4.4.1. Households' Solid Waste removal activities

As the study shown, (84.2%) of sample respondents were stated that communal solid waste container is not available and the remaining (15.8 %) of sample respondents stated that public solid waste container is available. In addition to the availability of the communal solid waste container for the feature, the accessibility of solid waste storage container was asked to know the average distance between a residence and a communal container so, a container is located between 10- 30 meters for (13.3%) of households; between 31 - 50 meters for(20%) of households ; between 51-200 meters for (20%) of households ; between 201 - 300 meters for (20%) of households, and more than 300 meters for (26.7%) percent of households. Currently in Mekelle city communal solid waste storage containers does not have placed in the city (table 4.10).

Table 4.10: Availability, Distance and participation on deciding container placement to the respondents

1. Availability of Waste Disposal Container Near Home		
Availability	**Frequency**	**Percentage (%)**
Yes	15	15.8
No	80	84.2
Total	**95**	**100.0**
2. Distance of the Container from Home (Among Those Who Have Access)		
Distance Range	**Frequency**	**Percentage (%)**
10–30 meters	2	13.3
31–50 meters	3	20.0
51–200 meters	3	20.0
201–300 meters	3	20.0
>300 meters	4	26.7
Total	**15**	**100.0**

Source: Researcher's own survey, 2025

Solid waste gathering and transportation is not an end to solid waste management. Correct solid waste management also requires correct disposal of waste in a correct place. In sight of this in my field observation Mekelle city solid waste disposal site and its management is inadequate and below the standard. The waste collected is disposed on open field at a place called "*Mayalem*" (**ማይዓለም**). The disposal site is surrounded by mountain ridges at distant location, but there are settlement areas, a church and agricultural fields (crops, animal grazing, children play ground) just adjacent to the disposed waste.

Waste of all nature is indiscriminately disposed with no further treatment in the existing dumping site. The wind-blown waste is scattered all over the site and some light plastics and paper might travel back all the way to the city. Hauling of solid wastes and final dumping is not well scheduled and coordinated as refuses are observed to have been disposed of haphazardly, litters scatter everywhere before reaching the designated final dumping site and such practices are even

worsen during the rainy seasons. There are several agro-industries in the town that disposal the waste inappropriately causing a series threat to public health and environment.

4.5. Factors that influence Solid Waste Management in Mekelle city

The decay of waste into constituent chemicals is a common source of local environmental pollution. This crisis is particularly acute in developing nations; very few existing landfills in the world's poorest countries would meet environmental standards accepted in industrialized nations, and with limited budgets there are likely to be few sites rigorously evaluated prior to use in the future. The problem is again compounded by the issues associated with rapid urbanization. As land becomes scarce, human settlements encroach upon landfill space, and local governments in some cases encourage new development directly on top of operating or recently closed landfills (Chukwubueze, 2011).

The information obtained from the sampled respondents and researcher observation that some of the factors affecting the SWM system of the were lack of appropriate skilled man power in the city to organize SWM activities as well as the proper site, lack of labor engaged in daily taking away of solid wastes because of the community payments for MSEs is very low cost and in road sweeping in the city affects the sanitary of some parts of the city by making it ugly and smelly, lack of equipments to collect the waste in different parts of the city is the another challenge. The other challenge was the municipality did not work a lot on community mobilization and did not create awareness regarding SWM system.

4.5.1. Socio-cultural Factors

Table 4.11: Households awareness on solid waste rules and regulation and Household education, training or information about solid waste management

1. Understanding of Respondents on Rules and Regulations of Solid Waste Disposal		
Understanding	**Frequency**	**Percentage (%)**
Yes	19	20.0
No	76	80.0
Total	**95**	**100.0**
2. Education, Training, or Information Obtained by Respondents About Solid Waste Management		

Response	Frequency	Percentage (%)
Yes	17	17.9
No	78	82.1
Total	**95**	**100.0**
3. Respondent Source of Information on Solid Waste Management (Among Those Informed)		
Source	**Frequency**	**Percentage (%)**
Municipality	10	58.8
Kebeles	4	23.5
NGO	3	17.6
Total	**17**	**100.0**
4. Concern of Respondents to Learn More About Solid Waste Management		
Response	**Frequency**	**Percentage (%)**
Yes	86	90.5
No	9	9.5
Total	**95**	**100.0**

Source: Researcher's own survey, 2025

The above table 4.11, shows about (80.0%) of the respondents revealed that they did not understand that there is a solid waste related law and regulations are available. The remaining (20.0%) of the selected households stated that they knew about the presence of laws and regulation. The survey results were also shows that awareness creation by the municipality of city on solid waste management is high but not enough. The majority of the respondents (82.1%) stated that they have not obtained education, training or information about solid waste management and the remaining (17.9%) of respondent replied that they are obtained education, training or information about solid waste management.

Besides, the sample respondents who said "Yes" (those who obtained education, training or information about solid waste management) were asked their source. From the total of respondents majority (58.8%) of them stated that they got information by municipality; (23.5%) of them stated they got information from the kebele and(17.6 %)of them stated they got

information from the NGO. Therefore, lack of public knowledge and attitudes creation priority was another challenge for the municipal solid waste management in city. The majority of the households were not well informed about the consequences of poor solid waste handling and disposal methods.

Public education or awareness of solid waste and its management is very crucial to improve solid waste management system. Public attitudes towards in proper removal of solid wastes must be adjusted in order to avoid placing of additional burden on the collection program. While create awareness on generators sides, it is very important to give emphasis on selection of information that flow to the public. In other words, the information should give an assurance about whether the public (generators) are aware of the negative aspect of inappropriate solid waste management (USAID, 2004).

Table 4.12: Households Opinion, attitude and perception about Solid waste importance

1. Attitude of Respondents on the Importance of Solid Wastes		
Attitude	**Frequency**	**Percentage (%)**
Useful	27	28.4
Somewhat useful	25	26.3
Useless	39	41.1
Do not know	4	4.2
Total	**95**	**100.0**
2. Opinion of Respondents on the Importance of Proper Waste Management Practices		
Opinion	**Frequency**	**Percentage (%)**
Yes	68	71.6
No	27	28.4
Total	**95**	**100.0**
3. Evaluation of the Efforts Made by the Municipality on Solid Waste Management		
Evaluation	**Frequency**	**Percentage (%)**
Very good	6	6.3
Good	14	14.7
Fair	21	22.1

Bad	54	56.8
Total	**95**	**100.0**

Source: Researcher's own survey, 2025

This table shows that, the households, (41.1%) of them stated that solid waste means totally useless whereas, (26.3 %) were stated somewhat useful, again (28.4 %) were also stated solid wastes are useful and (4.2%) were stated don't know about solid waste importance. The majority (71.6%) of the respondents agree on the issue of appropriate management of household solid wastes. The municipality of the city to provide solid waste management service indicated that (56.8%) of respondents reported that the effort is bad; (22.1%) of the respondents claimed that the effort is fair. While (14.7%) of respondent reported that the effort is good and about (6.3%) of respondent reported that the effort is Very good.

Table 4.13: Households awareness and participation on cleaning program of solid wastes in the city

1. Respondents' Attitude on the Frequency of Solid Waste Cleaning Program in the City		
Attitude	**Frequency**	**Percentage (%)**
Rare	58	61.1
Weekly	11	11.6
Monthly	15	15.8
I do not know such program exists	11	11.6
Total	**95**	**100.0**
2. Respondents' Participation in the Cleaning Program in the City		
Participation	**Frequency**	**Percentage (%)**
Yes	39	41.1
No	56	58.9
Total	**95**	**100.0**

Source: Researcher's own survey, 2025

Table 13 above shows that the household's awareness and participation on cleaning program in there kebele and (61.1%) responded there was cleaning program rarely and (11.6%) responded they don't know such cleaning program exist and the rest (11.6%) responded weekly and (15.8%) responded monthly. With respect to the participation in cleaning program sample households also asked did they participated on cleaning program and responded that (41.1%) of respondent participated cleaning program and the rest (58.9%) didn't participated in cleaning program.

4.5.2. Technical Factors

The information obtained from the sampled respondents and researcher observation that some of the factors affecting the SWM system of the were absence of proper skilled man power in the area to coordinate SWM activities as well as the proper site, lack of labor engaged in daily removal of solid wastes and in street sweeping in the city affects the sanitary of some parts of the city by making it ugly and smelly, absence of materials/equipment's to collect the waste in different parts of the city is the another challenge. The other challenge was the municipality didn't work a lot on community mobilization regarding SWM system.

The interview conducted with the staff of the municipality of the city to get the necessary information regarding factors affecting the SWM system of the study area revealed the existence of the following major factors behind the poor management of the city.

The information obtained from sampled households indicated that some of the respondents in the city as an alternative means of disposal by digging a hole around the house and burn it, throw it on an open space, in sewerage or on street and disposing on the backyards of the house. This indicates as more attention is not given on recycling and resource reuse as a common practice. In addition the location of solid waste disposal sites of the town also indicates as no focus made on the environmental impacts of solid waste, waste of all nature is indiscriminately disposed without any further treatment in the existing dumping site. The windblown waste is scattered all over the site and some light plastics and paper might travel back all the way to the city this affects the city.

4.5.3. Institutional factors

Financial problem is made the office not to give the necessary attention for SWM. As a result, the municipality was unable to provide the necessary materials used for hauling of solid wastes, to prepare sufficient and safe disposal sites, to employ labor engaged in daily removal of solid wastes, etc. The information gained from the staff of the municipality also indicated that, the lack of local NGOs those contribute financial and technical support on such aspects made the problem to entirely rely on a shoulder of the municipality.

The institutional factors are the major problems that extremely influence Municipal solid waste management in the city; or the major causes for the existence of such waste management related problems in addition to the previous determinant factors. In this section, the researcher investigated the influence of institutional factors on effective solid waste management; particularly, it includes law of enforcement, facilities, budget and manpower.

Law enforcement

Table 4.14: Enforcement of Rules and regulation on solid waste management

1. Respondents' Evaluation of the Rules and Regulations for Solid Waste Disposal in the City

Evaluation	Frequency	Percentage (%)
Regulation is strong	10	10.5
Regulation is weak	57	60.0
None at all	28	29.5
Total	**95**	**100.0**

2. Respondents' Opinion on Penalization of Violators of SWM Rules and Regulations

Opinion	Frequency	Percentage (%)
Yes	32	33.7
No	63	66.3
Total	**95**	**100.0**

Source: Researcher's own survey, 2025

From the total of 95 respondents 10 (10.5%) of them stated that the regulation is strong. But majority of sample households 57 (60.0%) responded that the regulation is week and the remaining 28(29.5%) of them stated that the regulation is none at all this implies that related to waste disposal and environmental protection issues the municipality intervention is actually low. Most 63 (66.3%) of respondent responded that they don't see when the violators penalized and the rest 32(33.7%) of respondent seen when the violators are penalized.

4.6. Results from Econometric Analysis

In this study, the econometric method of data analysis was used to identify the factors that determine households' solid waste management practice. In this regard binary logistic regression model was employed to identify the factors that determine households' solid waste management practice by incorporating a set of explanatory variables associated with the dependent variable.

4.6.1. Multicollinearity test

Before the estimation of the parameters of the model, the data has been tested for multicollinearity problems. The problem of multicollinearity arises when at least one of the explanatory variables is linearly collinear with the other independent variables. If there is a multicollinearity problem, the standard errors of the parameters are inflated, the sign of the estimated regression coefficients may be the opposite of the hypothesized direction, and the test statistics may lead to a wrong conclusion (Wooldridge et al., 2016).

Thus, the existence of multicollinearity was examined with the help of the variance inflation factor and pairwise correlation matrix. In this regard, for the VIF greater than ten, shows a strong correlation among explanatory variables, which results in a multicollinearity problem. The correlation matrix which is greater than a value of 0.7 shows the existence of a multicollinearity problem among the explanatory variables. From this, the correlation coefficient among the predictor variables was used as the first step to check the presence of multicollinearity. The correlation based on the test of pairwise correlation among predictors was not greater than 0.7 (see table 17). And the VIF based on the rule of thumb test was smaller than 5 (see table 18). Because the effect of multicollinearity is relatively low and less than 10, it can be concluded that multicollinearity is not a problem (Wooldridge et al., 2016).The problem of heteroscedasticity was also checked by using the Bruesh Pagan test. The

test indicated the existence of heteroscedasticity. To avoid this problem from the model robust standard errors were estimated.

Table 4.15: Correlation matrix of the explanatory variables

1. Correlation Matrix

Variables	(1) Sex	(2) Age	(3) Marital Status	(4) Family Size	(5) Education	(6) Annual Income	(7) HHPSWM	(8) Distance
(1) Sex	1.000	-0.152	0.090	0.000	-0.225	-0.000	-0.165	-0.368
(2) Age	-	1.000	0.244	0.022	-0.354	0.014	-0.080	0.117
(3) Marital Stat	-	-	1.000	-0.075	-0.013	-0.049	-0.100	0.093
(4) Family Size	-	-	-	1.000	-0.090	0.214	-0.181	-0.258
(5) Education	-	-	-	-	1.000	0.147	0.045	0.187
(6) Income	-	-	-	-	-	1.000	-0.146	0.021
(7) HHPSWM	-	-	-	-	-	-	1.000	0.244
(8) Distance	-	-	-	-	-	-	-	1.000

Source: Researcher's own survey, 2025

Note: HHPSWM = Households' Perception on Solid Waste Management

Table 4.16: Variance Inflation Factor **(VIF)**

Variable	VIF	1/VIF
Sex	1.370	0.729
Age	1.360	0.735
Marital Status	1.350	0.740
Family Size	1.320	0.755
Education Status	1.170	0.855

Income	1.140	0.877
Households' Perception	1.130	0.884
Distance	1.120	0.896
Mean	**1.250**	-

Source: Researcher's own survey, 2025

4.6.2. Model goodness of fitness test

The dependent variable is a variable that takes a value of 1 or 0 depending on whether the respondent is practices or non-practiced SWM and is regressed against eight explanatory variables. Before estimating the effect of the independent variables on the dependent variable, it is important to check the fitness of the chosen model. The classification table, the likelihood ratio test, and the Hosmer and Lemeshow test were used to show the existence of a relationship between the dependent variable and independent variables.

Likelihood ratio, and Hosmer and Lemeshow test

A likelihood ratio test is used by comparing the log-likelihood of the unrestricted model to that of the reduced model to test two hypotheses. The null hypothesis for this test statistic is that all the coefficients in the logistic regression model except the constant are zero, against the alternative hypothesis that the predictors have a significant effect on the dependent variables in the model. When the likelihood ratio test statistic is significant, at least one of the predictors is significantly related to the response variable (Hosmer & Lemeshow, 2000). In this study, the result of the full binary logistic regression model was compared to the null model (intercept model only) using the likelihood ratio test, which tests whether the full model predicts better than the intercept-only model. The result of the likelihood ratio test confirms that the full model predicts the data better than the null model since the value of the likelihood predicts the data better than the null model since the value of the likelihood ratio chi-square statistic is LR (8) = 20.31with p = 0.0092.This implies that the null hypothesis is rejected and there is evidence that at least one explanatory variable contributes to the prediction of the dependent variable.

The Hosmer-Lemeshow test is used to assess the overall goodness of fitness of the model. Under this test, the study tests the null hypothesis of the model that fits the data against the alternative

hypothesis of the model that does not fit the data well. As shown in Table 19, the Hosmer and Lemeshow tests of the fitted model are insignificant (chi (8) = 4.82, p = 0.7762), since the value of the Hosmer-Lemeshow goodness of fit test is greater than 0.05, implying a failure to reject the null hypothesis, and it can be concluded that the model fits the data well. Therefore, we can conclude that the model fits the data very well. So we can proceed to discussion and interpretation of the significant explanatory variables in the model.

Table 4.17: Likelihood ratio and Hosmer Lemeshow test

1. Model Fit Statistics

Test	Value	p-value (Prob > chi²)
Likelihood Ratio Chi² (8)	20.31	0.0092
Pseudo R²	0.2465	-
Hosmer-Lemeshow Chi² (8)	4.82	0.7762

Source: Researcher's own survey, 2025

4.6.3. Result of binary Logit model

Table 18, Shows the estimation result of the binary logit model for the determinants of household solid waste management practice. It reports the coefficients, odds ratio, marginal effect, standard error, and pseudo R_2

Table 4.18: Results of binary Logit model for the determinants of household SWM practice

Dependent variable: Household SWMP status (1= practice SWM, 0 = otherwise)						
Explanatory Variable	**Coef.**	**Odds Ratio**	**Marginal Effect**	**Std. Error (Coef.)**	**Std. Error (Odds Ratio)**	**Std. Error (Marginal Effect)**
Sex of HH head (Ref: Female)	-1.2074	0.298	-0.154	0.824	0.246	0.103
Age of HH head	0.0289	1.029	0.004	0.0254	0.026	0.003
Marital Status (Ref:						

Unmarried)						
└── Married	-0.1597	0.852	-0.020	0.419	0.357	0.053
Family Size	0.433**	1.542**	0.556**	0.180	0.278	0.022
Education Status (Ref: Illiterate)						
└── Literate	1.920**	6.830**	0.246**	0.809	5.531	0.093
Income of Household	0.000	0.999	0.000	0.000	0.000	0.000
Perception of SWM (Ref: Low)						
└── High	1.172**	0.309**	0.150**	0.568	0.176	0.067
Distance	-0.135**	0.873**	-0.017**	0.0725	0.063	0.008
Constant (_cons)	2.621	13.75	-	2.604	35.84	-

Note: ***, **, and * sign shows the rejection of the null hypothesis that the coefficients are statistically significant at 1%, 5%, and 10% significance levels respectively.

Source: computed from own survey data, 2025

The logistic regression model was deemed acceptable to determine the major factor of a household's SWM practice in the study area. Based on the above table, the logistic regression result revealed that out of eight independent variables, four of them are statistically significant at 5% levels of significance. These are family size, education status, household perception towards SWM and distance are statistically significant at 5%level of significance, holding other variables constant. This implies that significant differences were observed between households' SWM status and family size, education status, household perception towards SWM and distance. As for

other variables, significant differences were not observed between households' SWM status and sex, age, income and marital status.

The pseudo R2 indicates how well the explanatory variables explain the probability of a household's decision to practice SWM. The pseudo-R is found at about 0.2465. A negative sign in the column labeled coefficients indicates an inverse relation between the explanatory variable and the log odds of the dependent variable. In contrast, a positive sign column labeled coefficients indicates a positive relationship between the log odds of the dependent variable. Estimates of odds greater than 1.0 indicate that the probability of being practice SWM is greater than that for the reference category, vice versa.

Family size: this is a continuous variable, which is one of the factor that affect the status of household to practice solid waste management in the study area. The household's family size were statistically significant at 5% level of significance and positively affect solid waste management practice in the study area. The marginal effect of family size indicate that the probability of household to practice SWM increase by 0.556 as the family size increase by 1 person, being other factors remain constant. This may due to as family member increase labor force, as a result the household practice solid waste management.

Education status: it is a dummy variable, which takes a value of 1 if the household is literate and 0 otherwise. The variable is significant at a 5% level of significance (p-value = 0.018), and the marginal effect of the variable is also significance at the same level of significance. The odds ratio for a household who literate is 6.83 since the reference category was the household who are illiterate. Thus, keeping the effect of other predictors constant, on average household that are literate was 6.83 times more likely to be practice SWM , than the household that are not literate. This is due to literate household may had more knowledge about the importance of solid waste management and the negative impact of solid waste to the environment than illiterate households.

Household perception towards SWM: the households' perceived status towards SWM has been identified as a significant factor at a 5% level of significance for the household's decision to practice SWM in study area. The perceived status of household family members is

high, and the probability of their willingness to practice SWM increases. In this regard, the perceived status of the household was coded in terms of dummy variables, and the reference category is the household's perceived status rate as low. The household perceived status towards SWM is significant at 5% level of significance and has an odds ratio of 0.309. This implies households that have a high perceived status for SWM were 0.309 times more likely to practice SWM as compared to households that have a low perceived status for SWM practice in the reference category, keeping all other factors constant. This could be because people with high perception status towards SWM practice had a higher perceived risk of seeking care their environment from solid.

Distance: the distance between the waste disposal center and their home has been identified as a significant factor for household decision to practice SWM in the study area. It was statistically significant at a 5% level of significance. To practice SWM, households consider the distance of the waste disposal from their home. As the distance between the waste disposal place and home increases, households pay for additional transportation and other related costs which then decrease will their interest in disposing solid waste. There is a negative relationship between distance and solid waste management status of the households. The regression estimates that the coefficient of distance is negative, showing that there is a negative relationship between distance and SWM practice. The estimated result showed that as distance increase by 1km, the probability of household to practice SWM decrease by 0.017, being other factors remain constant.

4.7. The Impact of Improper solid waste management in the study Area

The major health problems of the study area are due to open dumping of solid wastes near to home, road side and at open space. The , water-born and airborne diseases such as, Cholera, Diarrhea, Amoeba, Giardiasis and other disease were commonly observed due to absence of effective waste management in the area. This result is comparable to (Staniskis, 2005), reported in Netherland. Top ten diseases recorded in Mekelle city health center in 2017 are Diarrhea, pneumonia, intestine parasite, malnutrition, common cold, scabies, otitis media, conjectimitis, anemia and tonsils. According to head of Mekelle city health sector these diseases are directly or indirectly associated to illegal solid waste management's and these diseases affects the community.

The present studies showed that, about (54.7%) of the respondents were openly dumping solid waste along the open space and on near to the road. It causes damage of road culverts in the area. This is resulted in difficulty of road usage for cars. Among the risk factors assessed in the present study, lack of adequate knowledge about openly thrown solid wastes blocked drainage channels which create storm water. This result was consistent with the decision described by (Yongsheng., 2014), around Nairobi, Kenya. That poor and improper solid waste management problems were causes socio-economic impact that cost of health and road maintenance as well as reduces productivity of the community. Moreover, people do not want to carry their businesses in the polluted and disturbed area. This clue was reliable with the conclusion pronounced by (WHO, 2016).

On the other hand in the study area, generated solid wastes are simply dumped in an open space, along the road and river channels. The environmental aesthetics of the area is extremely useless due to such activities practiced by the community. Solid wastes which are blowing by the wind cause disturbing the convenient environment. This indication was dependable with the conclusion noticeable by FDER (No.513, 2007

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

Various human diseases are directly or indirectly connected to the hygiene crisis that increases from inappropriate organization of solid waste. In appropriate organization of solid waste in the place threatens a number of risks to the environment and the public health. The street roads were damaged due to long open dumping of solid waste and closed drainage channels .Such phenomena hindered free movement of the people. Over sixteen kinds of diseases seen in the area are associated to inappropriate solid waste management. Successful organization of solid waste minimizes public health hazard and raise the aesthetical value or economic value of our environment.

Communities in study area are not in a situation of participating in Municipal Service and Delivery awareness of residents are also low that increases additional problems. The residents also increase many factors that hinder their participation in such actions. Therefore, large effort requires making public awareness and the participation of the community in urban service provision and solid waste organization of the Town. Environmental rules, regulations and policies in relation to solid waste organization were inefficient in implementation.

Disposing wastes by digging a hole around the house and burns it; throw it on an open space, in sewerage or on street and disposing on the backyards of their house are other means of disposing methods used by the respondents. Households, who used illegal site, mostly preferred to dispose their wastes at the time of early night and early morning. There is a problem of solid waste minimizing policy or separation, reuse, recycling, and resource recovery).

The discarding site and its organization of solid wastes also found inadequate. This is because the site is near to the center of the town and bounded by mountain ridges at distant location, but there are settlement areas, a church and agricultural fields just adjacent to the disposed waste, all types of Waste nature is indiscriminately disposed with no further treatment. The common knowledge and participation of households in the SWM are very low. Assessment results revealed that very few of the households have the awareness of Solid waste and its management.

The study employed binary logistic regression model to identify the factors that determine households decision to practice solid waste management in the study revealed that family size, education status, households perception towards SWM, and distance were the main factors that determine households decision to practice solid waste management in the study area.

5.2. Recommendations

Both of Mekelle city health sector and Mekelle city sanitation and beautification office can sit communal solid waste accumulation container, create new additional solid waste management micro enterprises and additional solid waste transportation car were needed especially around commercial centers. This access is very available for the Mekelle city. Because today the city has very high population number migrates from different town through different actors of the country.

- Efficient planning and implementation of community-based solid waste administration system is necessary to help the local community about the disposal mechanisms.
- Management and separation practices at households' level should be improved through awareness creation because the city of community understanding of payments to the MSEs is very low.
- The government and other stakeholders should enable the community to improve the treatment, separation, and storage and removal activity of recyclable materials.
- The present solid waste gathering rate of the city is very small and this shows that additional efforts should be made to transform the position. To develop the collection rate raise the number of MSEs and also raise their capacity by providing them waste collection trucks through create awareness to the community about payments. Because the assigned trucks are not sufficient, this accesses is stopped currently by technical problem and consequently a small amount of the waste is collected currently. So, to develop the collection rate additional trucks are essential. The trucks that may added should be compatible with the existing system and the overall health of the population. The resources needed for this reason may be achieved by the regional government or other funding agents.
- Since the poor understanding of the community was one of the main factor , MBPDD and health office of the city should engage continuous awareness creating campaign or education for the public through competitions among schools, institutions, NGOs,

businesses and by using popular individuals via the different medium of communication about MSWM in general and ISWM in particular.

- The result of this study reported that illegal removal of solid waste is practiced in Mekelle city. Besides, the law enforceability shows a significant impact on successful solid waste organization at household level. It means that the law enforcement sector of the local government gives little attention Thus, for laws to be effective people need to know the presence of laws through awareness creation activities and implementers should aggressively work to minimize illegal disposal activities and create clean environment through continuous follow up.
- The current waste dumping site is an open field and it has harmful effects to human health. Thus some actions are required to reduce the negative impacts. One of the significant actions to take is shifting the open dumping system to sanitary land filling system. Sanitary ground filling is a more advanced system used by various cities today. But it is an costly system, which may not be implemented at once given the current degree of importance given, and budget allocated to it by Mekelle city administration. Therefore searching for an additional option economic resource is necessary.

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Appendices

Mekelle University

College of Business and Economics,

Department of Management

Survey questionnaire for municipality employees and service users in Mekelle city

Dear Respondents:

Mekelle university school of graduate studies college of business and economics, department of management

This is a questionnaire to be filled by the Mekelle city municipality and service users of the city. This questionnaire is prepared by DVS master student of Mekelle University to conduct research on "the assessment of solid waste management practices in Mekelle city, the case of Kedamay Weyane district. This research is carried out for the partial fulfillment of the requirements for the completion of a Master's of degree in development studies in Mekelle University.

The researcher invites you to give your genuine response based upon the questions it entails. You can be sure about the confidentiality of your responses since it will not be disclosed to anybody without your consent. In addition to your free will the study allows you also to withdraw at any time in a way that prevents adverse consequences which requires you contacting the researcher. If you are willing to see the findings of the research I can promise you a copy of this research. Above all I express my heartfelt gratitude to every respondent of my questionnaire for sharing me your valuable information and time.

Annex 1: English Version questioners prepared for head of municipality and departments of Urban Beatification and Sanitation of the municipality.

I- Personal detail

Sex

Age

Educational qualification ----------

Years of duration in municipality ----------

1. Does the municipality have annual plans for solid waste management?

2. Is there localized polices, guideline, strategies and rules related to solid waste management?

3. What would be the main sources of solid waste releasing into the study area?

4. In what methods solid waste is collected?

5. What are the major challenges that affect management practices of solid wastes?

6. How solid wastes are transported to disposal site?

7. Is there any association engaged in solid waste collection in the town?

8. Is there any hazardous waste in your area?

9. What are solid waste storage system do the town use inside the plot/house yard?

10. What are solid waste disposal system do the town use?

11. What do you suggest to solve the problem of improper solid waste management in the town?

12. What is the physical composition and separation of solid wastes generated at household level?

13. What is the rate of household solid waste generation at household level in Mekelle city?

14. What is the rate of the monthly and yearly solid waste generation rate in Mekelle city?

15. What is the status of solid waste management practice in Mekelle city?

16. At what level is the community participation to manage the solid waste generation into the town?

Annex 2: English Version questioners prepared for head of Mekelle city Health Center.

I- Personal detail

Sex: ----------

Age: ----------

Educational qualification ----------

Years of duration in the Health Center ----------

1. How do you create awareness of community about the solid waste problem?

2. What is the common health problems observed in the kebeles?

3. What are the dominant diseases and what steps are you taking to reduce the diseases?

4. What are the top ten diseases identified in your health center and give the list of it?

5. Are there diseases associated with solid waste problem with in this top ten leading diseases in your health center?

5. What are solid waste management systems in the kebeles looks like?

7. What are the systems used to dispose solid waste in the kebeles to prevent solid waste related diseases?

8. How strong is the relationship between the municipality solid waste management section and your office?

9. How do you create awareness of the community about the solid waste problems?

10. What possible solutions you to suggest improving the quality of health service in the

kebeles?

11. What is the physical composition and separation of solid wastes generated at household level?

12. What is the rate of household solid waste generation at household level in Mekelle city?

13. What is the rate of the monthly and yearly solid waste generation rate in Mekelle city?

14. What is the status of solid waste management practice in Mekelle city?

15. What are the impacts of improper solid waste management of the town?

16. At what level is the community participation to manage the solid waste generation into

the town?

17. Please suggest other ideas that you think important for study?

Annex 3: English version questionnaire prepared for sample households in Mekelle city Administration

Section One: Socio demographic characteristics of the respondent

1. Sex: A. Male B. Female

2. Age of respondent: A. 18 - 30 B. 31 - 45 C. 46-65 D. over 45

3. Educational level: A. No formal education B.1-8 grade complete C. 9-12 grades complete D. college and university complete

4. Marital Status: A. Married B. Single C. Divorced D. Widowed

5. Professional Status: A. Government employee B. Private sector employee C. merchant

D. Self-employed

7. Family size: A. 1-2 B. 3-4 C. 5-9 D. ≥ 10

8. Average monthly income of household (in birr): A. < 1500 B. 1500 - 3500 C. 3500-5000 D. > 5000

Section Two: questions associated with solid waste management practices

1. What arethe major sources of solid waste in Mekelle city?

A. Household B .Commercial institutions C. industries D. hotels E. hospital

2. Do you have a temporary solid waste storage material in your house?

A. Yes B. No

3. If the answer is yes question2 What kind of solid waste storage material do you use in your house to store solid wastes?

A. sack or madaberia B. festal C. Other

4. Do your household practice waste separation?

A. Yes B. No

5. If your answer for question no 4 is „Yes", for what purpose do you separate those wastes? A. To reuse B. To sell / exchange C. To compost D. Other

6. If your answer for question no 4 is „No", what do you think the reason?

A. Lack of enough knowledge about waste separation practice B. Lack of understanding about the importance of waste separation C. Other

7 what are solid waste transportation systems of Mekelle city?

A. By vehicle(car) B. By human

8. What are the reasons majority of solid waste transportation can apply by human in the city? A. It is low cost B. It gain accesses day to day

9. Do you have access to door to door solid waste gathering service delivered from the MSEs of the city?

A. Yes B. No

10. What do you think is the current number of Sufficiency of access to door to door waste collector (MSEs)?

A. Enough access B. Not enough access

11. How often do the private MSEs collect solid waste from your house?

81A. Weekly B. Twice a month C. monthly

12. How many birr Payees for the MSEs Service of Solid Waste Collection per Twice a month?
A. 5 birr B.10 birr C. 20 birr D. 30 birr

13. What are the Conditions of waste disposal method can apply in the city?

A. On open space B. on proper disposal site C. near to the road D. other

14. Is solid waste disposing container available in your area?

A. Yes B. No

15. If your answer for 14 is yes, how distant is container from your house?

A. 10 – 30 meters B. 31 – 50 meters C. 51 – 200 meters

D. 201 – 300 meters E. > 300 meters

16. Do you have Understanding of Respondents on Rules and Regulations of Solid Waste Disposal systems? A. Yes B. No

17. Have you always obtained education, training and information about solid waste

management?

A. Yes B. No

18. If your answer for question 17 is “YES”, who give the education and information?

A. Municipality B. Kebelle C. NGO

19. Do you have idea to learn more about solid waste management importance?

A. Yes B. No

20. How do you think of solid wastes?

A. Useful B. Somewhat useful C. Useless D. Do not know about solid waste uses

21. Do you agree with the importance of proper waste management practices?

A. Yes B. No

22. How do you evaluate the efforts of made so far by the municipality of the city to provide solid waste management services?

A. Very good B. Good C. Fair D. Bad

8223. How do you evaluate the cleaning programs frequent in your city?

A. Rare B. Weekly C. Monthly D. I do not know such cleaning programs exists

24. Have you always participated in a cleaning programs in your city?

A. Yes B. No

25. How do you evaluate the set – up by the responsible bodies to apply the rules and regulations of solid waste management in Mekelle city?

A. Regulation is strong B. Regulation is weak C. None at all

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

A. Yes B. No

Annex 2: Photographs for wastage disposal site of the study area