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SCHOOL OF GRADUATE STUDIES

MUNICIPAL SOLID WASTE MANAGEMENT SERVICE IN ARADA SUB CITY OF ADDIS ABABA

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF ADDIS ABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN URBAN AND REGIONAL DEVELOPMENT PLANNING

BY

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ENVIRONMENTAL STUDEIS

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Declaration

The researcher declare that assessment of municipal solid waste management in Arada sub city is my own work and that all source that i have used or quoted have been indicated and acknowledged by means of complete reference and that this work has not been submitted before for any other degree at any other institutions .

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This thesis has submitted for examination with my approval as a university advisor.

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LIST OF ACRONYMS

AAU = Addis Ababa University

BPR = Business Process Reengineering

CBOs = Community Based Organizations

FEDO = Finance and Economic Development Office

GPS = Global Positioning System

HH = Household

JICAIIC = Japan International Cooperation Agency Institute for International Cooperation

MoH = Ministry of Health

MSSE = Micro and Small Scale Enterprise

MSW = Municipal Solid Waste

MSWM = Municipal Solid Waste Management

NGOs = Non-Governmental Organizations

SSMD = Sanitation, and Solid waste management Department

UK = United Kingdom

UNCHS = United Nations Center for Human Settlement

UNEP = United Nations Environmental Program

US = United States

WHO = World Health Organization

WP = Work Process

DEFINITION OF TERMS

BPR:	The fundamental rethinking and radical design of work process to achieve dramatic improvements in work.
Case team:	A group of experts that work together in one work process.
Household:	Persons who live together in one house or dwelling.
Kebelle:	The lowest administrative unit in Ethiopia (Zebenay, 2010).
Liwach:	The A name given to individuals that exchange old shoes, cloth and house materials informally through door to door visit
Quraleos:	A name which is given to individuals that buy reusable and recyclable solid wastes from the society informally through door to door visit.
Sanitation agents:	A person employed by the concerned organ to supervise and control over the illegal disposal solid waste.
Work process:	Represents specific departments of an institution that organize to perform its assigned tasks.
SWMD	Solid waste management Department

ABSTRACT

Municipalities in developing countries are incapable of meeting the demand for urban services. Some years ago Addis Ababa, the capital of Ethiopia, took the initiative to overcome some of these problems by starting a reform process. This study was aimed at the overall assessment of the existing MSWM service of Addis Ababa city in Arada sub city. Besides this, the study had also specific objectives such as investigation of households' solid waste generation rate, physical composition and management practices, the existing status and spatial coverage of MSWM, and current institutional arrangement and capacity of MSWM service delivery of the sub city. In order to accomplish these objectives, the researcher used both primary and secondary data sources. The primary data were gathered through questionnaires, interviews, field measurement, and field observations. Whereas secondary data were extracted from different published and unpublished materials. The analysis of this paper was carried out using both qualitative and quantitative techniques. The findings of this study revealed that the present system of MSWM of Addis Ababa in Arada sub city entirely relied on the municipality which provided the full range of waste collection, transportation and disposal service. Based on the findings of this research, the sub city households' dominantly produced biodegradable solid wastes. The MSWM of the sub city is found in very low status and spatial coverage. This poor status of MSWM is also intensified by three critical factors. The first one is poor institutional structure and capacity of Sanitation, and solid waste management Department. The second shortcoming is limited participation and contribution of stakeholders' i.e. unsatisfactory participation of communities, no collaboration of various CBOs and NGOs, no private sector involvement, very limited contribution of MSSE, .The third constraint is poor households' solid waste management practices resulted from improper handling of solid waste storage materials, low level of solid waste separation and resource recovery activities, and illegal solid waste disposal system. Therefore, the best ways that used to tackle the above problems are: execution of sustainable solid waste management systems through awareness creation and training, improvement of the SSWMD institutional structure and capacity, and implementation of integrated MSWM approach which recognizes and comprises all stokeholds.

Key Words: - institutional structure and capacity; Solid waste management ,(MSWM); Household

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The rapid urbanization that has been taking place during the 20th century virtually transformed the world in to communities of cities and towns facing similar challenges on environmental issues in which most of them have to be addressed at international level (Smith, 2010). Among those environmental issues solid waste management is a critical one because as long as humans have been living in settled communities, solid waste generation has been an unavoidable and critical issue both in developed and developing nations. As a result, solid waste management became a worldwide agenda at united nation conference on environment and development in Riodejieneiro in 1992 with a great emphasis on reducing wastes and maximizing environmentally sound waste reuse and recycling at first step in waste management (UNEP, 1996).

Solid waste management is defined as the collection, transportation, processing, recycling, and disposal of solid waste materials so as to reduce their effect on health ,environment and aesthetics. It is highly related with urbanization and industrialization (web page accessed, June , 2019 . For instance in early societies, solid waste management consisted of digging pits and throwing garbage into them. When cities began to be more concentrated; however, solid waste management became a serious and complex issue. Houses that did not have room to bury their garbage would throw it into the streets. In response, many cities started to set up municipal garbage collection teams which would dispose of unusable garbage. This is mainly because modern societies generate far more solid waste than early humans ever did. As a result, recent events in major urban centers both in developed and developing countries have shown that municipal solid waste management has become a big challenge (web page accessed, June 10, 2019).

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the streets. In response, many cities started to setup municipal garbage collection teams which would dispose of unusable garbage. According to World Bank (2012), every year developing nations spend nearly $46 billion on managing their municipal solid waste. These investments could exceed $150 billion per year by 2025.

Solid waste management (SWM) in Africa is often weak due to lack of appropriate planning, inadequate governance, poor technology, weak enforcement of existing legislation and lack of economic incentives (UNEP, 2005). This impacts environment and public health. Different approaches are used by countries to manage solid waste in order to prevent its impacts on the environment and health. Until recently, solid waste management (SWM) services in Ethiopia were mainly the responsibilities of municipalities, which results in inadequate service provision reflected by lack of proper collection, poor sanitary facilities, improper planning and co-ordination (Tadesse Kuma, 2004;Edmealem Bewuket,(2013).

According to data obtained from report produced by the Finance and Economic Development Bureau of Addis Ababa City Administration, the total amount of solid waste generated daily in 2011 was 1,808.6m^3 whereas the capacity of waste disposal was only 1,480.2m3 per day. The waste disposal capacity of the city was close to 82 percent. That is to say, the municipality was capable of disposing about 82 percent of waste collected per day. Out of the total waste generated, wastes from households, industries , institutions and street sweeping constituted about 76%, 18% and 6%, respectively (FEDBA, 2010).The report produced by CSA based on the 2007 population and housing census revealed that out of the total 658,986 housing units, the proportion of housing units the dry waste of which is collected by the municipality and the private enterprises was close to 70 percent, The remaining 30 percent was disposed in to open spaces, rivers, backyards, etc.(summarized report on the study of infrastructure demand and supply of Addis Ababa city 2012).

In this research, Municipal solid waste quantity and composition analysis was conducted in Arada sub-city, which is the central sub-city of Addis Ababa. The sub city was selected for the study for the following reasons.

- It is characterized by low-rise densely built up and city center areas, which needs different, waste collection systems;

- It is the area that is drained by different rivers that carry solid wastes (like Genfele river, kebena river,) etc. washed out by flood and illegally disposed to down streams.

1.2 Statement of the Problem

Dealing with the environmental costs in rapidly growing economic development, urbanization and improving living standards in cities have led to an increase in the quantity and complexity of generated waste, representing a phenomenal challenge (UNDP 2004). This is particularly true in the area of solid waste management. While cities are generating an ever increasing volume of waste, the effectiveness of their solid waste collection and disposal systems are declining. In urban centers throughout African regions, less than half of the solid waste produced is collected, and 95 percent of that amount is either indiscriminately thrown away at various dumping sites on the periphery of urban centers, or at a number of so-called temporary sites, typically empty lots scattered throughout the city (Mohammed 2003).

Addis Ababa city started its solid waste management approximately some three decades back. The service cannot meet changing demands. The solid waste collection service is unsatisfactory, and scenes of scattered waste are common in most part of the city (UNDP 2004). However the municipal solid waste collection service is not functioning properly. Disposal site situated at one corner of the city is also the main determining factor for collection and disposal of wastes in the city. This means that it is only those people close to the dump sites that benefit. Dump sites and trucks for solid waste disposal are insufficient. In densely populated Kebeles, the majority of people live 0.5 – 1.00 km from accessible roads where transfer containers are located, when the recommended distance is 150 m from the housing units (Zerayakob 2002).

Currently in Addis Ababa, solid waste is increasing beyond the management capacity of the municipal governors, the volume of waste totals more than three million cubic meters per

year with the prospect of increase by a constant rate of 2.1 cubic meters per person annually (Misrak Workneh, 2016). However, the (2016) estimate of UN shows that only 65 percent of the waste generated in the city is collected, having the rest being disposed of in open sites, drainage channels, and rivers. This fact can be observed by strolling on the street of Addis Ababa city. the government had structured a process where SMEs and privately owned sanitation companies work with the government's sanitation entities in line with proclamationNo.513/2007. Despite, government's procedural mechanisms put in place to cope with the above problem, the matter of solid waste disposal seems far from being resolved due to the lack of technology, technical knowhow, financial capacity, poor institutional structure and understanding of the community required to properly manage solid wastes by the service providers (Tesema, 2010). The determinants of poor solid waste management practices observed in the sub city were very much unclear. The main objective is identification of the determinants of poor management system to improve the performance of the system as a whole for the benefit of the public. As far as the problems exist and the condition gets worse, it is important that research is done in this area.

1.3 Objectives of the Study

General objective; The general objective of the study to assess the current municipal solid waste management service of Addis Ababa in Arada sub city .

Specific objectives; the specific objectives of this study are to.

I. Investigate the generation rate and physical composition of household's solid waste in the sub city

II. Evaluate the condition of household's solid waste management practices in the sub city

III. Examine the existing status and spatial coverage of municipal solid waste management service in the sub city.

IV. Assess present institutional arrangement and capacity of municipal solid waste management of the sub city

1.4. Research Questions

So as to achieve the intended objectives stated above, the following research questions were formulated.

1. What is the existing institutional arrangement and capacity of municipal solid waste management in Arada sub city?
2. What are the common types of solid wastes prevailing in the study area?
3. What are determinants affecting the SWM system of the sub city?
4. In what ways the problem of solid wastes is reduced in the study area?

1.5 Scope of the study

Likewise other parts of the world in general and Ethiopia in particular, SWM problem is serious case. Because of resource, financial and time constrains, it is difficult to assess many woredas and sub cities in Addis Ababa city Administration. So, the scope of this research was limited to the problems of municipal solid waste management of Addis Ababa, in the case of Arada sub city. However, thematically the study focuses mainly on assessing on municipal solid waste management.

1.6 . Significance of the Study

Poor management of solid waste is a growing issue that has caused environmental degradation in urban Ethiopia. Identifying the main factors that result in poor management of solid waste may help to address the problems through mainly by creating public awareness about the cause and effects of unwise solid waste management on environment in general and health related problems in particular. Arada sub city is selected to conduct this study for the following main reasons. First, it is one of the urban centers where, there is uncontrolled urban expansion and problems of solid waste management are clearly observed. This study may have two main significances. First it may give some guide line information to policy makers, solid waste managers and environmental protection agencies about existing situation municipal solid waste management of Addis Ababa city administration. The study may also important in putting base line information to the next work who would like to conduct detailed and comprehensive studies either in Arada sub city or other study area.

It also serves as a source of information and further study for similar researches to be conduct concerning the MSWM system in the study area. Furthermore, by identifying the challenges and opportunities of ensuring a safe and reliable solid waste disposal system the study be a guide the concerned organs in their effort to tackle the problems of MSWM at hand. Additionally, the study also identifies the major stake holders in efficient MSWM management and there by inculcate a sense of responsibility towards ensuring safe and healthy environment.

1.7. Limitation of the Study

The researcher did not incorporate all woredas in the sub city. Some of them were lack of data, shortage of money during data collection. The researcher also faced shortage time to collect data. Workers in the municipality of the sub city also refused to give detail information related to operational cost of the sub city work process of some consecutive years.

1.8 Organization of the Thesis

This paper is organized in to five chapters with four parts. The first part is chapter one which is an introductory part. The second chapter deals with review of related literature obtained from various published and unpublished reference materials, the third chapter describes the research methodology, background of the study area. Chapter four is result and discussion which present analysis and interpretation of data about the existing status and spatial coverage of municipal solid waste management practice, and institutional arrangement and capacity of municipal solid waste management of the sub city .finally the last part of this study is chapter five which is conclusion and recommendation. Bibliographies and appendices are also attached at the end of the study.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Concepts of Municipal Solid Waste management

2.1.1 Definitions of Key Terms

Waste -according to UK environmental protection act (1990), "it is any substance which constitutes scrap materials, an effluent or other unwanted surplus arising from application of any substances or article which requires to be disposed of which has broken, worn out, contaminated or otherwise spoiled."

Solid waste - can be defined as "any garbage, refuse, sludge, and other discarded solid materials resulting from industrial, commercial, agricultural operations, and community activities, but does not include dissolved materials" (U.S. Code of Federal Regulations, 1995 cited in Samuel, 2006,p.5). In short "it is anything that is neither liquid nor gas and is discarded as unwanted" (Federal Negarit Gazeta of Ethiopia, proclamation number 513 of 2007).

Municipal solid waste (MSW) - refers to materials discarded in urban areas for which municipalities are usually responsible for collection, transportation, and final disposal.

Municipal solid waste management - is an activity of planning and implementation of solid waste management components such as collection, transfer and transportation, recycling, resource recovery, and disposal MSW under jurisdiction of local government.

2.1.2 Sources and Types of Municipal Solid Waste

In order to categorize what exactly municipal solid waste constitutes, there have been different attempts of categorization based on numerous classification criteria. Some of those criteria are source from which solid waste emanates, and nature of solid waste components. On the basis of the nature of items that constitute solid wastes, it can be classified into

organic or inorganic, combustible or non-combustible, and putrescible or non-putrescible (Edelman, 1997) .

Categorized municipal solid waste as household (residential) refuse, institutional wastes, street sweepings, commercial areas wastes, as well as construction and demolition debris. In developing countries, MSW also contains various amounts of industrial wastes from small scale industries. In these sources there are diverse types of solid wastes. But, some of typical solid wastes of those sources are described by (Dereje, 2010, p.36) .

Domestic solid wastes: wastes generated from household activities such as food preparation, cleaning, fuel burning, old cloths, furniture, obsolete utensils and equipment, packaging, newsprint, and garden wastes. In developing countries, food waste and ashes dominate households' solid wastes.

Commercial wastes: waste from shops, offices, hotels, restaurants, etc. and typically consisting packaging materials, office supplies and food wastes. In low income countries food markets contribute the largest proportion of commercial waste.

Institutional wastes: waste from schools, hospitals, clinics, government offices, military bases etc. and comprise hospital and clinical wastes including potentially infectious and hazardous materials.

Industrial wastes: composition of industrial waste depends on the kind of industries involved. It consist food waste from kitchens, and canteens, packaging materials, plastics, papers and metal items.

Street sweepings: dust, soil, paper, etc. In developing countries street sweeping also include fruit and vegetable residues, household wastes dumped along roads, drain cleanings, animal manure and plant remains.

Construction and demolition wastes: its composition depends on type of construction materials used, but it typically includes soil, brick, stone, concrete, ceramic materials, wood, packaging materials and the like.

2.1.3 Characteristics of Municipal Solid Waste

For effective and efficient management of solid waste generated in a particular city, adequate knowledge and data about the characteristics of solid waste is essential. 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 (G/tsadkan,2002). Though all the above characteristics are important, for this study the researcher emphasize only on municipal solid waste physical composition and generation rate.

Solid waste generation rate: refers to the "amount of waste disposed during a given period of time and the quantification of it involves different methods: by measurement at the point of generation, through use of vehicle survey and by examination of records at the disposal facility" (UNEP, 2009;cited in Zebenay, 2010). The rate of solid waste generated in a given town is basically determined by demographic growth, seasonal variation, geographic location, economic development and people's attitude towards waste. Nashiim irimana (2004) explained the influence of economic development by comparing gross national product of developed and developing countries with their waste generation rate. And he concludes that the higher the gross national product of a country result the higher the generation of waste. It means due to difference in level economic performance, waste generation rate of developed countries is highly greater than that of developing countries. Although developing countries have a lower rate of waste generation compared to developed countries, their quantum of waste is high owing to their higher levels of population growth. This clearly shows impact of population size on waste generation rate (Ibid, 2004).

On the other hand, people's attitude towards waste can also conditioned solid waste generation rate in the form of their pattern of material use and waste handling, their interest

in waste reduction and minimization, and the degree to which they refrain from indiscriminate dumping and littering (Schubeler, 1996).

Therefore, an accurate knowledge of quantity and rate of solid waste generation in a given area is essential for preparation and implementation of appropriate MSWM. Because it provides information on human, financial and equipment resources required for collection and transportation of waste, to enact appropriate laws on waste reduction, and establish current and future needs for solid waste disposal sites (Abel, 2007).

Physical composition: refers to quantity of various material types in a particular waste stream. Just like waste generation rate, physical composition of solid waste is also extremely variable as a consequence different factors. The major once are of the following:

a) Economic level difference: higher income areas are usually produce more inorganic waste while low income areas produce relatively more organic waste.

b) Demography (difference in amount of population for example, tourist places).

c) Locations: includes abundance and type of regions natural resource, and socio-cultural factors which highly contribute for variation of waste in different areas.

d) Season: for instance during certain season's yard wastes such as grass clippings and raked leaves add greatly to solid waste (,2019).

Unlike various composition of solid waste in different areas, process of defining waste composition is similar in each area i.e. by measuring mass percentage of each material group present in a sample. Conduct of waste composition studies by using this method has several importance's. "Some of these are: for identification of potential resource recovery activities, facilitate collection, transport and processing equipment, taking essential health, aesthetic and environmental precautions, and for monitoring changes in waste composition over time and improving waste management system" (Gidarkos, Havas, and Ntzamilis, 2005). Therefore, composition study is core stone for successful planning and implementation of solid waste management.

2.1.4 Functional Elements of Municipal Solid Waste Management

In the course of municipal solid waste management there are six functional elements. Identification of these functional elements allows description of relationships involved in each element, and development of a framework. As a result, to handle a specific solid waste management it is obligatory to observe the following six elements in combination. These are:

2.1.4.1 Waste Generation

Waste generation encompasses activities in which materials are identified as valueless and either thrown away or gather together for disposal. This functional element is very important because all activities that lead to identification and understanding of solid waste generation rate, volume, composition, area specific variations of waste generation and their expected changes overtime are belong to this component solid waste management. So, this functional element is a vital stage for acquiring accurate information that is necessary to monitor existing management system and to make regulatory, financial and institutional decisions (Gebrie, 2009).

2.1.4.2 On site Handling, Storage and Processing

This functional element constitutes activities associated with handling, storage, and processing of solid wastes at point of generation. Waste handling involves activities associated with management of wastes until they are placed in storage containers for collection. It also encompasses movement of loaded containers to point of collection. Storage refers stock up of wastes as soon as they are generated. There are two types of storage activities at source. The first one is temporary storage done at household level as a part of their hygiene. The second type is communal solid waste storage system on public solid waste containers prepared by municipality. While processing at source involves activities such as waste composting and separation of solid wastes for reuse and recycling. All of these components are important for protection of public health and aesthetics and environment (2019).

2.1.4.3 Collection

Collection involves the process of picking up of wastes from collection points, loading them in to a vehicle, and transporting it to processing facilities, transfer stations or disposal site. In most municipal solid waste management systems, cost of collection accounts a significant portion of total cost. For instance, "in industrialized countries collection accounts about 60-70% of total cost, and 70-90% in developing and transition countries" (UNEP, 1996). Collection is structurally similar in developing, transition, and industrialized countries, but there are important technical and institutional differences in implementation. In most cases, industrialized countries have more efficiency and effectiveness than developing ones in terms of their approach of collection, role of municipal governments, private-sector participation, and demographic and social factors relevant to collection. In developing countries, collection often involves a face to face transaction between generator and collector. The level of service is low, and generators often have to bring their wastes long distances and place it in containers. As a result many collection activities in developing countries carried out by informal sectors (UNEP, 2018). In general, there are four basic methods of collection described by (Tchobanolous, et al 1993cited in Ramachandra and Bachamanda, 2006):

i. **Community bin**- they are placed in convenient locations where community members carry waste and throw it in. This method is comparatively cheaper than other methods, and most widely adopted method in western countries. For this method to be adopted it is important that bins are covered, aesthetic, attended regularly, kept clean, easy to handle, and separate bins are provided.

ii. **Curbside collection** - homeowner is responsible for placing containers to be emptied at the curb on collection day and for returning empty containers to their storage location until the next collection.

iii. **Block collection**- collection vehicles arrive at a particular place or a set day and time to collect waste from households. Households bring their waste containers and empty directly into the vehicle. This method requires a higher homeowner cooperation and scheduled service for homeowner collaboration.

iv. **Door to door collection**- waste is placed at doorstep at a set time when waste collector arrives. In this method, collector of waste has the responsibility to collect waste separately. This method is very convenient for households, however requires homeowner cooperation.

2.1.4.4 Transfer and Transport

These activities are associated with transfer of wastes from public storage facilities to collection vehicle and the subsequent transport of wastes to disposal site. Transfer refers to movement of waste or materials from primary collection vehicle to a secondary, larger and more efficient transport vehicle. When location of final disposal site is at a long distance from points of collection, transfer stations may be used. With respect to transfer stations, "there are two basic modes of operation: direct discharge and storage discharge. In storage discharge refuse is first emptied from collection trucks in to a storage pit or to a large platform. While in direct discharge station, each refuse truck empties directly in to larger transport vehicles" (Meenakshi, 2005).

Transportation on the other hand covers all types of vehicles under operation to transport solid waste from its generation point to transfer station and then to treatment or disposal site. "All vehicles in operation are considered including manually driven small carts, mechanically driven sophisticated transportation vehicles, and special vehicles for hazardous, bulky, and recyclable wastes. Generally, a properly design transfer and transportation system highly reduces cost of collection" (Ibid, 2005).

2.1.4.5 Processing and Recovery

This functional element includes all techniques, equipment's and facilities used both to improve the efficiency of other functional elements and to recover usable materials, conversion products, produce energy, and compost from solid wastes. In addition it also provides several advantages. First, it can serve to reduce total volume and weight of waste material that requires collection and final disposal. Volume reduction also helps to conserve land resources since land is the ultimate sink for most waste materials. On the other side, it also reduces total transportation cost of waste to its final disposal site (Uriarte and Filemon, 2008).

Solid waste processing and recovery has been carried out beginning from separation and processing of wastes at the source. But, separations of mixed wastes usually occur at materials recovery facility, transfer stations, combustion facilities and disposal sites. It often includes separation of bulky items, separation of waste components by size using screens, manual separation of waste components, and separation of ferrous and non-ferrous metals. Then they enter in small and large scale industries for recovery activities. For example, organic fraction of MSW can be transformed by a variety of biological and thermal processes. The most commonly used biological transformation process is aerobic composting and, the most commonly used thermal transformation process is incineration (web page accessed 2019).

2.1.4.6 Disposal

This is final functional element in solid waste management 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" (Techobanglous, 2002). "Though 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, 2017).

2.1.5 Economically and Environmentally Sustainable Municipal Solid Waste Management Methods

2.1.5.1 Incineration

Incineration is one option for sustainable solid waste management. It is defined as the process of burning solid waste under controlled conditions to reduce weight and volume of solid waste, and often to produce energy. This process is really waste reduction, not waste disposal, though following incineration ash must still be disposed. It is recognized as a practical method of disposing of certain hazardous waste materials (such as medical waste).

Incineration can be carried out both on a small scale by individuals and on a large scale by industry.

This facility does not require much area so that it is common in countries like Japan where land is scarce (web page accessed 2019). Incineration has several advantages and disadvantages. These are summarized in table 2.1.

Table2.1: Advantages and disadvantages of incineration

Advantages	Disadvantages
•Requires minimum land •Can be operated in any weather Condition •Produces stable odor free residue •Can generate electricity •Effective way for hazardous waste Management •Reduce solid waste weight up to 70 % and volume up to 90 %	•expensive to build and operate especially for developing Countries •high energy requirement •requires skilled personnel and continuous maintenance •emission of gaseous pollutants •If not carried out properly, incineration results air pollution •Difficult to site because of citizens opposition •Encourages waste production because it is output approach

Source: (Miller, 2007)

Generally, according to UNEP (1996) there are considerations that we should keep in our mind when we want to choose incineration. These are:

- The necessary environmental controls are properly installed and maintained.
- The facility is properly sized and sited to fit well with other components of the MSWM
- The material to be burned is combustible and has sufficient energy content.

2.1.5.2 Composting

It is a process of allowing biological decomposition of solid organic materials by bacteria, fungi, worms, insects, and other organisms in to a soil for transforming large quantities of organic materials to compost (humus like materials). "The organic materials produced by composting can be added to soil to supply plant nutrients such as nitrogen, phosphorus,

potassium, iron, sulfur, and calcium, slow soil erosion, make clay soils more porous or increase water holding capacity of sandy soils" (Enger and Smith, 2008) There are three scales at which composting has been implemented; residential level, decentralized community level, and centralized and large scale municipality level The larger the undertaking the more capital investment is required. Most developing countries which have found success with composting revealed that composting works best when implemented at household level, with some project doing well at community level as well. At municipal level financial commitment required to maintain equipment has resulted in wide spread failures (zerbock, 2017).

Generally composting has many advantages; first it would reduce amount of waste requiring ultimate disposal and extending the life of landfills. When it done correctly the end result becomes a useful product, capable of being used at household or farm level to augment soil nutrient levels and increase organic matter in the soil, increasing soil stability. If the product has high enough quality and markets exist, it can be sold. Environmentally, process of composting is preferable than landfill processes. In a landfill, bacteria break down organics anaerobically (in absence of oxygen) and resulted in release of methane gas. However, in composting organic matter is decomposed using an aerobic process and produces no methane by product (zerbock, 2003). Contrary to the above benefits, composting has the distinction of being failed waste management system.

Reuse and Recycle

Reuse involves cleaning and using materials over and over. In other words, it means the use of a product more than once in its original form for the same or a new purpose. It relays on items that can be used over and over instead of throw away items. This method is used to decrease the use of matter and energy resources, cuts pollution, creates local jobs, and saves money (Miller, 2007). "Reusing is more efficient and better than recycling and composting methods because cleaning and reusing materials in their present form avoids the cost of energy for remaking them in to something else" (Cunningham,2008).

In addition to reuse, recycling is also an obvious solution of solid waste problem. It is an important way of collecting solid waste materials and turning them in to useful products that can be sold in the market place. Such materials can be reprocessed in two ways: primary and secondary.

"Primary recycling is a process in which original waste material is made back in to the same material for example, newspapers recycled to make newsprint. In secondary recycling, waste materials are made in to different products that may or may not be recyclable for instance, cardboard from waste newspapers" (Miller, 2007). Recycling is both environmental and economic issue. Many peoples are motivated to recycle because of environmental concern i.e. it reduces pollution, it also save energy, space and resources, helps to protect biodiversity and reduce litter. Economically, it can save money for items like paper, metals and some plastics, and generally it is important part of economy. However there are also some critics forwarded on recycling dominantly on economic aspect of its benefits. Economists say that recycling does not make sense if it costs more to recycle materials than to send them to a landfill or incineration. They also forwarded that recycling is often not needed to save landfill space because many areas are not running out of it (Miller, 2007).

2.1.6 Institutional Aspect of Municipal Solid Waste Management Service

2.1.6.1 Relationships between Institutional Structures and Municipal Solid Waste Management

It is a common perception that improving MSWM means making waste collection and disposal systems more efficient, raising public awareness and enforcing environmental MSWM laws. However, according to Antipolis (2000) in Obeng etal,(2008) "a prerequisite for all these factors is a well-planned management, operating within an enabling institutional framework, and capable of generating the financial resources required to meet operating, maintenance and investment costs. Otherwise, poorly managed facilities lead to declining service levels, which in turn reduce the chances of good cost recovery in terms of both willingness to charge and willingness to pay" (Obeng etal, 2008,p.1). In addition, several studies also point out the strength of institutional structure as a key underpinning factor to sustainable solid waste management. For example, (Schubeler et al, 1996) stated key

institutional structure issues associated with MSWM which are considered as the building blocks of an enabling institutional framework for MSWM. These are:

- Decentralization of responsibility of MSWM i.e. a corresponding distribution of powers.
- Private sector involvement and participation of communities and user groups. Private sector involvement in MSWM implies a shift in role of government institutions from service provision to regulation. As a result, create essential conditions for successful private sector.
- Capacity building measures for MSWM should give primary attention to strategic planning and financial management.
- The contribution of informal waste collection workers may be significantly improved through appropriate organizational measures (Schubeler et al, 1996).

2.1.6.2 Relationship between Institutional Capacity and Provision of Municipal Solid Waste Management

First of all, Institutional capacity means "the ability of institutions to perform functions, solve problems, and set and achieve objectives in a sustainable manner" (UNDP, 2008 in Abeje, 2009). According to Hilderbrand & Grindle's in Watson (2004) capacity of an institution to deliver municipal solid waste management is mainly depend on three factors. These include; 1) capacity of individuals to perform their job or tasks; 2) considerations of structure and culture characteristics of organization and its leadership; and 3) institutional context of public sector and expansion of the task network.

A. The capacity of individuals to perform job or tasks

Environmental capacity building initiatives have not only stressed the importance of organizational and institutional strengths, but also the abilities of agents, the role of human capital, technical expertise and functional skills needed to carry out environmental protection measures. In relation to solid waste management, "the capacity of an individual is expressed based on the will and ability to set MSWM objectives and achieve them using one's own knowledge and skill, linguistic competence, expertise, will and sense of responsibility" (JICAIIC, 2005). "Strengthening the efficiency of environmental protection through capacity

building has therefore focused increasingly on improving the skills of individuals through various forms of training because sustainable policy implementation capacity cannot be achieved without strengthening the ability of institutions and employees to carry out policy initiatives" (Hirschman, 1993cited in Watson, 2004,p.5).

B. Structure of the organization and task networks

For the purpose of evaluating institutional capacity for MSWM, it is more important to examine the present level of cooperation between government agencies charged with waste management responsibilities; the present state of solid waste management policy; efforts undertaken for its implementation and the level of cooperation between its implementing agencies; and the level of municipal government financial and decision-making autonomy for determining appropriate waste management options for their area (Hirschman,1993cited in Watson,2004).

Specifically, organizational capacity for MSWM can be viewed in terms of, human aspect (human resource in the engineering, management, and planning sections in MSWM, including the development of such resources), physical assets(facilities, equipment's, land, fund, and capital all required to provide MSWM), intellectual assets (expertise in MSWM system; statistical information including waste flows, literature; manuals; and research data, organization forms, management, leadership, and ownership that can put these assets to good use, and also a shared awareness with in organizations (JICAIIC, 2005).

C. Institutional context of the public sector and expansion of the task network

Institutional context refers to the environment and conditions necessary for demonstrating capabilities at the individual or organizational level, including the decision making process, systems and frame works necessary for the formation, implementation of policies and strategies that are over and above an organization. As a result, for better provision of solid waste management service it is necessary to have the following capacities;

- Formal legal framework, laws, decrees and ordinances that define wastes and clarify where the responsibility for waste management lies. And formal

regulations and standards on management, treatment and disposal of wastes; standards on waste generation rates, environmental standards; and legal force.

- Articulated solid waste management policies, policy objectives.
- Social infrastructure for solid waste management services, social organizations involved in solid waste management (CBOs), NGOs, formal and informal recycling markets and industries.
- partnership designed to ensure that the opinions of local residents and communities are taken account of good governance, involving a partnership between all stakeholders in MSWM, Social ownership of the implementation of solid waste management (public feeling, consensus or willingness to work together, etc. (JICAIIC, 2005).

2.2 Municipal Solid Waste Management in Developing Countries

The rapid extent and nature of urbanization in developing countries made MSWM as a major issue of concern in those countries. "In the next 35 years, the urban population of world is expected to be double to more than five billion people, and from this 90% of growth is taking place in developing countries" (World resource institute, 1997; in Ahmed and Ali, 2002,p.468). As a result of this, the existing MSWM of developing countries fail to catch up with the rapid increase of solid waste production in these countries. To show this situation, UNCHS (1996) cited in Schertenleib and Meyer (1992,p.1) report identified "one third to one half of solid waste generated with in most cities in low and middle income countries are not collected, rather it ends up as illegal dumps on streets, open spaces, and sewerage systems, and contribute to spread of diseases". Furthermore, MSWM schemes generally serve only part of the urban population. For instance, "in Kenya -Nairobi municipal solid waste collection service is mainly concerned in central business district and more affluent communities. As a result, in poor suburban zones indiscriminate disposal of solid waste at riversides, roadsides, and other open spaces are common" (Henry et al., 2005 cited in Gebrie, 2009, p.22).

The operational inefficiency of MSWM in developing countries is also further reflected in resource recovery. Although the material recovery from the waste stream has a great potential in economic as well as environmental point of view, municipality and formal private sector contribution in this activities is minimum. Besides this, waste disposal is also a neglected area in many low income countries and causes for environmental health hazards. Most of municipal solid wastes in developing countries are dumped on land in a more or less uncontrolled manner. These dumps make very uneconomical use of the available space, allow free access to waste pickers, animals and flies and often produce unpleasant and hazardous smoke from slow-burning fires (Zurbrugg, 2003).

2.2.1 Constraints of Municipal Solid Waste Management in Developing Countries

As it is noted earlier a typical solid waste management system in a developing country displays an array of problems including low collection coverage and irregular collection services, and crude open dumping and burning without air and water pollution control. These problems are caused by various factors which constrain development of effective municipal solid waste management systems. They can be categorized into technical, financial, institutional, social constraints, and awareness and attitudes (Ogawa, 2002). Each of these constraints is discussed below.

2.2.1.1 Human and Technical Constraints

In most developing countries, there is lack of human resources and technical expertise both at national and local levels. Many officers in charge of municipal solid waste management, particularly at the local level, have little or no technical background or training in engineering or management (Ogawa, 2002). This is a main reason for lack of comprehensive waste management planning in developing countries. Furthermore, collection and analysis of solid waste data are generally not given sufficient attention. As a result, there are few opportunities for waste management administrators to become experts and to formulate and implement waste management plans that are tailored to the actual situation in their country. This in turn makes it extremely difficult to license or develop technologies that are best suited to the local conditions

Moreover, research and development activities in municipal solid waste management have often low priority in developing countries. This lack of research and development activities in developing countries leads to selection of inappropriate technology in terms of local climatic and physical conditions, financial and human resource capabilities, and social or cultural acceptability. “Several guides or manuals on appropriate solid waste management technologies in developing countries are available in the literature, and selection of technology could be made sometimes based on these guides. However, in most cases these guides must be modified to local conditions prevailing in the country, and therefore local studies are normally still needed” (Ogawa, 2002).

2.2.1.2 Financial Constraints

MSWM is given low priority in developing countries; as a result, very limited funds are allocated to the sector by government. This problem is acute at the local government level where local revenue collection system is inadequately developed and financial base for public service including MSWM is weak. In addition to limited funds, many local governments in developing countries lack good financial management and planning. For instance, “in a developing country town over 90% of annual budget provided for solid waste management was used up within first six months. Lack of financial management and planning, particularly cost accounting depletes limited resources available for the sector even more quickly and causes solid waste management services to halt for some periods, thus losing trust of service users” Zurbrugg (2003) in Gebrie (2009).

2.2.1.3 Institutional Constraints

The waste management regime in developing countries is seldom integrated, and there is often no clear assignment of responsibilities and schedules among the organizations involved. Furthermore, there is often no umbrella organization to coordinate overlapping responsibilities for waste management that involve more than one agency. This situation not only hinders effective implementation of waste management operations, but also produces confusion in relation to technical cooperation and assistance projects among donors. Along with these organizational and structural problems, lack of an effective legal system and technical standards constitute a major

constraint. Legal provisions related to solid waste are often incorporated as fragmented elements in disparate laws, such as laws for public hygiene, local administration, and environment protection Generally speaking, there is no integrated legal framework to deal with waste management in developing countries.

2.2.1.4 Social Constraints

Social status of solid waste management workers is generally low both in developed and developing countries, but more severe in developing countries than developed countries. Such people's perception leads workers to disrespect their work and in turn produces poor quality of their work. At dump sites, transfer stations, and street refuse bins, waste picking or scavenging activities are common scenes in developing countries. People involved have not received school education and vocational training to obtain knowledge and skills required for other jobs. They are also affected by limited employment opportunity available in formal sector. The existence of waste pickers (scavengers) creates often an obstacle to the operation of solid waste collection and disposal services. However, if organized properly their activities can be effective in waste management system. Such an opportunistic approach is required for sustainable development of solid waste management programs in developing countries (Ogawa, 2002).

2.2.1.5 Awareness and Attitudes

Public awareness and attitudes to waste can affect the whole municipal solid waste management system. All steps in municipal solid waste management starting from household waste storage, to waste segregation, recycling, collection frequency, willingness to pay for waste management services, and opposition to sitting of waste treatment and disposal facilities depend on public awareness and participation. Thus, lack of public awareness and school education about the importance of proper solid waste management for health and well-being of people severely restricts use of community based approaches in developing countries and also crucial factor for failure of a MSWM service in developing countries (Zurbrugg, 2003).

2.2.2 Municipal Solid Waste Management in Ethiopia

Solid waste management is becoming a major public health and environmental concern in urban areas of Ethiopia. In Ethiopia, like developing countries, increase of solid waste generation is resulted from rapid urbanization and population booming. "The average solid waste generation rate is about 0.221kg per person per day and it is also estimated that only 2% of the population received solid waste collection services" (Zebenay, 2010). This shows that the operational condition of MSWM service and efforts made to change the situation are low. As a result, small proportions of the urban dwellers are served and large quantity of solid waste left uncollected. "The public sector in Ethiopia is unable to deliver services effectively, as result illegal dumping of solid waste along road sides and open areas is a common practice due to inadequate supply of waste containers and longer distance to these containers" (web page accessed, 2019). The involvement of private sectors are also very limited, but currently a number of micro and small scale enterprises are emerging to participate in primary solid waste collection i.e. collect garbage at source from households and transport it to the municipal waste containers and transfer points.

situation of MSWM in Ethiopia indicates that the problem of solid waste cannot be solved only by mere effort of municipal government, there should be large involvement of the private sectors in general and participation of micro enterprises and community in particular (Abebe,2006).

Waste Disposal

The safe and reliable long-term disposal of solid waste residues is an important component of integrated waste management (Tchobanoglous *et al*., 1977). Disposal is the ultimate fate of all solid wastes collected and transported to landfill site, incinerator, compost or other substances from the various solid waste processing plants that are of no further use to society.

The planning, designing and operation of modern landfills involve the application of a variety of scientific, engineering, and economic principles environmental concerns and regulatory requirements; types of landfill and landfill methods; landfill sitting considerations;

landfill gas management; landfill leach ate control; surface water control; landfill closure; post-closure care, etc. are some of the principles of modern landfill designing and operations (Tchobanoglous *et al*., 1993). Land filling is a very good method of waste disposal where solid wastes are well regulated and controlled. By compacting and covering the refuse with clay material, we can decrease smell and litter and we can discourage insects and rodent populations. Modern sanitary land filling is not a common practice in Ethiopia most probably due to unavailability of the necessary machineries and fear of running cost. Some developing countries use simple land filling methods just dumping wastes in low-lying areas, which are prone to flooding and.

These types of disposal operations can pose health hazards as well as pollutant of the air and water (Mantell, 1975). The wastes are exposed to the wind and rain, as well as rat, houseflies, birds and other vermin. There are also people who spend their time sorting through the garbage for edible or recyclable materials in a very risky way to health.

CONCEPTUAL FRAMEWORK

2.21.6 This part talks about the conceptual Framework that will guide the study**.** According to UNDP (2016), municipal solid waste management is a complex task which must go beyond purely technical considerations to political, institutional, social, financial, and economic aspects. Literature review, discussion with experts, empirical studies, and personal observation, the conceptual framework for the study is formulated.

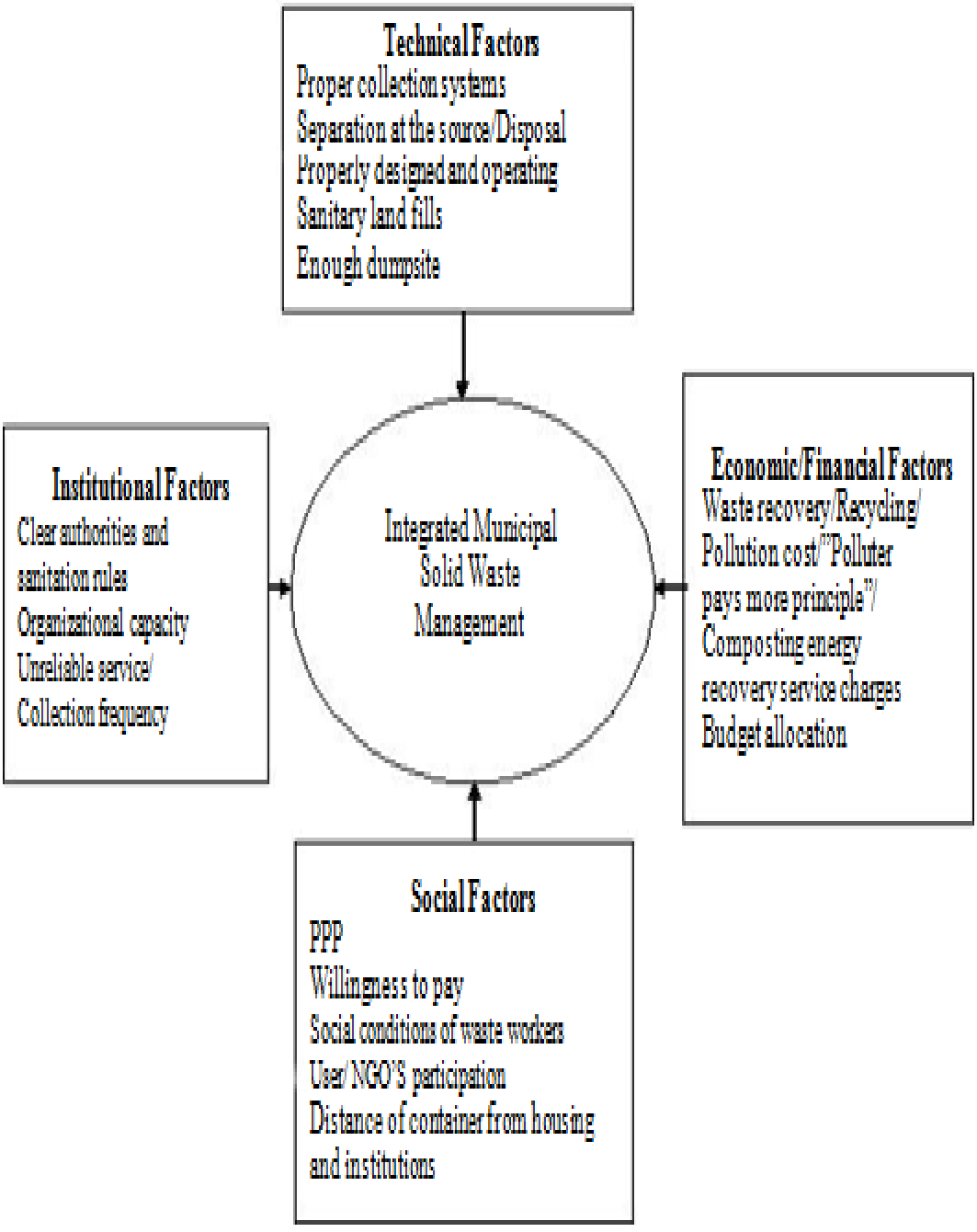


Figure 1: Conceptual Framework

CHAPTER THREE

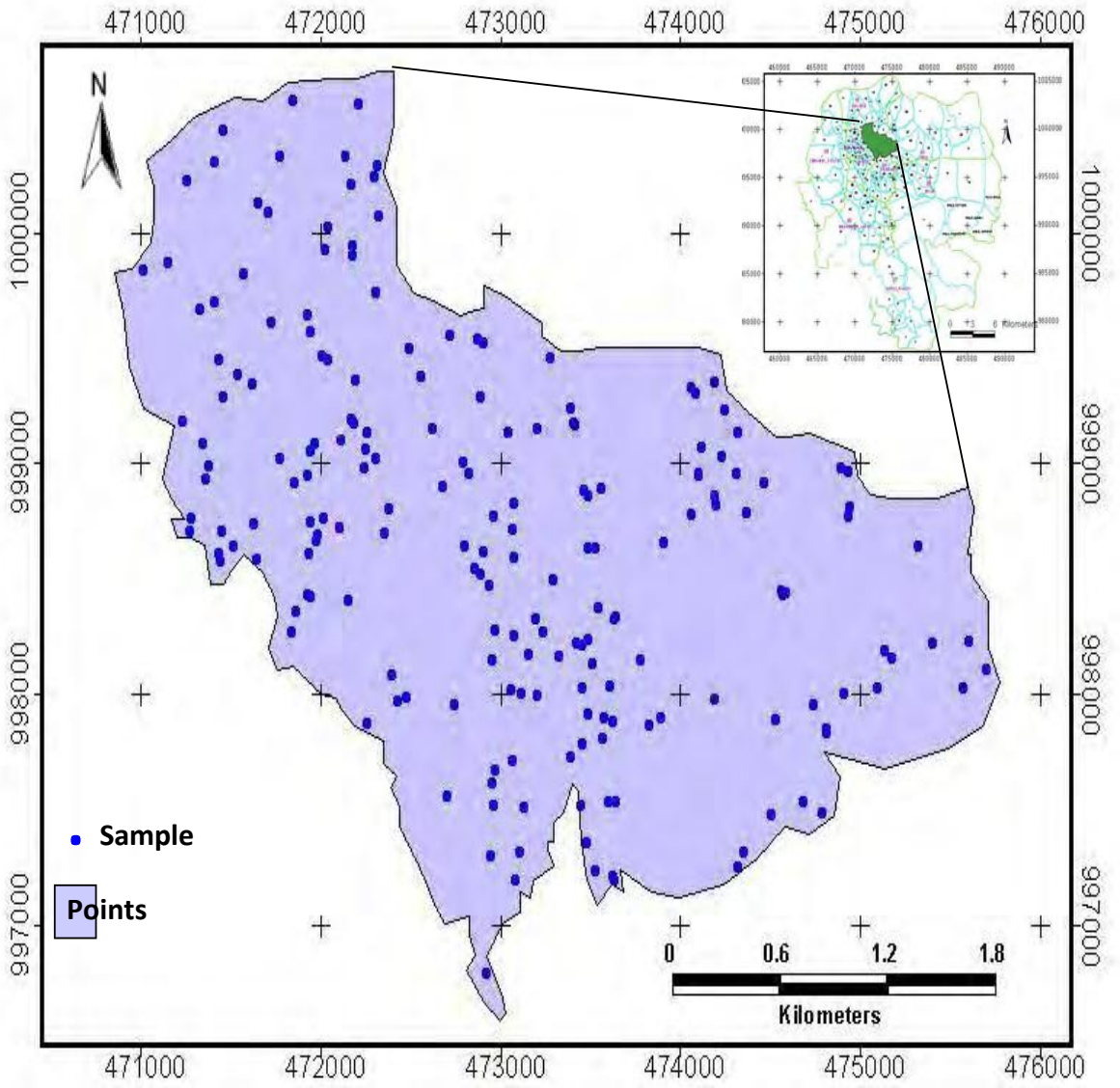
3. METHODOLOGE

This chapter describes historical, physical (location, topography, and climate) and socio economic back ground, such as demography, social and physical infrastructures, and economic activity of the study area .

3.1 Description of the Study Area

3.1.1 Location and Biophysical Situation of the Study Area

Arada sub city is one of the sub cities in Addis Ababa with an area of: 9.9 sq.km with Population 225,999 Male: 105,963 Female: (331,962) and 120,036 densities per sq.km and recently in the sub city due to the old settlement is changed by new settlement the total population size is has varied within a year. The sub city has 10 Weredas and the Location of the sub city is northern area of Addis Ababa 4 Kilo. The drainage system of the sub-city is defined by streams and rivers (Kebena, Akaki), which start from Entoto, run North to South within the city and drains to the Awash River The altitude of Arada sub-city ranges between 2300m and 2,500m A.S.L (AACAD, 2017). The lowest and the highest annual average temperature of Arada sub-city are about 10°C and 25°C.



Figre 2: Location map of Arada sub-city

3.1.2 Research Approach

The research design of this study was explanatory method. Because, it was more appropriate to describe the existing situation of MSWM service of Addis Ababa in Arada sub city by direct observation of the researcher and through grasping people and officials' responses, opinions, and perceptions about MSWM.

3.1.3 Data Source and Methods of date Collection

In this study, the researcher used both primary and secondary data sources. For gathering primary data researcher employed questionnaires, interviews, household survey, Semi-structured and structured interviews, questionnaires, field observation and focus group discussions (FGDs). Secondary data were collected from published and unpublished documents, With regard to questionnaires, there were two types of questionnaires (both open and close ended) which were prepared in order to look the MSWM practices and capacities of the Sub city together with the research mainly employed both qualitative and quantitative data were used whenever is necessary. Thus, both quantitative and qualitative data were collected from primary and secondary sources.

These questionnaires were first prepared in English but later it was translated in to Amharic for making it easily understandable to respondents. Moreover, primary data were also gathered with the help of semi structured and unstructured interviews with sanitation and solid waste management department head and workers about the overall institutional setting, capacity and constraints of the department.

Apart from these, the researcher used field observation and field measurement as major data sources for this study. Field observation was employed for assessing spatial distribution of MSWM infrastructures, households' solid waste handling practices, illegal dumping, solid waste collection and transportation systems and disposal site facilities of the sub city. Photographs were taken during field observation for partial exposure of transfer stations, disposal site, illegal dumping of residents. While, field measurement was carried out for investigating households' solid waste generation rate and physical composition.

On the other hand, secondary data were extracted from different sources including published and unpublished materials from administrative office, of the sub city, municipality.

3.1.4 Questionnaires

To collect primary data, structured and semi-structured questionnaire was prepared for selected respondents. The questionnaire was prepared in English and translated into Amharic language (if necessary) and it was distributed.

3.1.5 Interview with Key informants

Interviews allow researchers to gain access to information about events, opinions, and experiences while noting that people opinions and experiences vary across age, ethnicity, and sexuality and class (Hay 2008). Generally three interview where conducted.

3.1.6 Focus Group Discussion

Focus Group Discussions (FGDs) was employed to find out knowledge and participation of communities on SWM.

Two focus group discussions where conducted. Each focus group had ten (10) participants. Questions will be open ended to encourage respondents to take over the discussion and to allow multiple responses. In conducting focus groups, it is essential to establish 'rapport' between researcher and participants. The researcher was discussed to each participant prior to the application of the focus group discussion and the other data gathering instruments explaining the research aims and methods and answering any question they have about the study.

3.1.7 Personal observation

The main advantage of this method is that subjective bias is eliminated, if observation is done accurately. Secondly, the information obtained under this method relates to what is currently happening; it is not complicated by either the past behavior or future intentions or attitudes. Thirdly, this method is independent of respondents' willingness to respond and as such is relatively less demanding of active cooperation on the part of respondents as happens to be the case in the interview or the questionnaire method. This method is particularly suitable in studies, which deals with respondent, who are not capable of giving verbal reports of their feelings for one reason or the other (Kothari, 2004).

3.1.8 Sampling Procedures and Sample Size

Based on geographical location, population density and availability of different infrastructures the researcher selected 3woredas, from each stratum, using random sampling method. This was mainly because; the writer believed that those woredas located in each stratum have homogenous characteristics with respect to proximity to the center of the subcity, population density, and availability of infrastructures. As a result, taking one woreda from each stratum can be representative.

The researcher took a total sample size of 384 households from three sample woredas in general. This was decided by using scientific statistical method from (Kothari ,1990) .The formula that used for determining sample size was the following.

To determine the sample size, the following formula was employed (Kothari, 1990)

$$n = \frac{(P * (1.00 - P)}{e^2} * Z^2$$

Where:

n=Sample size

p= Estimated proportion of respondent. As the proportion was not known 0.5 was used as p value to obtain maximum number of the respondents. P = the proportion in the targeted population estimated to have characteristics being measured (from previous studies or studies in other comparable countries i.e. 0.8 from Melaku, 2008)

Z = The number of standard error corresponding to 95 percent interval which is 1.96

e= Margin of error that the researcher tolerate which is 0.05

Therefore: The total number of sample will be included in the study

$$= \frac{(0.5 * (1.00 - 0.5)}{0.05^2} * 1.96^2$$

=384

Therefore, n = 384 was the minimum sample size of households for reliable results. Finally, by using proportional allocation method the researcher was decided to take sample households from selected Wredas. These sample households was drawn for data collection using simple random sampling method.

3.2.8 Sampling procedure

In order to collect primary data, the researcher used three different sample sizes with different sampling procedures. In all cases, sample sizes were determined by considering financial, time and resource constraints.

The first sample size was designed for collection of data from households on their solid waste management practice, and their attitude towards MSWM practice of the sub city. For deciding this sample size and selecting samples, the researcher used three stages. The first stage was classifying 11 Woredas of the sub city in to 3 separate strata namely inner (close to the center), middle (located in the middle distance to the center), and periphery.

The researcher selected three woredas. based on the intended objectives of the study, both probability and purposive sampling techniques were employed in the study purposive sampling used to gather general information with the issues understudy to provide the general information required to realize the objectives of the study. And probability sampling technique was used to select sample households/respondents of the survey from the target population.

A total of three thousands seventy nine households living/residing in the three/3/ woredas of the sub city were the target population of the survey. As some studies suggest for social science the researcher by his convenience could select the minimum portion (10% to 30%) of the total population (S,arantakos. 2005).

Table 3.1: Selection of Sample Household

Group	Woreda	Sample woredas	Total number of HHs (N)	Sample HHs (n)
Woreda close to center	**1,4, 6 ,**	**Woreda 4**	**903**	**112**
Woreda located in middle	**5,2,6,7**	**Woreda 6**	**1300**	**162**
Woreda located in periphery	**9,10,11,12,**	**Woreda 10**	**883**	**110**
		Total	**3079**	**384**

3.2.9 Method of Data Analysis

Both qualitative and quantitative techniques were used for data analysis. Quantitative methods include percentages, means, graphical and tabular analysis, maps, ratios, rates and frequency distribution.

3.2.10 Ethical consideration

At the very begging letter of support was written by college of Social science, Department of Geography and Environmental studies, Addis Ababa University. Following the letter Arada sub city administration council wrote a letter to all respect offices to assist the researcher in providing data for the research work.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 Introduction

Arada sub city is one of the populous, and fast growing sub cities of Addis Ababa. It is also known by being a trade and communication center unlike these features of the sub city, municipal solid waste management service provision for its residents was not a recent phenomenon. However in paradox with this, MSWM service delivery, solid waste generation of the sub city was continued to grow and currently it has reached to 32188 m^3/ annum (Sub city report, 2019). As a result of this, huge generation of solid waste, the sub city residents considered MSWM as a necessary and vital urban service. For instance, from total 384 sample households of the sub city around 171 (71.54%) of the respondents are believed in regarding this service as a burning urban service, just like road, water and electricity. This is because absence of qualified and efficient municipal solid waste management service exposed them to various health and environmental impacts.

On the other hand, respondents are also asked to evaluate the effort made by the sub city to provide efficient municipal solid waste management service compared with other services of the sub city. The majority 220 (92.05%) of them responded that the sub city has made weak effort in improving the current situation of MSWM system. For this reason, this chapter briefly discussed and evaluated the existing condition of MSWM service in general and household solid waste management practice in particular.

4.2 Socio Economic and Demographic Characteristics of Sample Households

Because of solid waste generation and its handling shows a great variation related with difference in background characteristics of households, in this study the researcher tried to constitute different sample households with various socio economic and demographic characteristics. In this study more than half (53.1. %) of them are females.. Besides this, out of the total respondents about 69.1 % are belong to adult age group (20-50 ages).

Table 4.1: Socio economic and demographic characteristics of respondents

Variables	Category	Frequency	Percentage
Sex	Male	180	46.8 %
	Female	204	53.1%
	Total	384	100 %
Age	15-19	70	18.2 %
	20-30	90	23.4 %
	31-40	87	22.6 %
	41-50	89	23.1 %
	51-60	34	8.9%
	Total	384	100 %
Educational level	1-4 grade complete	75	19 .1 %
	5-8 grades complete	57	14.8 %
	9-12 grades complete	65	16.9%
	Certificate	56	14.5%
	Diploma	45	11.7 %
	First degree	60	15.6 %
	Second degree and above	26	6.7 %
	Total	384	100 %
House ownership condition	Keble rental house	67	17.4 %
	private rental house	95	24.7 %
	private house	164	42.7 %
	Total	384	100 %
Family size	1-3	145	37.7 %
	4-6	122	31.7 %
	7-9	29	7.5 %
	10 and above	88	22.9 %
	Total	384	100 %
Average monthly income	Less than 500	99	25.7 %
	501-1000	87	22.6 %
	1001-1500	55	14.3%
	1500-2000	40	10.41%
	Greater than 2000	50	13 %
	Not mentioned	53	13.8%
	Total	384	%

Source: Survey data, 2019

Furthermore, with respect to educational level, greater numbers of respondents (16.9 %) have educational level of 9-12 grades complete. Next to this diploma Certificate (14.5. %) has relatively great share. These educational characteristics of sample households also resulted positive impact to get brief and different perceptions. Finally, income level of participated households' also illustrated in table 4.1. Households were categorized into five

groups based on their monthly household income. Thus, dominant (25.7 %) number of sample households' average income is grouped in the first category who earns less than 500 birr per month. But the least numb of households (13. %) are clustered in category five that earn greater than 2000 birr. So that income level determine the amount and type of solid waste.

4.3 Characteristics of Municipal Solid Waste in Arada sub city

One of the basic services that are currently receiving wide attention in many towns of Ethiopia is municipal solid waste management. This is mainly because solid wastes that are generated in most towns of Ethiopia are not appropriately handled and managed. However, it is possible to minimize and solve these problems through strictly planning and implementing different municipal solid waste management components. The first and the most prerequisite step for provision of efficient MSWM is began by identification of major sources, and determination of generation rate and composition of municipal solid waste. This is because these elements are considered as a baseline for the rest of municipal solid waste management components. Therefore, for appropriate management of municipal solid waste of Arada sub city, reliable and accurate data about these elements is very decisive. Despite this, Arada sub city sanitation and solid waste management department gave less attention. For instance, regarding the sub city residential solid waste composition and generation rate, there has been lack of frequent and ongoing surveys opposed to frequent variation characteristics of it. Furthermore, those available data are also scattered and unorganized. In order to fill this gap a researcher investigated household solid waste generation rate and physical composition since the majority of solid waste constituents of the sub city are comes from households.

4.3.1 Municipal Solid Waste Sources and Their Solid Waste Generation

Municipal solid waste consists of highly heterogeneous mass of discarded materials from urban residences, commercial establishments, institutions, street sweepings, and light industrial activities. Similarly, according to Arada sub city sanitation and solid waste management department (2019) there are five major sources of MSW of the Sub city. These are residential areas, commercial areas, street sweeping, institutions, and small scale industries. Based on this report, the daily total solid waste generation of these sources is around (32,188m^3) and annually it reaches to (11,587,680m^3 /annum).

Table 4.2: Major solid waste sources and their daily and annual generation in 2019

Source of solid waste	Solid waste generated per day(in M3)	Solid waste generated per annual (in m3	Percentage Share
Residential areas	52.8	19312.8	60 %
Commercial areas	16.72	6115.72	19%
Street sweeping	9.68	3540.68	11%
Institutions	7.04	2575.04	8 %
Small scale industry	1.76	643.76	2 %
Total	88.00	32,188	100 %

Source. SSWMD report, 2019

Table 4.2 revealed that the lion share (60%) of solid waste of the sub city is generated from residential areas. Even if massive amount of solid waste of the sub city is generated from this source, the sub city did not give much weight for it in planning and implementation process of MSWM. For example, in order to make plan to the sub city solid waste management has used daily and annual household solid waste generation of 52.8 (19536 kg) and 19312.8 (7145736 kg) respectively using **0.786**/day generation rate as constant. However, based on this study the daily and annual generation rate of household of the sub city is much greater than the above estimation of the department. For making this survey researcher identified 36 households who are not involved in any type of business activities. Based on their monthly income, ownership status of household residence and housing condition, they were categorized in to higher, middle, and lower income groups. After this researcher gave plastic containers for each household and measure their solid waste for seven consecutive days in difference months. The findings of this survey are summarized in table 4.3.

Table 4.3: Solid waste generation rate of households in 2019

Income groups	No of sample HHs	Family size	Qt/HH/week(kg)	Qt/HH/day(kg)	Generation rate of a group Qt/day/person(kg)
Higher	6	40	85.3	12.186	0.3
Middle	12	59	101.6	14.514	0.246
Lower	18	93	165	23.572	0.24
Total	36	192	351.9	50.272	**0.786**

Source: field survey,(2019)

Daily total solid waste generation rate of residential areas of the sub city is calculated as total population of the sub city (331,962) times per capita household solid waste generation rate. Based on the per capita household generation rate of 0.786kg =260,922.1kg /day. Indicated in table 4.3, daily total solid waste generation is 260,922.1, kg the annual total generation of solid waste is also daily total solid waste generation times 365 days it reached 952,365,665 kg annually. However, when this generation rate is compared with the sub city SSWMD existing capacity to handle ling this amount of solid wastes it is very high and created high load for the department.

4.3.2 Composition of Municipal Solid Waste

As it is indicated in review of literature part municipal solid waste is a term usually applied to a various mixtures of solid wastes produced in urban areas. But commonly urban wastes can be subdivided into two major components called biodegradable and non-biodegradable. The biodegradable component of urban solid waste constitutes organic wastes such as food waste, garden waste, and agricultural waste which undergo biological degradation under controlled conditions and can be turned into compost or organic fertilizer. While non-biodegradable wastes includes inorganic materials which can't be decomposed and degraded. Likewise, from my own observations in disposal site, illegally dumping areas and in residential areas, Arada sub city physical composition of municipal solid waste is also composed from both biodegradable and non-degradable components.

The dominant types of biodegradable solid wastes are food leftovers, vegetable peelings, onion, seed coats, grasses, kitchen and garden wastes, animal wastes, ash, dust, leaves, scarp of chat, market place wastes (vegetable and fruit wastes), papers, wood scraps, bones, straw, dead animals, cardboard, cartons and paper packaging materials etc. Whereas non-biodegradable wastes of the town includes different types of plastics(like plastic bags or "festals", broken pieces of plastic materials, plastic packaging materials), cables and useless electronic materials, pieces of ceramics, glass, cans, pieces of metals, textile scraps, discarded old shoes, packaging materials, etc.

Figure 3: Partial view of biodegradable and non-biodegradable solid wastes generated. Source: field survey, (2019)

Apart from these, construction and demolition waste that is generated during the course of repair, construction, and destruction activities constituting sands, soil stones, nails, cement concrete, wood, and so on, are also observed in the sub city. This is due to high construction activities of the sub city and such wastes are not stored by waste generator within their compound rather they deposited just outside in streets and open areas. Different types of medical waste such as syringes, gloves, glucose materials etc. from hospitals, clinics, and other health care establishments are also detected in different disposal areas of the sub city. But such wastes should be managed carefully and separately from the above types of solid wastes because of its hazardous health impacts.

Figure 4: Partial view of medical solid wastes. Source: field survey, 2019

Though the sub city municipal solid waste is comprised from the above listed solid waste fractions, it is dominated by organic waste streams generated from households, markets and commercial areas. The main reason behind this is about 60 % of MSW of the sub city arises from residential areas and this source is dominantly characterized by biodegradable solid wastes. To reach this conclusion the researcher made measurement on major solid waste composition of households by sorting and weighting it for seven continuous days from 36 houses in conjunction with solid waste generation rate measurement.

Table 4.4: Composition of residential solid waste

Category	**Type of solid waste**	**Qt/day/person in Kg**	**percentage share**
Biodegradable Waste	Ash and dust	0.1028	13.7%
	Food waste	0.4211	11.69%
	Grass, leaf, straw, paper, cardboard, and wood scarp	0.4211	53.57%
Non Biodegradable	Plastic, textiles and leathers	0.0797	10.1%
	Glass, ceramics and metals	0.0918	11.6%
Total		**0.786**	100%

Source : (field survey, 2019)

As it is expected in developing countries, around 25.39% of households solid waste stream of the sub city is covered by biodegradable waste such as ash and dust (13.7%), and food waste (11.69%). This is because majorities of the population frequently generate dust, and uses wood and charcoal as energy source. Food wastes also generate from house cooking, food slip and fruits. This condition is appropriate and sustainable method for composting. In addition to this, there should also be an activity of reuse and recycle for those inorganic materials even if their proportion seems insignificant. Otherwise, in the long run those solid wastes may deteriorate the human health and the town environment.

4.4 Solid Waste Storage Facility and Its Handling in Arada sub city

This functional element of MSWM constitutes an activity that is carried out both by solid waste generators and solid waste managers of the sub city. It encompasses an action of storing solid waste in a certain kind of material or equipment as soon as it is generated and safe control of it until it is permanently disposed. Accordingly, studying solid waste storage facilities and their handling has 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 (G/tsadkan, 2002). As a result of this, the researcher collects information about solid waste storage and handling practice of the sub city and briefly explains in two categories. The first category constitutes primary or temporary storage facility of households, while second category comprises secondary or communal storage facility of the sub city which includes public solid waste container and dustbins. The detail examination of both of these storage facilities is described in the following sections.

4.4.1 Primary Solid Waste Storage Facility and Its Handling

Residents of the sub city used different type storage materials in their compound which is stationary like pit and portable like sack. In order to assess type and quantity of storage materials of residents, around 384 households were asked. The result has shown that 78.24 % have one storage material, while the remaining 21.76 % have two storage materials. But, on the type of storage materials used by households there is high variation.

This is mainly because the nature of storage material of households is depend on characteristics of solid waste (rate of generation, physical and chemical composition, moisture content of waste etc.), collection frequency and types of collection equipment, space available for placement of the storage materials, and economic power of solid waste generators (Techobanglous, 1977 and 1993 cited in G/tsadkan, 2002). The concrete evidence of this situation is shown in the following

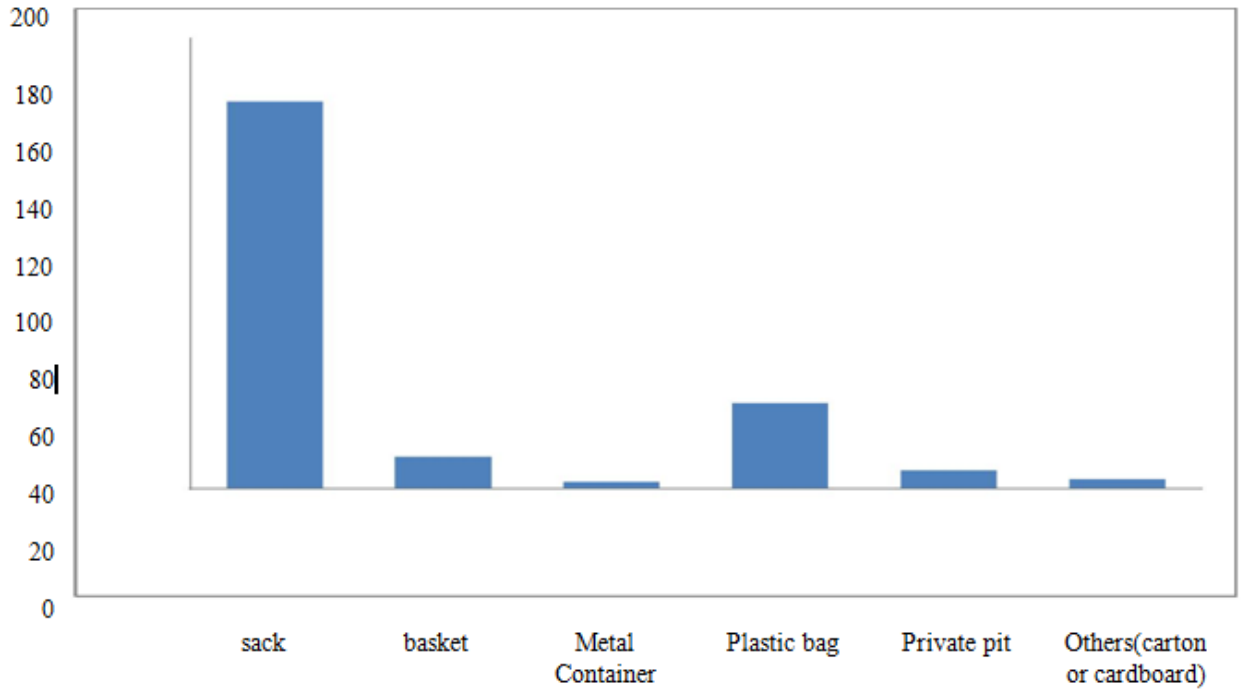


Figure 5: Types of primary solid waste storage materials of households. Source: field survey, (2019)

As it is clearly observed in figure 4.1, the majority of households (44.2. %) stock up their solid waste in sack ("Madaberiya"). This is highly related with the least cost of sack, easily availability in the market, its suitability for holding large volume of solid wastes, and low frequency and spatial coverage of door to door solid waste collection service of the sub city. Next to sack, about 10.4 % of households use plastic bag followed by basket (5.2 %) because of their frequent but low generation of waste and economic power to utilize replicable storage materials such as plastic bags.

Following these there are households that use private pit (1.3 %) and cardboard (1.4 %) as

storage material of solid waste in their home. This is due to availability of space in their compound and households need to prepare fertilizer for vegetable growing. But, the least used storage material is metallic container (1.2 %). This is essentially because of its difficulty for transportation, high cost and low access in market.

Figure 6: Partial view of solid waste storage materials of households. Source: field survey

Ha ever different from preparation and usage of storage material, most of the residents do not have well established handling practices and give low attention for it. The storage materials of households are characterized by unpleasant feature resulted by inappropriate handling, and drop out of solid waste around storage material. Majority of households are also located it very near to houses especially in condominium houses storage materials are placed inside the house due to absence of space.

4.4.2 Secondary solid waste storage facilities and their handling

Secondary storage facilities refers to different types of solid waste containers which involve 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 sub city solid waste management department. Until early 2019 Arada sub city put 87 public solid waste containers in different areas of the sub city where frequent illegal dumping of waste was mostly occurred, and in areas where high population density is assumed to exist. Residents around those containers were highly exposed and attacked by different solid waste

caused diseases (sub city annual Report 2018). This is mainly due to lifter truck being out of service and absence of frequent collection of those public solid waste containers. As a result, the sub city SSMD was forced to collect those public solid waste containers instead of serving the intended purpose.

These sites are found at the edge of main roads in order to make such places accessible for transportation. However, in many cases those transfer stations are not well designed, not protected from rain and sun. They are just road side open dumps without any health and aesthetic impact considerations and optimum travel distance of beneficiaries. So, those sites are created bad smell, unsightly urban picture, and deterioration of the neighborhood .According to interview made with the sub city head of SSWMD, those transfer stations give service only to MSSE workers who collect solid waste from households, institutions and commercial areas. But regulation is made by the sub city. It stated that in order to use transfer stations one should have to accumulate waste by using sack and also he/she should load his/her accumulated waste by waiting municipality truck until it comes.

Figure 7: Typical solid wastes transfer stations and their respective users (MSSE solid waste collectors). Source: field survey, 2019

However, in some transfer stations such as in front of Basha welde condominium, piyasa ,seratena sefer ,eri bekentu etc indiscriminately dispose waste without storing it by sack or any other storage material. As a result of this, it is common to observe accumulated solid wastes in such transfer stations of the sub city.

Figure 8: Partial view of solid wastes transfer stations (Piyasa Eri bekentu) which are characterized by indiscriminate disposal of HHs. Source: field survey,(2019)

Besides this, those fifteen transfer stations are also characterized by uneven distribution both in terms of distance from beneficiaries specific locations. When we go far from the center numbers of transfer stations are decreased in relation with low solid waste collection service of MSSE and municipality truck. On the contrary, distance between each transfer stations

and illegal disposal of solid waste are increased as we go out of the center to the periphery of the sub city.

Majority of transfer stations (about 5 of them) are situated in woreda which are located close to the center. But in periphery there are no transfer stations at all. This situation clearly shows that there is very low spatial coverage of secondary solid waste storage facilities in the sub city. Apart from transfer stations, there are also dustbins which used to collect pedestrians' litters waste like napkins, pieces of paper, and remains of fruits such as banana, orange etc. Nevertheless, according to the interview taken from the sub city SSWMD head, there were around 200 dust bins that were located at the major roads, recreational areas, institution and market areas, but most of them are stolen and currently the number of dustbin in the sub city are highly decreased . The main reason behind this was placement of dust bins were not well cemented in to ground since it is easy to move and pick.

4.5 Solid Waste Separation, Processing and Recovery Activities in Arada sub city

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 lifespan 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. However, in the case of Arada sub city such activities are found at a very grass root level without any significant outcome and progress. Generally, in the following sections we will see the separation, processing and recovery activities both at the households and sub city level.

4.5.1 Solid Waste Separation, Processing and Recovery Activities of Households

A. Solid waste separation

As the researcher tried to observe households solid waste separation activities in the sub city, only solid wastes that are sellable to Quraleos, exchangeable to Liwach, and to some extent organic wastes are separated. Supporting to researcher's observation, response of sample also shows that about 69.76% separately store solid wastes which are sellable to "Quraleos" and exchangeable with "Liwach". According to those respondents the dominant types of such wastes include: textile and old shoes (30.23 %), tin and metals (26.67 %), plastics (18.78 %), glass, bottles, and can (13.33 %), and electronic wastes (3.64 %). Households' awareness about usefulness of such discarded wastes for Quraleos and Liwach together with their low economic performance led households to separately store such wastes and generate income and new equipments to their house.

However, beyond such solid wastes, separation of other types of solid wastes in different dwellings of the sub city is very low, only 40 (10.4%) of sample households are currently separating. Some of solid wastes that are separated by such small number of households are:

- ash, dust, , and food wastes for the purpose of using it as home garden
- grass, leaf, wood scrap, waste of chat to use them as fuel
- Plastic, paper and other burnable solid wastes for reducing the volume of waste by burning.

B. Resource recovery activities

In order to assess resource recovery activity of residents the researcher used recycling, reusing and composting activities as a baseline and tried to collect the responses of sample households. Accordingly, it is found that participation of the society is still very low, even as it is compared to separation of solid waste. From the very beginning the number of respondents who have awareness about the concept of recycling, reusing, and preparation of compost are low 34.28 % This fact demonstrates that there is lack of awareness about sustainable solid waste management practices within the society since reusing, recycling and composting concepts are considered as pillars of sustainable solid waste management.

Aside from awareness of the society, the numbers of respondents who are currently practicing such activities are also very insignificant in number. About 40 (10.4 %) of them are carried out reusing. The major types of materials which are reused by the society are glasses, bottles, metallic materials, plastic materials, textiles, and umbrellas with accompanying some sanitation and maintenance activities by themselves or through taking it to maintenance experts. In terms of recycling, none of the respondents are practicing this task. The main reason behind low recycling and reusing activities of the society is their less interest and very low economic feasibility of recycled materials. Even though few people have interest to practice such activities, lack of technical ability, financial capacity, material and space, and absence of support from their family and society discouraged them.

On the other dimension, 5 (1.3 %) respondents are presently preparing compost. But, based on the response of those respondents and my own observation most of compost preparation activities of households are failed due to lack of technical skill of compost preparation.

Figure 9: Partial view of households composting activity. Source: (field survey, 2019)

4.5.2 Solid Waste Separation, Processing and Recovery Activities

Even though the rapid pace of urbanization of Addis Ababa and parallel increment of its solid waste volume are adding burden to sanitation and solid waste management office of the sub city, the existing waste composition of the sub city which carries a high potential for composting create a better chance to municipality for undertaking environmentally as well as economically viable for urban agriculture.

Understands this potential resource and included it as one strategic plan of the department. However, contrary to their strategic plan sanitation and solid waste management office of the sub city has not carried out any type of composting activity. Towards recycling and reusing the department does not also make any attempt, rather it is totally engaged in collection, transfer, and final disposal of solid waste as the only means of municipal solid waste management. This is attributed to lack of commitment, finance, material, and manpower resource. Furthermore, to fill this gap the department did not also play any role in organizing, encouraging, and giving incentives to different stakeholders such as informal workers, private investors, NGOs, and communities to participate in such activities. For instance, in the sub city there is a recycling activity held by hand crafts through scavenging recyclable materials using informal waste collector called Quraleos.) And used metal, tin cans, oil containers, etc. to produce a variety of materials like container, fuel saving stove etc. .

4.6 Solid Waste Collection and Transportation Systems in Arada sub city

Collection and transportation of solid waste involves the process of picking up of waste from place of generation, taking it to nearby public solid waste containers or transfer stations, and finally dumping it to disposal site. This functional element is very decisive and mandatory component of municipal solid waste management because productivity and efficiency of this service is highly determined by it. Currently, in Arada sub city there are two methods of waste collection such as door to door and transfer stations collection.

4.6.1 Door to Door Solid Waste Collection and Transportation Systems

This method is largely implemented for collection of solid waste from residential areas. It is provided by MSSE and rarely by municipality collection trucks. But the service of MSSE is

reached to very small number of residents. Currently in Arada sub city there are 15 MSSE which engaged in deliver of solid waste collection service to the sub city residents.

Table 4.5: Overall characteristics of MSSE solid waste collectors in 2019.

List of MSSE	No of client		Average service charge		No of equipment	No of man Power
	HHs	Hotels and institutions	HHs	Hotels		
Edget beseta	676	9	20-15		4	22
Selam berhan	760	35	10-15	30-50	3	10
Tesfa	162	3	20-30	30-50	1 cart	6
Berta	189	6	5-15	50-300	1	5
Lwet Besera	321	2	10-15	50	-	8
Total	2,108	55			9	51

Source: field survey, 2019

According to the personal interviews with MSSE leaders, Ato Teshome they have around 2,108 clients and they charged 20-30 birr per month from households and 30-300 birr for institutions and hotels based on amount of solid waste and distance from the transfer stations. They collect solid waste from residents with one weak interval. When this figure is compared to total household size of the sub city (331,962) it only covers 0.63.5 % of them. This is largely attributed to small number of MSSEs and their less human and material capacity. But, 67.64 % of sub city workers and 20% of sample households' appreciate MSSE effort and give fair price to them. Related with this, the researcher observed that they are being operating and contributing to the cleanness of the town. Nonetheless, due to multidimensional challenges they did not optimally utilize their efforts. Those challenges are: Scarcity of equipment's. For instance Lewet bsera MSSE has no any type of collection equipment and they simply collect solid waste by human power, while Berta and Selam Brehan only have 1cart for each. Generally all MSSEs have 51 members but their total number of cart 9 i.e. 1cart for 6 workers.

As a result of this according to interview made with the sub city department head Ato Negatu they didn't do full day rather they are working by shift. Lack of support from different stakeholders such as NGOs, MSSE office etc. made the work difficult. The MSSE office of the sub city refused to give credit to them for purchasing equipment's and collection vehicle. Shortage of collection car. Lack of respect from the community as well as municipality and unwillingness of some households to pay for MSSE monthly collection fee after used the service aggravated the problem. So, In order to solve the problem of the sub city MSWM the municipality as well as the community should support them and should work a lot of activities to improve them.

Similar to MSSEs, door to door collection of municipality truck also reached only to very few residents (7.18 % of respondents) who are situated in central part of the town and along the main roads are accessed to get this service. Even those residents have to wait for unknown period for the truck to come and collect waste. People usually carry waste to the main road and wait for the truck. Due to unknown collection schedule people may wait for the whole day and finally they either deal with informal collectors or dump in illegal place (River side etc.)

Finally, these small contribution and very limited spatial coverage of MSSEs and municipality truck together with unwillingness and incapability of households to pay monthly charge of MSSE, lead large number of households turn their face to use informal collectors.

4.6.2 Collection and Transportation of Solid Waste from Transfer Stations

According to the interview taken from head of Solid waste management office of the sub city and my own field observations, in the sub city there are three lifter trucks which are currently functional and used for transportation of solid waste from transfer stations to final disposal site by loading metallic solid waste container. The vehicle carries only a single container with a maximum capacity of (2960kg) at a time. On average, the vehicle make about one trips per day from 15 transfer station instead of making 4 trips within a day. However, the vehicles did not collect waste daily from each 15 transfer station, it collected

maximum of from nine transfer station within a day.

These situations made the sub city municipal solid waste collection and transportation to be very low. I.e. on the basis of 1 trips, total amount of solid waste which is daily collected and transported by municipality is 26640g (2960kg ×1 trips from 9 transfer station (9x2960 x one trips=26640). But the actual daily generated solid waste from all solid waste sources of the sub city is 32188 k. Therefore, only 82.7.% of municipal solid waste of the town is collected and transported. But the remaining 17.3. % (5548kg) of solid wastes left is uncollected. This clearly indicates within a month it reached 166, 440, kg is unmanaged. This fact showed how the sub city municipal solid waste management is very poor and below expectation.

4.7 Street Sweeping Activity in Arada sub city

In addition to collection of solid waste from transfer stations, street sweeping is also included in municipal solid waste management service offered by the municipality. For cleaning these roads about 54 women sanitation workers are employed. Street sweeping takes place every day since it needs to be done more frequently because of no street dustbins and regular generation of solid wastes like napkins, pieces of paper, residual vegetables and fruits such as banana, orange etc. The street sweepers are separately spaced on streets, and clean roads using brooms that gifted from the department.

However, from my own observation and interview made with solid waste management department head, there is serious shortage of manpower for street sweeping. The existing employees are not able to cover all streets. Most of street sweeping takes place around the center of the town where streets are busy with many activities. Moreover, residents are very careless to clean their front yards and street and see it as the responsibility of the municipality. For example, about 82.41 % of respondents clean their houses in every day. But, annually most of residents (43.76 %) participated on cleaning campaigns of their surroundings on average 3-4 times. This clearly shows how communities give little attention to clean their surroundings. Much of the residents of the sub city are only stressed to protect their home but they do not care for others. Whatever the case may be, it is becoming a common problem both for local people and municipality.

4.8 Solid Waste Disposal Practices in Arada Sub city

4.8.1 Households' Solid Waste Disposal Practices

As it is described earlier, door to door solid waste collection of the sub city is very insignificant both in spatial coverage and efficiency. As a result, the only solid waste option of majority households is restricted to two choices. The first one is simply burning, burying, or dumping of solid waste in their compounds. While the second option is throwing of solid waste at roadsides, open fields, nearby rivers, bridges and gullies. Hence in order to assess the routine method of solid waste disposal practices of households and to know the destination of uncollected solid wastes, the researcher asked sample respondents about their common disposal system.

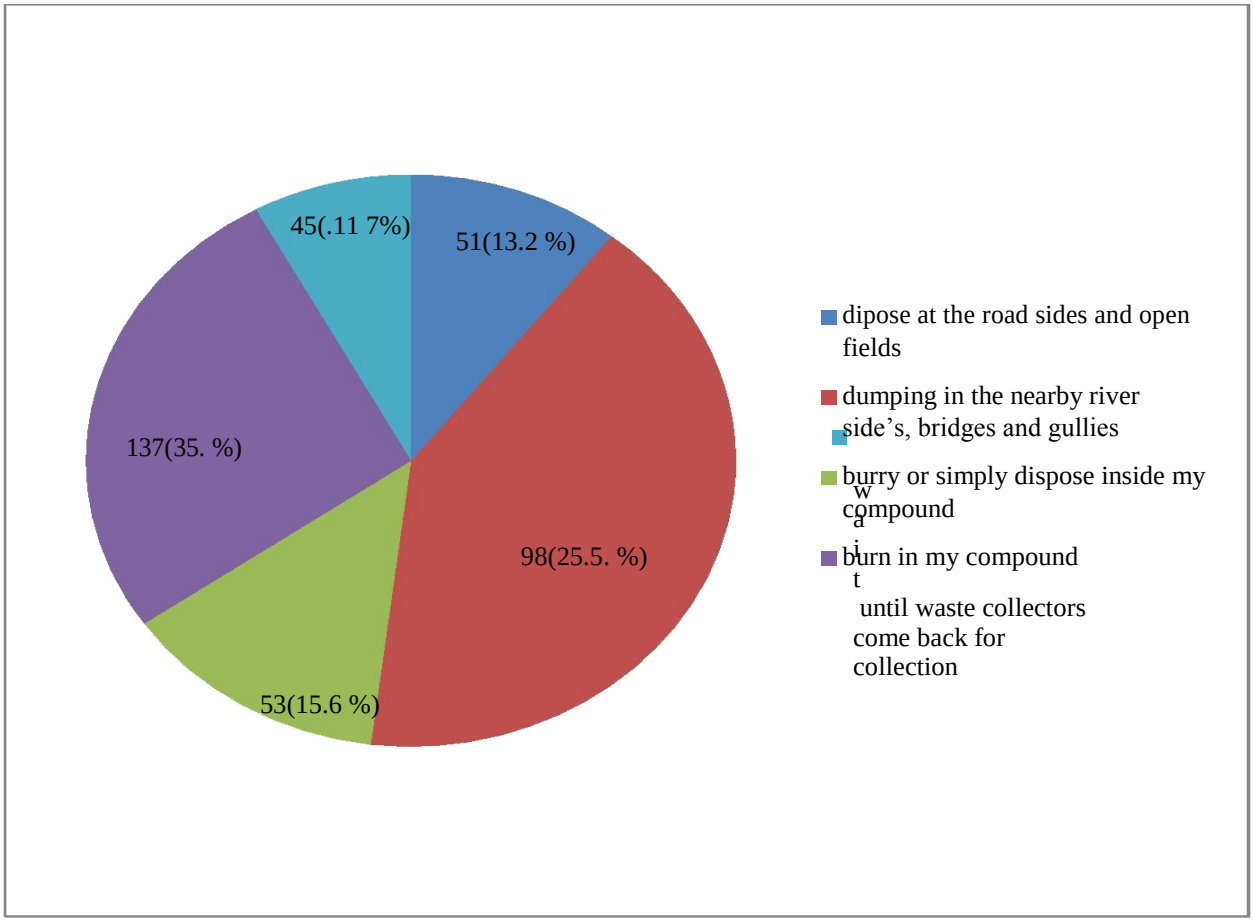


Figure10: Households solid waste disposal practices. Source: field survey, 2019

Quit large numbers of households (54.3%) preferred improper and unauthorized solid waste practices. This confirmed that the destination of the majority of uncollected solid wastes of households are in roads, sewers ,river banks, valleys, gullies, bridges, and open areas. This improper disposal of solid waste exposed communities to different respiratory and water borne diseases.

The major reasons behind this illegal disposal of solid waste of residents are lack of clear and adequate awareness about proper solid waste management system, cultural constraint which forces the society to give low emphasis to sustainable solid waste management, lack of door to door solid waste collection service, and absence of public solid waste containers.

For instance, at the HH level residents are responsible for storing waste in a proper way and disposing it in right and authorized manner using either MSSE, municipality vehicle or burning and burring, but the HH did not actively participate in using such activities rather most of them handle and disposed improperly. In support of this from the total respondents' large number of (62.76%) sample household also do not have taken education and training about solid waste management by responsible body of the town. But, around 94.14% of them are interested to learn more about solid waste management, environmental impact of waste, and various ways of minimizing and treating the waste stream. The method to receive the education by those respondents preferred was dominantly on meetings (15.1.%) , Brochure 20.3%, solid waste management campaign (23.4%), door to door 23.17% , newsletter and magazine 21.8%, Radio and television 10.1% Through community organization 19.7%

Table 4.6: Households' choice of methods to receive education on solid waste management

Methods of educating households	Frequency	Percentage (%)
Meeting	58	15.1%
Brochures distributed to residents	78	20.3%
Solid waste management campaign	90	23.4%
door to door education	89	23.17%
Educational programs newsletter and magazines	84	21.8%
Educational programs in radio and television	76	10.1%
Through community organizations	69	19.7%
Total	544	100%

Source: field survey, 2019

4.8.2 Existing Situation and Management of Solid Waste Disposal Site

Solid waste collection and transportation is not an end to solid waste management. Proper solid waste management also requires proper disposal of waste in a proper place. In sight of this sub city solid waste disposal site and its management is inadequate and below the standard. The site called Sendafa is located at 60 km far from the center and generally described as open and unsanitary landfill site although it is not functional currently . Under such condition the site has been functioning for the last 5 yeasr.

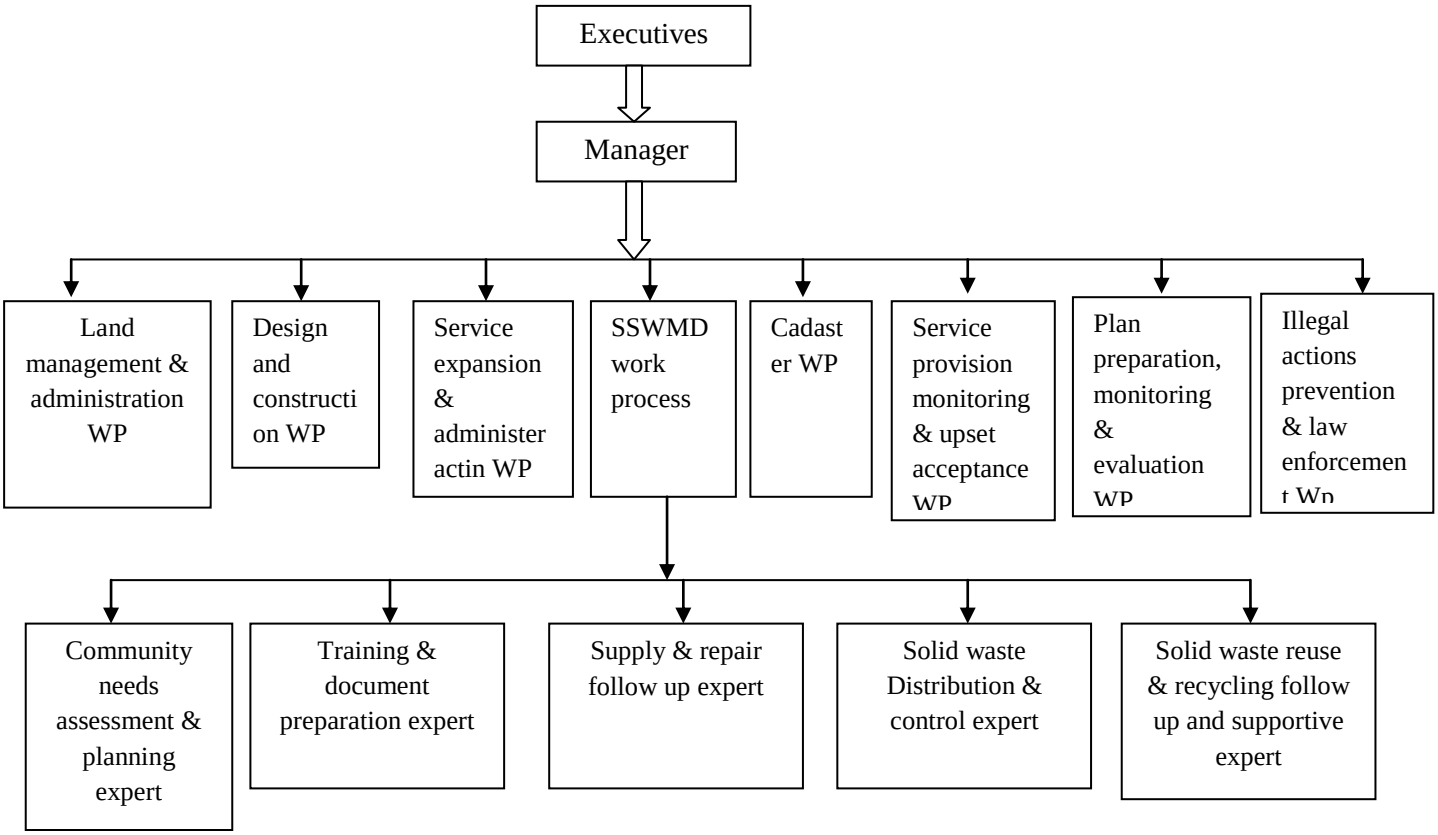
4.9 Institutional Arrangement and Capacity of Municipal Solid Waste Management Service of Arada sub city

It is a common perception that improving solid waste management means making waste collection and disposal systems more efficient, raising public awareness and enforcing solid waste management laws. However, a prerequisite for all these factors are a well-planned management operating within an enabling institutional frame work and capable of generating financial resources required to meet operating, maintenance, and investment costs Obeng (2008). So in order to build an acceptable and satisfactory level of MSWM service, the responsible institution primarily need to have well organized management that functions within an adequate institutional arrangement, skilled manpower and financial resources, appropriate rule and regulation, short and long term strategy, and good cooperation with

different stakeholders. Otherwise, if one or more of the aforementioned resources and frameworks are missing, then MSWM remains unattainable. This is one key reason why MSWM of Arada sub city is very poor in terms of status as well as spatial coverage. Therefore, before trying to find any solutions to this problem, first of all it is important to do detail assessment and get better understanding about the fundamental characteristics of the institution which is responsible for delivery of MSWM in the sub city. Hence, in dealing with institutional arrangement and capacity of MSWM service of the sub city the researcher is focused on organizational structure, strategic goal and objective, institutional mandate, human, material and financial resources, enforcement of rules and regulations, and inter organizational and stakeholders linkage.

4.9.1 Organizational Structure of Sanitation, and solid waste management Department of Arada sub city

It is obvious that for sound municipal solid waste management of any town, there should be well arranged and capable institution. The opening pace towards building of this type of institution is began from building clear, short and efficient organizational structure of responsible institution of the town's solid waste management. In line with these issues the sub city municipal solid waste management system is organized under a jurisdiction of municipality. The current structure with constituting solid waste management, liquid waste management, town beautification and parks development together. Its internal arrangement constitutes one work process manager and five different case teams.



Source, Arada sub city SWMD

Figure 11: Arada sub city sanitation and solid waste management organizational structure in 2019

The new structure of work process seems interesting on the base of minimizing bureaucracy and classification of works to different case teams. Despite this significant and appreciated modification, there are still a lot of weaknesses which contributed for the present inefficient MSWM of the sub city. The first and the most significant weakness is lack of practical applications of such structures and their respective works since the department could not avoid delay of work process at ground level. The existing work process is also exposed to high burden of work with solid waste management.

Accordingly, inadequate and improper distributions of resources (capital & equipment) among these work processes are observed and the share of solid waste management became low as compared to others based on the interview made with department head and workers.

4.9.2 Strategic Goal and Objectives of sanitation and solid waste management Department of the sub city

Following the new organizational structure execution, sets its goal and objective in its strategic plan. Accordingly, the goal that the department has set is 'to make the sub city clean, beautiful and hospitable town for residence as well as work' and its objectives constitute:

- cleaning areas which are characterized by illegal solid waste disposal and change them to greenery and parks
- improving the status of MSWM by outsourcing it to private sectors
- practicing reuse, recycle and compost preparation
- Encouraging the participation of community and other stakeholders through giving training and support.

4.9.3 Institutional Mandate of the Department

Contrary to the crucial goal and objectives, of the department the mandate given to the department is only limited to MSWM service provision i.e. collection, transportation and disposal of the sub city's solid waste. But, other related critical mandates are given to the department. (source sub city 2019)

- Undertake public awareness creation programs
- Monitor and supervise the sub city sanitation service,
- Contact municipality to pick waste frequently, and to construct solid waste infrastructures for those who do not have such facilities

4.9.4 Rules and Regulations of Municipal Solid Waste Management, and Its Status of Enforcement

These rules and regulations are largely emphasized on solid waste handling responsibilities and obligations of persons, establishments, and institutions. It didn't include specified rules which are focused on institutional issues of the department, different stakeholders' participation, and sustainable solid waste management system. Apart from this there is also low enforcement of those existed rules and regulation.

According to 234 (60.93%) response of samples and my own field observation of sample households did not know the rules and regulations related with solid waste management. Therefore, the absence of regulatory framework and law enforcement of rules and regulations hindered effective solid waste collection, storage and disposal system of the sub city at large.

4.9.5 Inter-Organization Linkage of Sanitation, and solid waste management Department of Arad sub city

Inter organizational linkage refers to a multi-dimensional interactions between two or more institutions on the basis of their organizational principles and expected responsibilities to perform their respective roles. So, enhancing inter organizational integration is very important to improve MSWM through creating functional interdependences such as experience sharing, and supportive activities. This collaboration can facilitate information exchange between them and initiate organizations to actively taking part in solid waste activities in particular and promoting public health and environmental protection in general. Based on the strategic plan of the sub city solid waste management department, there are several organizations which are identified for cooperation in solid waste management of the sub city. These are sub city administration office, health office, law and order securing office, urban agricultural office, micro and small enterprise office, information and communication office, and woreda and ketena sanitation agents. Based on this strategic plan, all the above organizations have their own responsibilities which are expected to play in sanitation, of the sub city. Nevertheless, according to the majority (69 %) responses, solid waste management workers, health office, law and order securing office, micro and small enterprise office and woreda sanitation agents are the only organizations which have been involved in solid waste management activity of the sub city.

Table 4.7: List of organizations and their expected aspect of involvement in solid waste management

List of organization	Expected aspects of involvement
The sub city administration office	Creation of suitable conditions including good governance and due emphasis to sanitation, and solid waste management
Health office	Protect health of the society through controlling and supporting solid waste management of the town like supervision and Awareness creation.
law and order enforcing office	They have the power and responsibility to penalize and control Illegal dumping of solid waste.
Urban Agricultural office	Give support to development of different areas, work with different stakeholders about compost and other related works
Information and Communication Office	Documentation of several waste management activities and communicating it to the society and other actors in order to upgrade their participation
woreda sanitation agents	organize society for sanitation campaign and also supervise and control illegal solid waste disposal in each ketenas
Micro and small enterprise office	Organize MSSE solid waste collectors

Source: sub city information office

Despite the importance of inter organizational linkages, among different offices and institutions which are vital for effective and efficient way of handling solid wastes in the sub city. About 67% of solid west management workers revealed that there is no strong linkage among different bodies at grass root level. If there are some linkages it is at high level and very formal and too bureaucratic to be operational. Furthermore, interview made with the sub city officer Ato Degene, lack of clearly stated duties and responsibilities among different offices has made the situation more complicated and led to fragmented actions by different offices.

4.9.6 Effort of Sanitation and solid waste management Department to Participate Different Stakeholders on MSWM

For many services that are delivered in many urban areas of the world, stakeholders' participation is regarded as a backbone because delivery of one big service by one actor makes the service very difficult and complex. However, the involvement of various stakeholders with their specialization can make the service provision easy, satisfactory and efficient. Similar to this, for proper management of MSW of a given town and to keep its sustainable functioning, participation of stakeholders also plays determinant and irreplaceable role. Those stakeholders of MSWM comprise community and community based organizations (CBOs), nongovernmental organizations and external support agencies, and formal and informal private sectors.

In developed countries, all these groups and individuals do play an important role beginning from policy preparation to provision of waste collection, resource recovery, and supplying waste collection equipment. However, in developing countries, it is recently that some urban authorities have recognized these actors, and eventually integrated them in to their MSWM systems (Achankeng, 2004).interview made with the sub city officer Ato Degene, Arada sub city is characterized by absence of stakeholders' involvement in strategy formulation, and insignificant participation of MSSE, informal sectors, and community on actual operation of MSWM. On the other hand, although there are 83 well functional and socially organized local area associations called 'Iddirs', and 10 woman and 10 youth associations in each 10 woredas in the sub city , none of these CBOs are participating in the sub city's MSWM. Moreover, according to the interview made with head of solid waste management department, there are also no NGOs and donor agencies, and formal private sectors that are operating in MSWM of the sub city. Therefore, those governmental institutions should recognize their defect and give great emphasis to initiate stakeholders' participation. Because, at the very beginning efficiency of solid waste management service could be real if and only if stakeholders are aware of their responsibilities and tries to practice it with a higher level of commitment, otherwise the movement to provide MSWM service without holding them is considered as clapping by

one hand.(source sub city report 2018)

4.9.7 Institutional Capacity of Sanitation, and solid waste management Department of the sub city

Institutions play vital roles in guiding change, facilitating development and succeeding national socio economic and political goals if they are well equipped in terms of various types of resources. These dominant resources which determine an institutional capacity are: human, material, and financial resources. Otherwise, they can cause for failure of designed goal since the management of an institution with a relatively low capacity has its own impact on its effectiveness. With this intention, in order to manage solid waste properly the capacity of institution that is delegated with MSWM of the town also needs to be raised to a higher level with adequate budget, man power, technical skills and equipment used. But, status of the existing institutional capacity of MSWM in the Arada sub city is basically inadequate arising out of insufficient manpower, financial, and material resources.

4.9.7.1 Human Resource Capacity of the Department

The most important factors that have influenced level and quality of operation of solid waste management services related with manpower of resource are actual size and required size, job requirement and actual qualification of staff, recruitment qualification, payment system, staff management activities like incentives and promotional opportunities, adequacy of waste management training and technical assistances, and moral aspiration of workers. As a result, to gain a better understanding of the human resource capacity of the sub city, questionnaire which focused the above factors was prepared and distributed to all solid waste related workers and an interview with the head of the department was made in addition to secondary data received from the department. According to the work process manual of the sub city solid waste management department, the present arrangement of the department was prepared in order to hold 125 workers. Among this, around 76 (60%) workers are involved in provision of solid waste management in the sub city. From this it is possible to conclude that the department has very weak manpower and this condition can be considered as a major problem for the existing MSWM activity of the town. Based on the information obtained from interview made with the manager, the reason behind this inadequacy of manpower is lack of budget and low attention given by the department.

Table 4.8: existing human resources and required number of workers related with solid waste management task in 2019

Job title	**Recruitment Type**	**Required no of workers**	**Existing no of workers**
WP manager	Permanent	1	1
WP assistant (secretary)	Permanent	1	1
Community need assessment & planning Expert	Permanent	5	4
Training & document preparation expert	Permanent	3	-
Solid waste reuse & recycling follow up & supportive expert	Permanent	2	2
Distribution & control expert	Permanent	2	2
Supply & repair follow up expert	Permanent	1	-
Town sanitation workers	Contract	35	5
Driver(Solid waste collection vehicle)	Permanent	10	6
Assistant(Solid waste collection vehicle)	Permanent	8	5
Street sweepers (one person for 500 meter square)	Contract	56	50
Total		125	76

Source: Arada sub city manual, 2018 (for detail understanding of this survey see appendix6).

In addition to shortage of manpower, failure to address fundamental need of workers such as salary increments, incentives, recruitment type, and promotion opportunities are also considered as second main reason that contributed to low SWM of the town. For instance, for many tasks of solid waste management the department depends on contractually employed workers. From the total workers of the department only, 21.11% of them are permanent employees whereas the remaining 78.89 % are employed in contract. Besides this, the contractual workers are also extremely upset by their low salary as well as absence of salary increment.

Specifically, the monthly salary of these staffs is 1000-1300 birr for street sweepers, 1500 birr for town sanitation workers and 1850 birr for driver. Genuinely speaking, this amount of salary is not matching with their difficult task, present inflation of money and high living expense. Related with this the workers stated that they are found in a big and difficult situation together with their family. In addition to this, these workers are also required to work around 8 hours in every day without any monthly or annual vacation or leisure time including Saturday, Sunday and holydays. In such type of wok loads over time payment is the only means of compensation but workers do not receive any form of over time payment. The department is not also fulfilling its responsibilities of provision of appropriate health protection gears like gloves, shoes, clothes etc. and health insurance on time. As a result, most of the department workers are motivated to leave their jobs due to the hardest condition of the job.

4.9.7.2 Financial Resource Capacity of Arada sub city solid waste management office

Finance is a very decisive factor for any public service delivery in any town or country. On the other hand, an environment which is safe and healthy for human beings is also a requirement for any town or country. Therefore, one country or town should provide adequate finance to conserve and manage its environment in general and its solid waste in particular because solid waste is one of the problems which damage the urban environment. Different from this, in the Aarda sub city the provision of adequate funding for MSWM is a sever challenge which causes the sub city environment to be deteriorated. It is characterized by poor budget for service delivery, insufficient funding for building infrastructures and absence of appropriate cost recovery mechanism

Table 4.9: Total budget of the department compared to total budget of the sub city in 2019

Year	Total budget of The sub city	Total budget allocated to solid waste management department	Percentage share of SBPDD
2017	23,530,948	2,350,678	9.9. %
2018	33,748,832	4,488,456	13.1 %
2019	42,479,672.95	5,809,417.60	13.6 %
Total	99,759,452.9	464,551.60	36.6

Source: sub city, 2019 report

4.9.7.3 Municipal Solid Waste Management Equipment's

In the process of municipal solid waste management there are various facilities/infrastructure that should be accomplished for providing efficient and effective service to citizens. But this facilities are highly correlated with the economic performance and good institutional concern of a given town or country. For instance, it is possible to observe developed countries which give high concern or attention to solid waste management and used different sophisticated technologies for managing it. Opposed to this, in developing countries solid waste management is mainly under taken by very inefficient equipment's and technologies due to low level of economic development and low attention given to this service. The situation of MSWM infrastructures or facilities in Arada sub city is also not different from the rest of developing countries. Equipment or facilities are not sufficient to convey the service when we compared with the rapid expansion of the town and the level of increasing waste generation rate of the society

Table 4.10: Amount of employees and vehicle related expenses in the year 2018.

Types of expenditure	**Expenditure (birr)in 2018**
Employees related expense	2,345,567
Vehicle related expenses	
Fuel	1,830,345
Tyre	180.000
Spare parts	99,108
Oil and filter	31580
Total	2,141,033
Grand Total	4,486,600

Source: SSWMD annual report, 2019

Table 4.10 revealed that in 2019 department spends around 2,141,033 birr for such vehicle related expenses. Vehicle running cost on average consume almost 4 times of the total expenses for the department workers even if the MSWM service of the town is dominantly labor intensive and workers are the major resources who work with other technologies or facilities.

Apart from this, absence of public storage facilities such as public storage containers and dust bin is also another problem area that greatly minimizes the performance of MSWM service of the town and it is regular to observe accumulated solid wastes like plastics, papers, food wastes etc on different parts of the town like the street, open areas, rivers etc. On the other hand, the problem on implementation of the proposed plan of the department which aimed to improve the facilities through purchasing different equipment's is worsening the low efficiency of SWM the sub city.

CHAPTER FIVE

5. Summary, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study was conducted to analyze the status and spatial coverage of municipal solid waste management service of Arada sub city in general. In particular, the study explored households' solid waste physical composition and generation rate, household's solid waste management practice, and institutional structure and capacity of sanitation, and solid waste management office of Arada sub city. As field observation result indicated that, Arada-sub city has a problem of solid waste collection and disposal. The majority of the households that live along the river -side disposed and burnt their solid wastes inside the river and it is not uncommon to see all types of solid wastes disposed in side drainage channel and littered on the streets and other places.

These investigations were addressed by employing questionnaires, field observation, field measurement, semi structured and unstructured interview with head of the department and workers of the sub city sanitation and solid waste management department, and reviewing published and unpublished documents. Finally, on the basis of qualitative and quantitative analysis of data, the findings of this study are summarized as follows.

The principal sources of municipal solid wastes in Arada sub city are residences, commercial areas, street sweeping, institutions, and small scale industries. However, the considerable amount of solid waste of the sub city (60%) is generated from residential areas. Though this source has such large dominance, the sub city solid waste management office didn't make frequent and ongoing inspections on its solid waste composition and generation rate. But, this study found out solid waste generation rate of household, it is about 0.786 kg /person/ day. This made the daily and annual total solid waste generation of residential areas of the sub city is (32,188 kg) and (965,640) respectively. Furthermore, according to this study about 78.89.% % of residential areas solid waste is composed of biodegradable solid wastes such as ash, dust, and food waste. This composition is very suitable to make compost. This is the best way of sustainable solid waste management both in terms of economic and environmental

value. But, there is no activity made by the sub city, as well as other actors towards application of this potential resource.

This study also indicated that in Arada sub city municipal solid waste management service is very weak in terms of status, spatial coverage and solid waste management facility. Presently, in the sub city there are no enough public solid waste storage containers and road side dust bins. As substitution of these facilities there are 15 communal solid waste transfer stations that give service only to MSSE waste collectors. Those stations are located at the edge of main roads, and they are not well designed. Simply they are road side open dumps without any health, aesthetic and environmental impact considerations. Besides this, those transfer stations are also characterized by uneven distribution both in terms of distance from beneficiaries and kebelle (ketena) specific locations. Furthermore, municipal solid waste collection and transportation activity of the sub city is carried out by two types of collection methods such as door to door and transfer stations solid waste collection. Door-to-door collection system is provided by MSSE waste collectors and rarely by municipality collection truck. It is largely implemented for collection of solid waste from residential areas to transfer stations. But, the status and spatial coverage of this service is very unsatisfactory, only covers residents who are living in the center of the sub city and along accessible streets. Whereas the transfer stations collection method is directly performed by the sub city using its collection truck. Based on average trip of a truck, the total amount of solid waste which is daily collected and transported by the sub city is from the daily solid waste generation 88.0m^3 or 32,188 kg. Only 82.7% of the municipal solid waste of the sub city is collected and transported to disposal site of the town daily. However the remaining 17.3% (5548kg) solid waste is left uncontrolled. This is considered to be 166,400kg /month.

As a result of this, huge amounts of uncollected solid wastes are indiscriminately disposed in unauthorized areas. In addition to poor solid waste collection and transportation practice, the town disposal site is also found in unacceptable and very risky situation. Because, it is simply naturally created gorge rather than manually prepared solid waste dumping through environmental, economic and social impact considerations.

5.2 CONCLUSION

Based on the findings of my study the following conclusion where made:-

This study has tried to investigated municipal SWM problem in Arada sub city. The results of the study showed that the major factors that influenced SWM service include institutional, economic and social factors. The city municipality does not have a well-organized and accountable SWM structure. Lack of adequate budget, low economic status of households and low attitude given to solid waste workers and to the job are identified as hindering factors of appropriate SWM service in the sub city. The study also revealed the current door to door SWM service delivered by SMEs is not satisfactory. The households dispose their waste like they did in the past and they are not fully aware about how waste should appropriately be disposed.

Finally, this research investigated three main factors which are exacerbating the existing poor status of municipal solid waste management service of Arada sub city. These are:

1. **Very poor institutional arrangement and capacity of sanitation, and solid waste management department**.

Structurally, the department is twisted by: delay in implementation of activities, burden of work .In terms of capacity, very poor institutional capacity of the department is arising out of:

- Very low financial capacity as compared with the burden of the work
- Absence of cost recovery mechanism and financial autonomy
- Insufficient manpower resource
- Scarcity of solid waste management facilities
- Weak enforcement of rules and regulations
- Fragile networks and linkage of the department with other sectors and organizations
- Mandate restrictions of the department

2. Very poor solid waste management practices of the sub city households

The first weakness of households is poor handling of temporary storage material of their house. I.e. they drop out solid waste around it. They also exposed it to rain and light, did not well covered, and placed near to residence. Second, the greater part of the town households didn't separately store solid wastes other than salable and exchangeable with Liwach and Quraleos. They did not also carry out sustainable solid waste management activities such as recycling, reusing and composting. Apart from this they regularly apply illegal solid waste disposal. Moreover, they have also low emphasis to clean their surrounding area and nearby road.

3. Very limited participation and contribution of stakeholders

The provision of municipal solid waste management of the sub city is dominantly performed by municipality with very limited contribution of MSSE, solid waste miners and handcrafts, and communities. Besides this, there is no involvement of CBOs, NGOs, and private sector.

5.3 RECOMMENDATIONS

Based on the findings of this study, the following recommendations were provided.

- Wider and strong public awareness creation activities and adequate training about side effects of solid waste, and application of sustainable solid waste management practices.
- Giving special attention to women of the sub city who are the most powerful change agent.
- The sub city institutional arrangement should be allowed, stakeholder's participation, and characterized by real decentralization of tasks and authority.

- Prepare specified rules and regulations that focused on local problems such as institutional issues about the sub city 's MSWM service responsible body, stakeholder's participation and sustainable solid waste management options, and strictly enforcement of this rules and regulation under close supervision and inter organizational linkage.

- MSES are one of the most important stakeholders to improve the sub city SWM. So that the sub city should give grate attention to make them strong, in both capacity and working equipment's.

- Promote and initiate communities, private sectors and different CBOs of the Sub city to involve in solid waste management is important.

- In areas where the road is inaccessible and population density is high, collection vehicles should be used to avoid the problem of waste collection .

- In cities /sub-cities like Addis Ababa (in general) or Arada sub-city (in particular) where potentially compostable solid wastes are generated, landfill spaces are limited and inappropriate solid waste disposal is common, composting and recycling practices should be encouraged because They reduce volume of wastes besides to their economic advantages.

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APPENDIX 1

Questionnaire prepared for sample households in Arada sub city

This Questionnaire is prepared for an academic purpose for the fulfillment of MA degree in urban and Regional Development planning. Specifically the objective of the study is to assess the current practice, infrastructural and institutional capacity of municipal solid waste management service in Arada sub city. Therefore, your response is very important for the success of the study because all information that you provide determines the analysis and conclusion of the research. Hence, you are kindly requested to give your response by selecting (circling) your answer from the given alternative choice or describing your opinion. Please be informed that your response is kept in confidential and you are not required to write your name. I would like to thank you for your cooperation.

Part one: Background information about the respondents

Instruction: In order to answer the following questions, put a right sign (√) in the boxes that located in front of your choice.

1. Sex: Male ☐ Female ☐

2. Age _____

3. Educational level:
   - No formal education ☐
   - 1-4 grade complete ☐
   - 5-8 grades complete ☐
   - 9-12 grades complete ☐
   - Certificate ☐
   - diploma ☐
   - First degree ☐
   - Second degree and above ☐

4. House ownership condition:

   Kebelle rental house ☐ private rental house ☐ private house ☐

5. Family size: _____.

6. Average monthly income (in birr):

Less than 500 ☐ 501-1000 ☐ 1001-1500 ☐

1500-2000 ☐ ☐ greater than 2000

7. Kebelle _____

Part two: Questionnaire prepared for investigating households solid waste management awareness, and practice together with their attitude regarding municipal solid waste management of the sub city.

1. How often do you clean your house

   A. Every day B. with two days interval C. with three days interval

   D. with one week interval E. if others please specify it_____.

2. How many solid waste storage materials do you use to store solid wastes produced in your dwelling? _____
3. What type of solid waste storage material do you use in your house to store solid waste produced from your dwelling?

   A. sack B. basket C. metal container D. plastic container (‘festal’)

   E. private pit F. I don’t use G. if others please specify it_____.

4. Do you separately store solid wastes that are produced in your house and salable to “Quraleos” And exchange with “Liwach”?

   A. yes B. no

5. If your answer for question **no 4** is **‘yes’**, which of the following items do you separate for Selling it to “Quraleos” and exchange to “Liwach” (possible to select more than one)?

   A. Metals, B. Plastics C. Glass, bottles, can etc. D. Organic wastes

   E. Electronic wastes F. textile and old shoes G. if other please specifies it_____

6. Do you separate other solid wastes produced in your dwelling apart from solid wastes which are salable to “Quraleos” and “Liwach”?

   A. yes B. no

7. If your answer for question **no 6** is **'yes'**, state the type of those solid waste?

   _____
   _____

8. If your answer for question **no 6 is 'yes'**, for what purpose do you separately store (possible to select more than one)?

   A. Using as fertilizer B. giving to other users C. to use as fuel D. to use as feeding animals E. to recover resources by using my own effort F. for reducing the volume of waste, makes throwing convenient and contributing to Environmental protection. G. if other please specify it _____.

9. Do you know the idea of solid waste recycling and reusing?

   A. yes B. no

10. If your answer for question **no 9 is 'yes'**, do you recycle or reuse solid wastes generated from your house? A. yes B. no

11. If your answer for question no 9 is 'yes', what type of materials do you reuse and recycle (possible to select more than one)?

    A. used Paper B. used glasses, bottles and glass materials. C. used metallic materials D. used plastics and plastic materials E. textile and used umbrellas F. if other please specify it _____

12. If your answer for question **no 9 is 'no'**, please describe your reasons.

    _____
    _____

13. Do you know that compost can be prepared from solid waste?

    A. yes B. no

14. If your answer for question no **13 is 'yes'** do you prepare compost from solid waste produced in your house? A. yes B. no

15. Do you have access to door to door solid waste collection service delivered from the municipality solid waste collection vehicle?

    A. Yes B. No

16. If your answer for question **no 15 is 'yes'**, in how many days interval you get this service?

    A. 1-3 days B. 4-7 days C. 8-15 days D. 16-30 days E. above 30 days F. as available

17. Do you use MSE for door to door solid waste collection from your residence?

A. Yes B. No

18. If your answer for question **no 17 is 'yes'**, in how many days interval you get this service?

A. 1-3 days B. 4-7 days C. 8-15 days D. 16-30 days E. above

19. If your answer for question **no 17 is 'yes'**, how much do you pay for the service render per month._____

20. Do you use informal sectors such as daily workers, laborers, and mentally retarded people for door to door solid waste collection from your residence?

A. Yes B. No

21. If your answer for question **no 20 is 'yes'**, how much do you pay for the service render per month, and specify solid waste service provider criteria for fixing your charge.

_____

_____

22. Apart from the above bodies what are other means you frequently use to dispose the solid waste of your household?

A. at the road sides and open fields
B. dumping in bridges
C. burry inside my compound
D. simply disposes in my compound
E. dumping in river side's and gullies
F. burn in my compound
G. if other please specify_____

23. Do you need the containers back again under regular follow up and place in your surrounding?

A. Yes B. No

24. Does solid waste management service in your area is a burning issue as it compared with other service like road service, water supply etc.

A. yes B. no C. if other please specify it_____.

25. Have you ever obtained training, education or information about solid waste management, and environmental and other problems created due to carelessly thrown solid waste?

A. yes B. no

26. Would you be interested to learn more about solid waste management, environmental impact of waste, and various ways of minimizing and treating the waste stream?

A. yes B. no

27. If so, what would be your favored method of increasing your knowledge?

    A. open seminars B. Brochures distributed to residents

    C. solid waste management campaign D. door to door education

    E. Educational programs newsletter and magazines F. Educational programs in radio and television

    G. Exhibitions presenting good practices in solid waste management, sorting and recycling

    H. other (please specify)

28. Have you ever participated in a cleanup campaigns in your kebelle?

    A. yes B. no

29. If your answer for question **no 28 is "yes"**, how many times you participate in the last year_____.

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

    A. yes B. no

31. Have you ever seen the sanitation agent making supervision and control on illegal dumping of solid wastes on the streets, open areas, river side's and other areas?

    A. yes B. no

32. In general, are you satisfied with the municipal solid waste management service of the town which is delivered by sanitation, beautification and park development of Dessie under the jurisdiction of municipality?

    A. Very satisfactory B. satisfactory C. fair D. unsatisfactory E. very unsatisfactory

33. How do evaluate the effort made by the municipality to provide efficient solid waste management service compared with other services of the town such as water supply, electricity, telephone etc.

    A. Very weak B. weak C. fair D. strong E. very strong

34. If your answer for question **no 32** is 'unsatisfactory or very unsatisfactory', what would you suggest for the Environment and Sanitation, Beautification and Parks Development Department to do in order to overcome the constraints and improve the service?

    _____

If you have any additional comments, suggestions, or would like to elaborate on any of your previous answers, please include it here, or attach a separate sheet.

APPENDIX 2

Interview questions prepared for Sanitation, and solid waste management Department workers of Arada sub city

Dear respondent this interview is conducted for an academic purpose for the fulfillment of MA degree in Geography and Environmental studies. Specifically the objective of the study is to assess the current practice, infrastructural and institutional capacity of municipal solid waste management service in Arada sub city. Therefore, your response is very important for the success of the study because all information that you provide determines the analysis and conclusion of the research. Hence, you are kindly requested to give your response. Please be informed that your response is kept in confidential. I would like to thank you for your cooperation.

Part one: Background information about the respondents

1. Job title in your department _____.
2. Employment condition

Permanent	☐	contract	☐

3. Educational level

No formal education	☐	1-4 grade complete	☐
5-8 grades complete	☐	9-12 grades complete	☐
Certificate	☐	diploma	☐
First degree	☐	Second degree and above	☐

4. Work experience_____.
5. Monthly salary _____.
6. Family size _____

Part two: structured Questions prepared for investigating MSWM practice and capacity together with their attitude regarding households' solid waste management of the sub city.

1. Have you ever been participated in solid waste management trainings or education given in our country?
2. Does your institution give incentives, promotions and salary increment to you?
3. If your answer for question no 2 is 'yes', how do you evaluate the level of training, education, incentives, promotions and salary increment opportunities offered to MSWM workers?
4. Does your SBPD department work with other government and non government organization in its solid waste management operations? If your department works, please list the organization and their activities on solid waste management of the town.
5. How do you evaluate your institution status on interaction with other government and non government organizations regarding MSWM of the town?
6. How do you see the institutional arrangement of the sub city? Does such arrangement have any problem on the efficient performance of your division? If it has please explain it?
7. Do you feel your organization has efficient capacity to handle MSWM responsibilities?
8. Do you think the controlling mechanism of municipality it is effective? If your answer is "no", what do you think the reasons?
9. Do you work on Saturday and Sunday per time? If you work, do you get over time payment?
10. Do your collection, transportation and disposal service cover all parts of the town? If it not covered, please specify the major reasons?
11. Are you provided with medical care, safety wares, and other materials that are necessary to keep your health?
12. Do you think residents of the sub city have clear and adequate awareness about solid waste management systems?
13. What do you think should be done to improve the situation of MSWM of the sub city in general?

If you have any additional comments, suggestions, or would like to elaborate on any of your previous answers, please include it here, or attach a separate sheet.

APPENDIX 3

Interview questions prepared for head of Sanitation, solid waste management Department of Arada sub city

Dear respondent this interview is conducted for an academic purpose for the fulfillment of MA degree in Geography and Environmental studies. Specifically the objective of the study is to assess the current practice, infrastructural and institutional capacity of municipal solid waste management service in the sub city. Therefore, your response is very important for the success of the study because all information that you provide determines the analysis and conclusion of the research. Hence, you are kindly requested to give your response. Please be informed that your response is kept in confidential. I would like to thank you for your cooperation.

1. What types of solid waste collection methods does your department adopt?
2. Mention the types and total number of equipments that your department used for collection, transportation and disposal of municipal solid waste of the town?
3. Is there a mismatch between the amounts of municipal solid waste that regularly generated in the town and, total quantity of solid waste that is collected and disposed by your department? If there, please discuss the major reasons of a mismatch.
4. Explain the major reasons of why your department didn't place public solid waste containers and street bins at the major roads of Arada sub city?
5. Do the sub city sanitation, beautification and parks development department practice different types of resource recovery, waste minimization or waste treatment activities? If any, please describe those activities and, if not please mention the major reasons?
6. Did your department carry out the following surveys on disposal sites of the town in order to evaluate its suitability? If your department under take the survey, specify the outcomes. But if didn't carry out, please specify the major reasons.

   A. Geological survey or study B. Surface and ground study of the area

   C. Environmental impact assessment D. Surrounding land use assessment

   E. Distance of Disposal sits versus future expansion of the town G. Its appropriateness based on the master plan of the town. H. Cost benefits analysis of the area.

7. Explain the overall institutional structure, mandate and functions of sanitation, beautification and parks development department and, the major positive and negative impact of these arrangement on the existing performance municipal solid waste management of the town.
8. Briefly discuss Polices, Strategic plans, and its Implementation and monitoring mechanisms that have been proposed by your department for efficient practice of municipal solid waste management in Arada sub city.
9. Describe the total budget and revenue of municipal solid waste management related with their sources and the major challenges that faced your department about it?
10. Does your department collect charge from the residents of the town for its municipal solid waste management service delivery?
11. Do you think that there is inadequacy of man power in your organization? If there is, what do you think the reason behind this?
12. Do employees leave your department frequently? If yes, please specify their number, major reasons and your department response for it.
13. Do you think that your organization has sufficient autonomy from other levels of government in its every day decision making.
14. Does your department invited different stake holders of solid waste management to participate both in planning and implementation process of municipal solid waste management? If yes, please describe those actors and their significant activity.
15. Did your department give education to the community about solid waste management and prepared cleanup campaigns? If you did, for how many times and describe your method of delivery.
16. List challenges of your department.

If you have any additional comments, suggestions, or would like to elaborate on any of your previous answers, please include it here, or attach a separate sheet.