



**Dissertation Title: - The Assessment of Solid Waste Management in Addis Ababa: - The Case of Kirkos Sub-Cities**

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**The Assessment of solid waste management in Addis Ababa:  
The case of kirkos Sub-City.**

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## **Certificate of Declaration**

I, Eden Amdebrhan, declare that this study entitled “The Assessment of Solid Waste Management in Addis Ababa: The Case of Kirkos Sub-City” is my own work. I have carried out independently the research work with the guidance and support of the research advisor.

This study has not been submitted to any degree\diploma in this originally other institution. It is done in partial requirement of the M-A degree in public administration.

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## Statement of Certificate

Certified that Dissertation entitled- “The Assessment of Solid Waste Management in Addis Ababa: The Case of Kirkos Sub-City” submitted by Eden Amdebrhan is her own work and has been done under my supervision. It is recommended that this dissertation be placed before the examiner for evaluation.

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## Table of Content

<b>Titles</b>	<b>Page</b>
Acknowledgement-----	i
Table of content-----	ii
List of tables-----	vi
List of figures and charts-----	vii
Acronyms-----	viii
Abstract-----	ix
<b>Chapter One</b>	
1 Introduction-----	1
1.1 Background of the study-----	1
1.2 Statement of the Problem-----	4
1.3 Objective of the Study-----	6
1.4 Significance of the Study-----	6
1.5 Scope of the Study -----	7
1.6 Limitation of the Study-----	7
1.7 Methodology of the Study -----	8
1.7.1 Study Area and Study Period-----	8
1.7.2 Study Design -----	8
1.7.3 Source of Data and Tools of Data Collection -----	8
1.7.4 Sampling Procedure -----	9

1.7.5 Sample Size -----	9
1.7.6 Data Analysis -----	10
1.7.7 Benchmarks of the study-----	10
1.8 Definitions of terms -----	11
1.9 Organizations of the Paper-----	12
 <b>Chapter Two</b>	
2.1. Literature Review -----	13
2.1.1 Historical Development of Solid Waste Management -----	13
2.1.2 Classification of Solid Waste -----	14
2.1.3 Solid Waste Management (SWM) System -----	16
2.1.3.1 Waste Generation -----	16
2.1.3.2 Waste Storage -----	17
2.1.3.3 Waste Collection-----	18
2.1.3.4 Transfer and Transport-----	20
2.1.3.5 Processing -----	21
2.1.3.6 Recycling-----	21
2.1.3.7 Waste Disposal-----	22
2.1.4. Waste Composition -----	24
2.1.5. Health and Environmental Effects -----	24
2.1.6 Determinants of Solid Waste Management -----	26
2.1.7 Household Solid Wastes -----	27
2.1.7.1 Household Waste Collection in Informal Settlements-----	27

2.1.8 Sustainable Solid Waste Management-----	29
2.1.9 Community Participation in Solid Waste Management -----	30
2.1.9.1 Community-Based Enterprises -----	31
2.2. Empirical Literature Review -----	31
2.2.1. The Experience of Solid Waste Management in Addis Ababa-----	31
2.2.1.1 Description of the Study Area-----	31
2.2.2 Solid Waste Management in Addis Ababa -----	35
2.2.3 Legal Framework of Solid Waste Management-----	37
2.3. Conclusion-----	38
 <b>Chapter Three</b>	
3. Data Presentation and Analysis-----	40
3.1 Characteristics of the Household Respondents-----	40
3.2 Awareness of the Respondents-----	42
3.3 Habit of Solid Waste Collection-----	44
3.4 Solid Waste Separation-----	46
3.5 Municipal Solid Waste Container-----	48
3.6 Ways of Removing the Solid Waste from House-----	53
3.7 Household Solid Waste Generation-----	54
3.8 Service Provided by Micro and Small Scale Enterprise-----	55
3.8.1 Problems emanated from MSEs-----	56
3.8.2 The Main Problems Faced on Micro and Small Scale Enterprises (MSEs)-----	56



3.8.3 Evaluation of the service provided by MSEs-----	57
3.9 Problems of Illegal Dumping-----	58
3.10 Types of Solid Waste Management Options-----	60
3.11 Evaluation of the Habit of solid Waste Management-----	61
3.12 Major Constraints that Hamper Effective Solid Waste Management-----	64
3.12.1 Economic Constraints-----	65
3.12.2 Institutional Capacity Constraints-----	66
3.12.3 Infrastructural Constraints -----	69
3.12.4 Social Constraints-----	70
2.13 Evaluation of the Overall Solid Waste Management -----	72
2.14 Solution suggested by household respondents to curb the problems-----	72
2.15 Problems encountered during data collection-----	73
2.16 Conclusion-----	73
 <b>Chapter Four</b>	
4. Conclusion and Recommendations -----	75
4.1 Conclusion-----	75
4.2 Recommendations -----	77
Reference-----	79
Appendix A Questionnaire for household respondents-----	81
Appendix B Interview Guide Questions for Micro and Small Scale Enterprises-----	90
Appendix C Interview Guide Questions for Kebeles and Sub-city team leader-----	91

<b>List of tables</b>	<b>Pages</b>
Table1 List of Sampled <i>Kebeles</i> and Micro and Small Scale Enterprises (MSEs)-----	10
Table 2 Characteristics of the respondents-----	41
Table 3 Awareness about the advantage and the disadvantage of solid waste management----	44
Table 4 Habit of solid waste collection at home -----	45
Table 5 Reasons for improper solid waste management-----	46
Table 6 kinds of material used for waste collection-----	46
Table 7 Habit of solid waste separation-----	47
Table 8 Municipals solid waste container or on site storage -----	49
Table 9 Frequency of solid wastes disposal-----	50
Table 10 Evaluation of the municipal container -----	51
Table11 Reasons for the shortage of container -----	52
Table 12 Solid waste generation-----	55
Table 13 Service beneficiary by micro and small Enterprises-----	56
Table 14 Evaluation of the service provided by MSES-----	58
Table 15 Problems of illegal dumping and the involvement of the people-----	59
Table 16 Type of solid waste management practice-----	61
Table 17 Evaluation of the habit of solid waste management-----	62
Table 18 Major challenges that inhibit the solid waste management-----	65
Table 19. Evaluation of the overall solid waste management in <i>Kirkos</i> sub-city -----	73

**List of figure and charts**

**Pages**

Chart 1 Awareness of the household Respondents-----	42
Chart 2 Habit of waste removing from house-----	53

## **ACRONYMS**

AAU- Addis Ababa University

B/N- Between

AU- Africa Union

ECA- Economic Commission for Africa.

EPA- Environmental Protection Authority

Kg/m<sup>3</sup>- Kilogram per Cubic Meter

MSEs- Micro and Small Scale Enterprises

MSW- Municipal Solid Waste

NGOs- Non-Governmental Organizations

SBPDA- Sanitation Beautification Parks and Development Agency

SN- Serial Number

Sq. km- square kilometer

SW- Solid Waste

SWM- Solid Waste Management

UNCHR- United Nations Higher Commission for Refugee

UNEP- United Nations Environmental Program

WHO- World Health Organization

## ***Abstract***

*Solid waste nowadays is becoming a major urban problem in most countries. In the past since the population are too small and the technological advancement is too slow, the problem of solid waste did not cause much problems and has a little attention as compared to today. Today, Addis Ababa is one of the developing countries which face the problem of solid waste. This study is conducted in one of the sub-city of Addis Ababa that is Kirkos sub-city to assess and analyze solid waste management in relation to the constraints that hamper the effectiveness of the system. The study adopts a descriptive research design. It has employed questionnaire, interview, and observation. Moreover, secondary source documents were also reviewed. A total of 287 household respondents were included from four kebeles based on proportional sampling techniques (pps). In addition to the household respondents, six MSEs and five team leaders from the kebeles and sub-city were interviewed. The quantitative data were analyzed using descriptive statistics and the qualitative data has been used as a supplement for the quantitative data. The study finds that lack of awareness by the people about proper waste management system, shortage of trucks to pick up the containers, the poorly planned settlement structure of the sub-city and weak coordination among the stakeholders poses problems on the management of the system. Thus, the study underlined that creating the awareness of the people with the collaborations of other stakeholder and building the institutional capacity are critical for its improvement.*

# CHAPTER I

## 1. INTRODUCTION

This chapter presents the background of the study, statement of the problem, objectives of the study, significance of the study, scope and limitations of the study.

### 1.1 BACKGROUND OF THE STUDY

In the past, Africa was considered as rural, but now a day there is a progress towards urbanizations. Many countries are going through rapid urbanization with their attendant problems including the expansion of urban slums, unemployment, inadequate water supply and poor sanitation (Senkoro, 2003). As urbanization continues to take place, the management of solid waste is becoming a major public health and environmental concern in urban areas of many developing countries. The concern is very serious particularly in the capital cities, which are often the main gate ways to the countries for diplomatic, business and tourism activities.

Today the questions of urban waste management represent some of the major challenges facing urban managers, as a consequence of their effects on human health, sustainable development, and urban finance. Earlier, waste management in African cities has been perceived solely as a technical, organizational, and financial operation, but currently the realization is dawning that waste management gives leverage for power of the highest order.

According to Charles et al., (1995), wastes are material perceived to have little or no value by society's producers or consumers and nearly all human activities produce wastes. Among those wastes, solid waste is one that is generated during the acquisition of raw materials, refining and manufacturing process, and when products are used by consumers.

The problem of solid waste is often associated with the trend of urbanization and the growth of populations. Urbanization and technological advancement particularly having negative impacts on the physical environment, and the society is faced with menace of

waste heaps dumped indiscriminately on the streets, neighborhood corners, urban streams, public open spaces and other strategic locations in the built environment (Piere, 2003).

A typical solid waste management system in developing countries displays an array of problems including low collection coverage and irregular collection services, crude open dumping and burning, burning without air and water pollution control, breeding of flies and vermin, and the handling and control of informal waste picking or scavenging activities. These public health, environmental and management problems are caused by various factors which constrain the development of effective solid waste management (WHO, 2008).

In Addis Ababa, which is the capital city of Ethiopia, modern economic activities, social and infrastructural services are found relatively in a better situation than other cities of Ethiopia. However, the existing socio-economic and infrastructural service of Addis Ababa is slow to meet the needs of the increasing population from time to time due to both natural growth and rural urban migration (Enda Ethiopia, 1999).

According to Enda Ethiopia (1999), the increase in population growth in urban areas resulted in concentration of people followed by the generation of wastes. Together with the development of cities and increase of population, the amount of waste disposal is increasing from time to time and outpaced the financial and manpower resources of municipalities to deal with provision and management of services.

The vast amount of solid waste is generated in the highly populated areas, with virtually no on-site storage available, is often left outside the house, blocking paths and roads. Among those populated urban area, the poor and complete inadequacy of solid waste management is a major environmental problem in Addis Ababa (End Ethiopia, 1999).

In some cases, wastes are hazardous and require special handling or treatment in order to prevent serious harms from humans or ecosystems. In addition to solid wastes, human activities generate liquid and gaseous by-products which often exceed the assimilative capacity of the natural environment.

No matter what type of waste is being considered, individuals, organizations, and governmental bodies have a responsibility to find ways to minimize waste generation, control harmful waste stream and dispose of waste in a manner which protects human health and minimizes environmental degradation (Charles et al 1995).

As part of this process the 1994 Constitution of Ethiopia article 44 incorporates a number of provisions for the protection, sustainable use and improvement of the environment. Based on the constitution, the Addis Ababa city government issued regulations and established the necessary institutions. In accord to this the City Government of Addis Ababa has endorsed a comprehensive waste management regulations and policy of solid waste management. To boost the system the SBPDA empowered the sub-cities solid waste management team so as to lead them in a better way in managing the sub-city's solid waste..

Moreover, the policy of solid waste management incorporates integrated solid waste management system among different stakeholders. Due to this currently the involvement of private sector in municipal solid waste management is increasing, and today there are about 616 Micro and Small Scale Enterprises (MSEs) engaged in solid waste collection and disposal in Addis Ababa (SBPDA, 2008). According to Getachew (2007) Micro and Small Scale Enterprises solid waste collection activity is contributing a lot to the collectors themselves, to the environment (beneficiaries) and to the municipality at large by creating job opportunity to the jobless, by creating a clean and disease free environment, reducing workload of municipality, fuel consumption and vehicles maintenance cost.

Despite the involvement of different actors in solid waste management and improvement of legal provision are increasing, the problem of solid waste is going worse from time to time in Addis Ababa. Based on the researcher's observation, out of the ten sub-cities *kirkos* is one of which has a haphazard settlements and large number of population living in a crowded and congested area that is believed to generate large amount of solid wastes which can bring public health and environmental problems. Hence, this paper tries to assess solid waste management in *kirkos* sub-city.



## 1.2 Statements of the Problem

Human activities create wastes and it is the way these wastes are handled, collected and disposed of, which can pose risks to the environment and to the public health. In urban areas, especially in the rapid urbanizing cities of the developing world, problems and issues of Municipal Solid Waste Management (MSWM) are of immediate importance. Most governments have acknowledged this; however, rapid population growth overwhelm the capacity of most municipal authorities to provide even the most basic services (Zurbrugg, 2003)

Addis Ababa is one of the developing cities which face a critical problem in solid waste management. According to the study undertaken by Yibeltal (1997), among the major cities in Ethiopia, environmental problems are highly felt in Addis Ababa which is an international center, the capital city and the pole of high concentration in industry, commerce and transport activities. In Addis Ababa as the number of inhabitants increasing from time to time, less effort was applied in improving the collection systems of solid waste (Sewagegne, 2007).

Currently, the solid waste generated per year in the city is estimated to be 787,305 m<sup>3</sup> of which about 78 percent (615,335m<sup>3</sup>) municipal solid waste is collected and disposed of, while about 22 percent (171,969m<sup>3</sup>) of the waste generated dumped illegally on open grounds, course of rivers and sewer lines (SBPDA, 2008). Consequently, this can bring unacceptable health situation, loss of resources and affect the attractiveness of the environment which could be beneficial to the society as well as to the country at large.

Although waste collection creates job opportunities for the jobless, most waste collectors do not have access to proper safety and health care services. The temporary storages are not well protected and it could bring hazardous health problem to the community as well as to waste collectors. Moreover, there is also a problem of transferring the stored wastes from on-site storage to waste disposal place on time.

It is obvious that proper waste management save resources by reducing waste generation or converting the accumulated wastes through different mechanisms like recycling,

composting or proper disposal. According to Tadesse (2004) the community lack of awareness how to dispose the wastes they generate could not enable them to prevent or save the resources. In addition, the service for collection of wastes are inadequate, inefficient and lacking which resulted in the accumulation of waste on open lands, in drains and in the living areas of many people, causing a nuisance and environmental pollution.

To curb this problem, the Addis Ababa City Government issued regulation on waste management collection and disposal by regulation No.13/2004 which prohibits people from disposing waste along roads, avenues, rivers, ponds, and other sites. However, the regulation is continuously violated by people due to alternative means and lack of awareness for disposing the solid wastes (Tadesse, 2004).

Besides, to improve the solid waste management, the city administration has transferred the service provision of solid management to the Addis Ababa City Sanitation, Beautification, and Parks Development Agency (SBPDA) since January 2003, with the objective to make the city naturally balanced, green and favorable. The agency has been collecting the solid waste based on the decentralized system of the ten (10) sub-cities through established waste management teams. Out of the ten sub-cities, this study focuses on *Kirkos* sub-city which has a crowded and congested area where the population living in and that may bring problems of solid waste management.

Despite many research conducted on Addis Ababa municipal solid waste management, the researcher could not come across any attempts that specifically assess the solid waste collection activity in *Kirkos* sub-city. Hence, the researcher strongly believes that identifying the existing status of solid waste management in this sub-city will lay good ground for its improvement. In line with this, the study will try to answer the following basic questions.

- How do people of *Kirkos* sub-city and waste collectors of the Addis Ababa city Government collect and dispose solid wastes of the sub –city?
- What does the institutional capacity of the waste collector of the *Kirkos* Sub-city look like?

- What problems are encountered during solid waste collection and disposal at the *Kirkos* sub-city?
- What consequences are faced due to the problems related to inadequate solid waste collection and disposal at *Kirkos* sub-city?

### **1.3 Objective of the Study**

The general objective of the study is to assess and analyze solid waste collection in the *Kirkos* sub- city.

**The specific objectives are:-**

- To assess how the community and waste collectors collect and dispose solid wastes at *Kirkos* sub-city.
- To assess the institutional capacity of the *kirkos* sub-city that helps to provide the service for the community.
- To examine the various problems encountered during solid waste collection and disposal at *Kirkos* sub-city.
- To assess the consequence of poor solid waste collection and disposal at *Kirkos* sub-city.
- To forward the possible intervention strategies based on the findings.

### **1.4 Significance of the Study**

The sound management of waste among environmental issues is a major concern in maintaining the quality of the environment; especially in achieving environmentally sound, economically viable and socially desirable development. Proper waste management has significant contribution in minimizing wastes, creating job opportunities and optimizing resources. The main significance of this study is for academic purpose. It also helps in giving insight for different stakeholders to participate and benefited from its outcome.

Besides this, it enables policy makers to revisit their policy about solid waste management and serve as a springboard for further study in the area.

## **1.5 Scope of the Study**

Since there are different categories of solid waste management, this study mainly focused on household solid waste management with particular emphasis on the collection process. In order to cope up with the shortage of time and financial constraints, the study mainly focused on one sub-city of Addis Ababa, that is, *Kirkos* sub-city. The sub-city is selected purposively based on the high density population and its haphazard settlement pattern. According to SBPDA (2004) population density pattern in Addis Ababa is 6,760 people per square kilometer whereas in *Kirkos* sub-city 27,757 people reside per square kilometer. This revealed that *kirkos* sub-city has a crowded and congested area that believed to generate large amount of solid waste as compared to others. It also centre for the city in which many economic, social, and political activity are carried on. Besides this, the sub-city holds many national and international institutions like the AU, ECA, and Embassies of different countries, five star hotels and the National Palace which needs special attention in waste management. Moreover, the familiarity of the researcher to the study area made the researcher to select *kirkos* sub-city as a study area.

## **1.6 Limitation of the study**

With the resources at hand, the researcher was unable to deal with the whole sub-city of *Kirkos* and was confined to deal with few select *Kebeles* of the *Kirkos* sub-city (4 out of 11 *Kebeles*). Hence, this might have an impact on generalizing the data obtained to the sub-city at large. This is particularly a limitation because of the anticipated diversity of settlement and life style variations of the people across the different *Keble* of the sub-city. Due to the fact that this research paper is conducted based on the data collected from March 23, 2014 to April 11, 2014, it does not incorporate any information after the accomplishment of data collection and hence, it is difficult to apply the paper for the change that may happen in the management of solid waste after the period of data collection..

## **1.7 Methodology of the Study**

### **1.7.1 Study area and study period**

In this study, the researcher selected *Kirkos* sub-city purposively as a study area. This is because *Kirkos* sub-city has a crowded and congested area in which the residents living in and this helps the study to get a relatively clearer picture about problem of the solid waste management. Moreover, the researcher is more familiar with the sub-city. The research is conducted based on the data collected from the period of March 23, 2014 up to May 11, 2014.

### **1.7.2 Study Design**

The study adopted both quantitative and qualitative research approaches. The target population used for this study was the dwellers of *kirkos* sub-city. Moreover, the researcher used a descriptive survey study design to show the status of solid waste collection among the residents of *Kirkos* sub-city.

### **1.7.3 Source of Data and Tools of Data Collection**

The study used both primary and secondary data sources.

#### **i. Primary sources**

The primary data was collected using questionnaire and interview. Before administering the questionnaire, it was translated into Amharic to make the communication easier. For this purpose, the researcher employed four data collectors who took intensive training on how to collect the data before starting to collect it. Observation was also used to triangulate the data collected by the questionnaire and interview.

#### **ii. Secondary sources**

The secondary data was collected from published materials which are available in the form of books, journals, articles, internet sources, proclamations, policies, and reports.

#### **1.7.4 Sampling Procedure**

This study is conducted on a community-based urban population and hence, households were used as the sampling unit for the study. Two stage sampling procedure was used in order to select sample from the study area. At the first stage, selection of *kebeles* was made and thus, the researcher selected four *kebeles* by using simple random sampling (lottery method). At the second stage, in order to identify the eligible populations, lists of households with housing number which was obtained from selected *kebeles* were used for the selection of the specific household included in the study and the number of households of the sample size in each *kebeles* were allocated by applying proportionate to size and the ultimate sampling units (households in each *kebele*) were selected by systematic random sampling method. In each selected households only one eligible respondent (usually household head) was taken. When the household head did not present in the house, other available members of the family replaced him/her.

The household survey alone does not lead to sufficient understanding of the realities of the solid waste management in the study area. Hence, another stakeholder was included. Among the stakeholders, micro and small scale enterprises (MSEs) are the one who are engaged in sanitation and solid waste management, and they were randomly selected and interviewed. Moreover, the solid waste management team at the selected *kebele* and sub-city level were also interviewed.

#### **1.7.5 Sample Size**

A total of 300 households from the selected four *kebeles* served as the sample size for the study. The sample size was determined by its convenience to the researcher due to time and financial constraints. Moreover, from a total of 21 micro and small scale enterprises found in the four *kebeles*, the researcher selected six (6) micro and small scale enterprises as a sample based on simple random sampling method using the lottery method.

Table1: *Kebeles* and Micro and Small Scale Enterprises (MSEs) Sampled

Selected sub-city	Sampled <i>kebeles</i>	Number of household in the four <i>kebeles</i>	Sample of household in the four <i>kebeles</i>	Number of MSEs in the four <i>kebeles</i>	Sampled MSEs from the four <i>Kebeles</i>	Sampled Kebeles team leader
Kirkos sub-city	05/06/07	4665	89	2	1	1
	13/14	4595	88	3	1	1
	17/18	3541	67	8	2	1
	15/16	2919	56	8	2	1
Total		15720	300	21	6	4

Source: Kirkos Sub City administration report (2014)

### 1.7.6 Data Analysis

The analysis of the study is descriptive that combines qualitative and quantitative data. After information was gathered the data was presented and analyzed using different statistical tools such as tables, graphs and percentages that could reflect the true nature of information collected from respondents.

### 1.7.7 Benchmarks of the study

This research paper is designed to assess solid waste management in one of the Addis Ababa sub-city that is Kirkos in accord to the target set by the Addis Ababa City Sanitation, Beautification and Parks Development Agency (SBPDA). The paper assessed against the reference point set by SBPDA up to 2010 and the points of references (benchmarks) are:

- Household solid waste collection will increase from 65 percent to 90 percent.
- 30 percent of the households' solid waste will segregate (separate) at various receptacles at the source.

## 1.8 Definition of Terms

All the definitions of terms are taken from Addis Negarit Gazeta 2004 regulation on the collection and management of solid waste management.

**Industrial solid wastes:**-are wastes that encompass a wide range of materials of varying environmental toxicity emanated from different types of industry typically include general rubbish, packaging, food wastes, acids and alkalis, oils, solvents resins, paints and sludge.

**Hazardous solid wastes:** - are wastes which contain substances that are toxic to humans, plants or animals.

**Municipal solid wastes:** - wastes typically include household wastes, bulky consumer wastes as well as similar wastes from small commercial and industrial firms, institutions and markets, which are collected and disposed of.

**Air pollution:** - alteration of the atmosphere by the introduction of natural and artificial particle contaminants.

**Compost:** - are natural fertilizer decomposed by microorganism, from solid waste particularly from animal and plant by products and applied to the fertility of the soil.

**Incinerator:** - means a method and instrument that is used to burn compostable solid waste with high pressure, without causing nuisance of pollution, and that converts them to residues and ashes harmless to health

**Recycling:** - means extraction of valuable materials from solid waste and use directly or entering to factories as raw materials and manufacturing new products which may or may not be similar to the original product.

**Transfer stations:**-means temporary or facility site, where solid waste, collected by vehicles from different places is temporarily stored, that enables the dump trucks to transport the same to disposing site.

**Landfill:** - is a place where solid waste, collected and presumed useless is stored, buried discarded, burnt and disposed, on or under the ground, in a manner not harmful to health.



## **1.9 Organization of the Paper**

This research paper is organized into four parts. The first part is the introduction part which includes the background of the paper (introduction), statement of the problem, objective of the study, significance of the study, limitation of the study, scope of the study and methodology of the study as well. The methodology parts of the paper shows how the researcher collected presented and analyzed the data from respondents. The second part of the paper consists of the review of related literature which constitutes the theoretical parts of the study and the third part of the paper is the data presentation and analysis part which shows how the collected data related with the existing literature review and statement of the problem. Last but not least is the conclusions and recommendations part in which the researcher gave conclusions and recommendations based on the finding result.

## CHAPTER II

### 2. THEORETICAL LITERATURE REVIEW

This chapter consists of the literature part related to solid waste management concepts, definitions, theories, and solid waste management in Addis Ababa which are very essential while analyzing the data collected through questionnaire and interview in the coming chapter. Moreover, this chapter also consists of the background of the study area which necessitates the researcher to study up on this area.

#### 2.1.1 Historical Development of Solid Waste Management

Solid waste often called the third pollution after air and water pollution arises from various human activities and is normally discarded as useless. It consists of the highly heterogeneous mass of discarded materials from the urban community as well as the more homogenous accumulation of agricultural, industrial and mining wastes (Rao, 1996).

Solid waste management may be defined as:

The discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal of solid wastes in a manner with the best principles of public health, economics, engineering, conservation, and that is responsive to public attitudes (Thobanoglous et.al 1977).

From the days of primitive society, humans and animals have used the resources of the earth to support life and threw their wastes into the streets for animals to eat or dumped it into areas in close proximity to where it was produced in streams, streets, rivers, open pits, oceans and vacant land areas. In early times as compared to the present, the disposal of human and other wastes did not have a significant problem, for the population was small, the amount of land available for the assimilation of wastes was large and the vast majority of waste generated was composed of organic matter that decomposed rapidly in the open air (Pinderhughes, 2004 and Techobanaglous et. al 1977).

Of course, problems with the disposal of wastes can be traced from the time when human began to congregate in tribes, villages and communities and the accumulation of wastes become a consequence of life. Littering of food and other solid wastes in medieval towns the practice of throwing wastes into the unpaved streets, road ways and vacant lands led to the breeding of rats, with their attendant fleas carrying the germs of disease, and the outbreak of plague. The lack of any plan for the management of solid wastes led to the epidemic of plague, the Black Death, which killed half of Europeans in the fourteenth century and caused many subsequent epidemic and high death tolls. According to Techobanaglou et.al (1977), it was not until the 19<sup>th</sup> century that public health control measure becomes a vital consideration to public officials who began to realize that food wastes had to be collected and disposed of in a sanitary manner to control the vectors of disease.

Today, the environment is being polluted, as never before by the accumulation of solid wastes. Fundamental process associated with urbanization and industrialization have been developed with little concern for their environmental effects, resulting in governments, industries, business, and consumers generating greater amounts of waste which are inorganic and toxic (Ellis.1968 and Pinderhughes, 2004). The manner in which these materials are discarded contributes to the pollution of the whole environment- the air, the water and the land.

The problem associated with the management of solid waste in today's society are complex because of the abundance and diversity of solid wastes, the expansion of squatting in urban areas and increasing the number of population, and the shortage of finance for solid waste management services in many large cities. (Techobanoglous, 1993). Therefore, municipalities, environmental scientists and other stakeholders should work very hard not only to minimize but also to reuse and recycle the waste materials so that they could make money from it and also conserve the natural resources.

### **2.1.2 Classification of Solid Waste**

Solid wastes consists of both the organic waste materials ,composed primarily of biodegradable materials like wood, human and animal matter, paper ,etc...and the inorganic

waste materials composed largely or completely non-biodegradable materials (Pinderhughes,2004). Solid waste, thus, encompass, both a heterogeneous mass of wastes from urban community as well as a more heterogeneous accumulation of agricultural, industrial and mineral wastes. While wastes have little or no value in one setting or to the ones who wants to dispose them, the discarded wastes may gain significant value in another setting (Ramchand, 2006).

Adequate information about the types and composition of solid wastes as well as the rate at which wastes are generated or disposed are essential for the design and operation of the functional elements associated with the management of solid wastes. Solid wastes may be classified on the basis of source of generation, types, content, moisture and heating value, etc .... In this literature we used source based types as explained by Ramchandra (2006) in his book entitled “Management of Municipal Solid Waste”.

#### **Source – based classification**

Historically, the sources of solid waste have been consistent, dependent on sectors and activities and these include the following:

- **Household wastes:** also referred to as residential or domestic waste. These categories of solid waste are the consequences of household activities. It includes: old clothing, retired appliances, packaging and reading materials lefts, etc...
- **Commercial:** this refers to wastes consisting of leftover food, glasses, metals, ashes etc..., generated from stores, restaurants markets, hotel, auto- repair shops, medical facilities, etc...
- **Institutional:** this mainly consists of paper, plastic, glasses, etc... generated from educational, administrative and public building such as scrolls, colleges, offices, prisons, etc...
- **Municipal :** this includes dust , leafy matter, building debris treatment plant residual sludge ,etc ... generated from various municipal activities like constructions and demolition, street cleaning ,landscaping etc...

- **Industrial:** this mainly consists of process wastes, hazardous wastes etc ... due to industrials activities.
- **Agricultural:** this mainly consists of spoiled food grains and vegetable, agricultural remains litter etc....generated from fields, woods, vineyard, farms, etc...

### **2.1.3 Solid Waste Management (SWM) System**

Solid waste management system (SWM) is associated with the control of waste generation ,its storage, collection, transfer and transport , processing and disposal in a manner with the best principles of public health, economic, engineering , conservation, aesthetics, public attitude and other environmental considerations (Techobanoglous et.al 1977). The SWM processes differ depending on factors such as economic status (example, the ratio of wealth created by the production of primary products to that derived from manufactured goods, per capital income, etc...),degree of industrialization, social development (example, education, literacy, health care etc...) and quality of life. In addition, regional, seasonal and economic differences influence the SWM processes (RamChandra, 2006). These warrant management strategies that should be economically viable, technically feasible and socially acceptable

A solid waste management system refers to a combination of various functional elements associated with the management of solid wastes in the community at minimal costs, while preserving public health and ensuring little or minimal adverse impacts on the environment. The functional elements that constitute the system are:

#### **2.1.3.1Waste Generation**

Wastes are generated at the start of any process and thereafter at every stage as raw materials are converted into good for consumption (Ramchandra, 2006). Waste generation encompasses those activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal. What is important in waste generation is to note that there is an identification step and the step varies with each individual (Techobanogous, 1993).

The type and quantity of wastes generated in particular urban areas is determined by many factors including population density, economic prosperity, differences in manufacturing production and processing activities. Among these factors economic prosperity is the most salient (WB, 1999 as cited in Penderhughes, 2004). As nation and cities become wealthier and more urbanized, and people become more affluent and consumption oriented, more solid waste is produced and thrown away.

In contrary to this, low income countries have less to throw away and are more likely to reuse, recycle and restore goods that wealthier nations and communities would discard. Yet, despite the fact that people in developing countries generate less waste, cities in developing nations face severe waste accumulation problems due to rapid increase in population, urban density and changes in consumer behavior.

Many of the generated waste materials would be valuable resources if they were not mixed with other garbage. But, poor collecting and dumping processes mix and crush everything together; making separation an expensive and sometimes impossible task (Cunningham and Saigo, 1995). The sources of waste generation determine quantity, composition and waste characteristics. Wastes are generated from household, commercial areas, industries, institutions, street cleaning and other municipal services (Ramachandra, 2006).

### **2.1.3.2 Waste Storage**

Storage is a key functional element because collection of wastes never takes place at the time of their generation. The heterogeneous wastes generated in residential areas must be removed within eight days due to shortage of storage space and presence of biodegradable materials (Ramchandra, 2006). The cost of providing storage of solid wastes at the household level normally is borne by the households or apartment owner in the case of individuals, or by the management of commercial and industrial properties. Solid waste storage on streets and open spaces are of primary importance because of the aesthetic consideration, public health and economic condition (Tchobanoglous et al, 1977). Some of the options for solid waste storage are plastic waste containers, dustbins (of household), large solid waste storage (for institution and commercial areas or servicing depots) etc ... These storages vary in size, form and materials.

The design of an efficient waste collection system requires careful considerations of the type, size and location of container at the point of generation for storage of wastes until they are collected. However in many countries there are fewer attempts in standardizing the storage. While single family households generally use small containers, residential unit commercial units, institutions and industries require large container. Smaller containers are usually handled manually whereas the large, heavier ones require mechanical handling. Containers classified into two categories depending upon their mode of operation.

**1. Hauled containers:** - these containers used for the storage of wastes to be directly transferred to a processing plant, disposal site for emptying before being returned to either their original location or some other location.

**2. Stationary containers:** - these containers used for the storage of wastes remain at the point of generation except for occasional short trips to the collection vehicle.

### **2.1.3.3.Waste Collection**

The functional element of collection includes not only the gathering of solid wastes, but also the transporting of solid waste after collection to the location where the collection vehicle is emptied which may be a transfer station (i.e., intermediate station where wastes from smaller vehicles are transferred to large ones and also segregated) or final disposal area. Collection of solid wastes in urban areas is difficult and complex because, the generation of residential and commercial industrial solid waste is a diffuse process that takes place in every home, every apartment building and every commercial and industrial facility as well as in the streets, parks and even in the vacant areas of every community.

As the generation patterns become more diffuse and the total quantity of wastes increase the materials that are needed for waste collection become more complex (Techobanoglous, 1993). Efficient solid waste collection and transportation are essential part of the overall solid waste management programs since collection and transportation of solid waste activities constitute about 75% of the total cost in most developing countries (Rao, 1996).

The Collection of solid waste depends upon the number of waste containers, frequency of solid waste collection, types of waste collection services and the condition of routes.

Typically, solid waste collection is provided under different arrangements ranging from municipal service to contract services and under different forms of contracts. Despite the fact that a wide range of methods and equipment is used for the collection of wastes in developing countries, the collection system still is found at an infant stage (Diaz et al. 2007).

As Ramachandra (2006) stated, some of the major factors that could affect solid waste collection are the following:

**a. Collection point:**-this affect solid waste collection system components such as labor force and solid waste storages (number, size and types) which ultimately control the cost of collection. The collection point depends on the place where from which solid wastes are generated and it may be residential, commercial or industrial.

**b. Collection frequency:** - climatic condition and the settlement pattern of the locality as well as the type of containers (plastic, metals, etc...) and cost determine the collection frequency solid waste. Besides climates, the number of solid waste container on site also determines the collection frequency.

**c. Storage container:** - proper container selection can save waste collection energy, increase the speed of solid waste collection and reduce labor force. Container should also be durable, easy to handle, economical and resistant to corrosion. While selecting solid waste containers for residential solid wastes the following should be considered:-

- Efficiency: - the containers should help maximize the overall collection efficiency.
- Convenience: - the container must be easily manageable both for the residents and collection crew.
- Compatibility: - the container must be compatible with collection equipment.
- Public health and safety: - the container should be securely covered and stored.
- Ownership: - the municipal ownership must guarantee compatibility with collection equipment.



**d. Collection crew:** - the optimum crew size for a community solid waste management services depends on the availability of labor, solid waste collection methods and the condition of the routes by which solid waste transported to the deposal area. The size of collection crew also depends on the size and type of solid waste collection vehicle used, space between collection points, solid waste generation rate and collection frequency. An effective collection crew size and proper workforce management can influence the productivity of the collection system.

**e. Collection route:** - the collection programs must consider the route that is efficient for collection. An efficient routing of collection vehicles helps to decrease costs by reducing the labor expended for collection. Proper planning of collection route also helps conserve energy and minimize working hours and vehicle fuel consumption.

**f. Transfer stations:** - a transfer station is an intermediate station between final disposal area and collection point. If the disposal site is far from the collection area, it is justifiable to have a transfer station, where smaller collection vehicles transfer their loads to large vehicles, which then haul the waste long distance. The unit cost of hauling solid wastes from a collection area to a transfer station and then to a disposal site decreases as the size of the collection vehicle increases.

#### **2.1.3.4. Transfer and Transport**

Transfer and transport refer to the means facilities and appurtenances used to transfer of solid wastes from relatively small collection vehicles to larger vehicles and to transport them over extended distance sites (Techobanoglous et.al, 1977). The functional element of transfer and transport involves two steps:

- i. The transfer of solid wastes from the smaller collection vehicles to the large transport equipment and
- ii. The subsequent transport of solid wastes, usually over the long distances to the disposal sites.

### **2.1.3.5 Processing**

Processing techniques are used in solid waste management system to improve the efficiency of operations, to recover resources, conversion products and energy (Techobanoglous, 1993). Processing is required to alter the physical and chemical characteristics of solid wastes for energy and resource recovery and recycling (Ramchandra, 2006).

### **2.1.3.6. Recycling**

Solid wastes contain significant amounts of valuable materials that reduce the amount of waste to be collected and at the same time would yield significant salvage and resale income (Rao, 1996). Recycling includes various techniques, equipment and facilities used to improve both the efficiency of disposal system and recovery of usable materials and energy. Recycling is perhaps the most widely recognized form of source reduction involving the process of separating, collecting, marketing and ultimately using a material that would have otherwise been discarded. Recycling in general involves the reuse of secondary materials as a supplement to or wholly in place of virgin materials in the separation of various goods. Whether or not the material is used to produce the same goods which will recycle depends on the technical, economic and aesthetic considerations (James and Edward, 1993). Although it alone cannot solve a community municipal solid waste management problem, it can divert a significant portion of waste stream from disposal in land fill and combustion (Ramchandra, 2006).

Recycling has a lot of direct and indirect significance for the society and UNHCR (1994 cited in Ramchandra, 2006) grouped its significance into the following three areas:

**a. Economic significance:** -Although economic assessment of waste recycling is a difficult task to quantify, some of the economic benefits are: cost reduction, employment creation, energy saving, improve health care and save the money allotted for medical service, etc....

**b. Environmental and health significance:** - the volume of solid waste increases rapidly because of population growth and economic development. At the same time the composition of solid waste is also changing and leading to waste production with more

recyclables materials. Thus, recycling helps to facilitate effective solid waste management in the following ways:

- **Improved environment:** the environmental pollution may be due to its effect on other urban infrastructure. Recycling reduces the volume of the solid waste that has to be finally dumped, and thereby reducing the pollution at the waste disposal site.
- **Natural resource conservation:** recycling lowers our demand on natural resource there by making use of more and more recyclable solid wastes in industrial products, which will relieve the tremendous pressure on these precious resources (Cunningham and Saigo, 1995).

c. **Social significance:** people engaged in waste collection activities are normally of low social and economic standing. This is especially true with scavengers, which is evident from persisting poor life of their living and working conditions. The improved recycling activity will increase the economic value of the solid waste and will reduce waste scavenging activity by providing opportunity for scavengers to switch to a more socially acceptable occupation. In short, institutionalized recycling programmers will help to scavenging and transform it to an economic enterprise.

### **2.1.3.7. Waste Disposal**

Disposal is the ultimate fate of all solid waste, be it residential wastes, semi-solid wastes from municipal and industrial treatment plants, incinerator residues, compost or other substance that have no further use to the society (Techobanoglous, 1993). The process of selection of the right solid waste disposal method is a complex one due to the heterogeneity of the urban solid waste, the disposal method should be selected in such a way that provide opportunities for recycling of materials, if possible, and should not pollute the air, the ground water, the surface water or the land (Rao, 1996). According Rao (1996) several disposal methods are being used in the various parts of the world and the most prominent of these are: open dumping, sanitary land filling, incineration and composting;

### **i. Open Dumping**

For many people, the way to dispose of waste is to simply drop it someplace. Open, unregulated dumps are still the predominant method of waste disposal in most developing countries (Cunningham and Saigo, 1995). The open dumps cause public health problems by encouraging the breeding of flies, rats, mosquitoes and other pests. They also become a source of objectionable odors and cause air pollution when the solid wastes are burned in order to reduce their volume and conserve space (Rao, 1996).

### **ii. Sanitary Landfill**

Over the past fifty years most American and European cities have recognized the health and environmental hazards of open dumps. Increasingly, cities have turned to landfills, where solid waste disposal is regulated and controlled. To decrease smells and litter and to discourage insect and rodent, landfill operators are required to compact the waste and cover it every day with a layer of dirt (Cunningham and saigo, 1995). Sanitary land fill may be defined as a method of disposing waste without creating nuisances or hazards to public health and the operation is carried out without environmental damage (Rao, 1996).

### **iii. Incineration**

As urban authorities confront the problem of public opposition to landfill, as landfill space becomes increasingly difficult to find as a result of the increasing value and cost of land located within and on the periphery of urban areas, and as garbage continues to accumulate, waste planners and managers are increasingly proposing solid waste incinerators as clean , efficient waste disposal systems that reduce municipal solid waste accumulation and are an alternative to unattractive, overflowing landfills that poison water supplies and are increasingly unpopular with local residents ( Pinderhughes, 2004). Solid waste incinerators are designed to burn and sterilize waste and reduce the volume of material requiring final disposal. Conventional municipal incinerators can reduce waste volume as much as 80 percent to 95 percent (Tammemagi 1999 cited in Pinderhughes, 2004).

Although most waste management planners have become convinced that incineration should be an important part of their city's waste disposal infrastructure, it can lead to air

pollution unless the plant is designed, equipped and operated to comply with air pollution standards (Rao, 1996). Incinerators do not eliminate waste; they change the form of solid waste into toxic ash and hazardous air emissions, spreading hazardous contamination worldwide, contaminating air, soil, and water, and adding fly ash to a solid waste accumulation problem that has already reached crisis proportions (Africano, 2003 cited in Pinderhughes, 2004).

#### **iv. Composting**

Many cities rather than bury this valuable organic material they are turning it into useful product through composting biological degradation or break down organic matter under aerobic (oxygen –rich) conditions. The organic compost resulting from this process makes a nutrient-rich soil amendment that aids water retention, slows soil erosion and improves crops yield (Cunningham and Saigo, 1995).

### **2.1.4 Waste Composition**

Information on the composition of solid wastes is important in evaluating alternative equipment needs, systems, management programs and plans (Techobanglous et.al 1977). Waste composition varies with the socio-economic status within a particular community and cultural behavior. Waste composition also depends on the moisture content, density and relative distribution of municipal solid wastes (Ramchandra, 2006).

### **2.1.5. Health and Environmental Effects**

Improper handling of solid wastes is a health hazard and causes damage to the environment (Rao, 1996). An effective solid waste management system is necessary to avoid public health disasters, spread of disease by insects and vectors, and adverse effect on water and air (Phelps et al., 1995 cited in Ramchandra, 2006). Solid waste workers are the most exposed to the risks of parasitic infection and accidents, and therefore a solid waste management system must include proper mechanisms to avoid these incidences.

### **i. Public Health Effects**

Public health concerns are related primarily to prevent the invasion of areas for the storage of solid wastes which are conducive for the production of vermin and insects that often serve as potential reservoirs of disease (Tchonbaglous et al., 1977). The main risks to human health arise from the breeding of disease vectors, primarily flies and rat (Rao, 1996 and Ramchandra, 1996).

The consequences of improper management and handling of solid waste:

**a. Disease vectors and pathways:** - wastes dumped indiscriminately provide the food and environment for flourishing populations of vermin, which are the agent of various diseases. The pathways of pathogen transmission from wastes to humans are mostly indirect through insects- flies, mosquitoes, etc...

**b. Occupational hazards:** - workers handling wastes are at risk of accidents related to the nature of material and lack of safety precautions. The sharp edges of glass metals and poorly constructed storage containers may inflict injuries to workers. It is therefore, necessary for waste handlers to wear gloves, masks and be vaccinated.

### **c. Environmental Effect**

Besides causing health disorders that we have touched upon above, inadequate and improper waste management causes adverse environmental effects such as:

- **Air pollution:** burning of solid waste in open dumps or in improperly designed incinerators emits pollutants to the atmosphere.
- **Water and land pollution:** water pollution results from dumping in open areas and improper design, construction and/or operation of a sanitary landfill.
- **Odor pollution:** obnoxious odors due to the presence of decaying organic matter are characteristics of open dumps. They arise from an aerobic decomposition processes and their major constituents are particularly offensive. Proper landfill covering can eliminates this.

### 2.1.6. Determinants of Solid Waste Management

A sound solid waste management system can be affected by many factors and some of the listed below (Phelps et al., 1995 cited in Ramchandra, 2006).

- **Quantities and characteristics of wastes:** the quantities of wastes generated generally depend on the income level of a family, as a higher income category tends to generate larger quantities of wastes, compared to low income category. The quantity ranges from about 0.25 to about 2.3 kg per person per day, indicating a strong correlation between waste production and per capital income.
- **Climate and seasonal variations:** collection and disposal of wastes in the wet months are often problematic. High temperature and humidity cause solid wastes to decompose for more readily than they do in colder climates. The frequency of waste collection in high temperature and humid climates should be higher than that in cold climates.
- **Physical characteristics of an urban area:** In urban areas, where the layout of streets and houses has easy access for vehicles, door to door collection of solid waste is the accepted norm either by large compaction vehicle or smaller vehicle. The picture is quite different in the inner and older city areas where narrow lanes make service by vehicles difficult and often impossible. Access ways are narrow, unpaved and tortuous, and therefore, not accessible to collection vehicles.
- **Financial and foreign exchange constraints:** Solid waste management accounts for a sizeable proportion of the budgets of municipal corporations optimize vehicle productivity. The unfavorable financial situation of some countries hinders purchase of equipment and vehicles, and this situation is further worsened by the acute shortage of foreign exchange.
- **Cultural constraints:** In some regions, the long-standing traditions preclude the intrusion of waste collection on the precincts of household, and therefore, influence the collection system. In others, where the tradition of caste persists, and handling of waste must be drawn from certain sections of the population, while others will

not consent to placing storage bins in their immediate vicinity. Waste management is, therefore, sensitive to such local patterns of living and considers these factors in planning, design and operation.

### **2.1.7. Household Solid Wastes**

Management of solid wastes originating from households cannot be effectively undertaken through isolated approaches. Their effective management calls for the formulation of sustainable city development program. The waste management components of a sustainable city development programs is predicated upon that idea that sustainable cities are fundamental to social and economic development (UNEP, 1997 cited in Desalegn, 1998)

In this context, within the framework of sustainable city development programs, devising a system to meet the needs of entire population, including the poor are a prime responsibility of the government. Ensuring the implementation and effectiveness of the system, however, depends upon the smooth functioning and co-operation among households, communities and the government.

The goals of solid waste management from households are: - to protect environmental health, promote the quality of urban environment among the stakeholders in the efficiency and productivity of the economy and to generate a sustained employment and income (Desalegn, 1998)

In order to achieve these goals, the formulation of a sustainable city development program cooperation and coordination among stakeholders in the selection, transfer, recycling and disposal of solid wastes originating from households has paramount importance.

#### **2.1.7.1. Household Waste Collection in Informal Settlements**

While some public officials have the luxury of contemplating what kinds of changes they would like to introduce into their waste management system to reduce waste and encourage recycling, many city governments in developing countries do not have the financial resources necessary to develop even a basic structure for waste disposal and collection in some areas of their cities. At least 400 million urban residents in developing countries lack sanitation services, between 30 percent and 50 percent of urban solid waste in developing



countries is left uncollected (United Nations Center for Human Settlements 1994 cited in Pinderhughes, 2004). One of the most difficult household waste collection challenges exists in cities that have informal settlements (i.e., squatter camps and shantytowns) in their jurisdiction. Informal settlements exist in most developing countries; in 2000 informal settlements made up about 32 percent Sao Paulo, 33 percent of Lima, 34 percent of Caracas, 59 percent of Bogotá, 60 percent of Dar es Salaam, 70 percent of Luanda, and 85 percent of Addis Ababa (Choguill 1996 cited in Pinderhughes, 2004).

Most informal settlements located within and on the outskirts of many cities in developing countries have a haphazard settlements and road design that becomes even more haphazard as the population and informal settlements spread, typically causing the street grid to become more random and narrow. Lack of a formally developed street grid and infrastructure makes it difficult, and sometimes impossible, for trucks to enter the settlement area to pick up garbage. In many informal settlements, the streets grid is so narrow and/or unpaved that those even small carts cannot easily access them. This condition poses major structural challenges for waste collection vehicles and systems, especially when it rains. The situation made worse when public officials do not acknowledge informal settlements as neighborhoods and consequently deny these areas critical infrastructure and public services, a combination that results in no informal waste collection system whatsoever in many informal settlements areas. Under these conditions, garbage goes uncollected and builds up in the immediate area surrounding homes and/or accumulates in unauthorized open pit dumping areas located close to people's homes. Within a short time, these garbage dumping areas become homes to disease-carrying rodents and insects; they also smell awful and contribute to urban blight. Inadequate collection and disposal of waste is a major factor in the spread of insect-borne diseases and social despair. When residents take matters into their own hands and illegally burn waste that has collected in an open pit, local air contamination and health problems are increased.

To avoid waste accumulation and the problems associated with it, public authorities working in urban areas that include informal settlements with difficult road access for collection trucks and/or from which they cannot easily collect garbage need to create incentives that encourage individual households to physically collect their garbage and

carry it to designated sites where collection trucks and workers can receive it on designated pick up days. The best programs motivate household to separate the waste before they bring it to the pickup site or at the specific collection site in preparation for recycling and reuse (Pinderhughes, 2004).

### **2.1.8. Sustainable Solid Waste Management**

The framework for the environmentally sound municipal waste management is found on the hierarchy of objectives focused on the following major waste related program areas:

#### **i. Source Reduction**

Source reduction also known as waste prevention, is an approach that precedes waste management and addresses how products are manufactured and purchased. Put differently, this refers to the activities that reduce the amount of waste generated at source as well as activities that involve any change in the design, manufacture, purchase or usage of materials/ products to reduce their volume and toxicity before they become part of the solid waste stream (EPA, 1989 and 1995 cited in Ramchandra, 2006). Reducing waste before it is generated is a logical way to save cost and natural resources and preserve the local environment. However, a successful implementation of source reduction programs requires the co-operation of all stakeholders (Ramchandra, 2006). Policy measures must be introduced to make waste reduction easier, and there should be coordinated information campaigns (awareness creation) to help people understand what needs to be done and persuade them to do it (Wilson, 1996 cited in Pinderhughes, 2004)

#### **ii. Reuse and Recycling**

The term waste recycling refers to recycling waste that has already been produced and generated (Veta and Kizumi, 2001 cited in Pinderhughes 2004). A recycling program comprises the recovery of recyclable wastes, its processing into new materials or products. In the strict sense of the term, the processing step distinguishes recycling from reuse. In reuse, products simply cleaned for being reused, possibly in the same way before.

### **iii. Waste treatment and disposals**

The first priority in a waste management is to minimize or prevents waste arising from using various techniques and the second is recycling. However, complete abolition of waste arising or approaching to zero defects would be impossible even when wastes are minimized. Some waste will remain and even after treatment the waste may have some residual impacts on the receiving environment. Consequently, there is a need to improve a waste treatment and disposal practice.

#### **2.1.9. Community participation in solid waste management**

Most cities in developing countries face urban environmental problems and these are partly caused by inadequate provision of basic services such as water supply, sanitation facilities, transport infrastructure and waste collection. Due to lack of financial, human and technical resources, municipalities are not able to provide basic services to all neighborhoods with in the city (Moningka, 2005). These limitations of municipality call for community participation.

Community participation is a process by which individuals and families assume responsibility for their own health and welfare and for those of communities and develop the capacities to contribute theirs and the communities' developments (Moningka, 2005). For instance, to keep any solid waste management systems running at a minimum participation of the communities is required in putting the garbage at the street in a proper way at the right time. At the individual level residents are responsible as users. This evolves actions like storing waste in a proper way in bag or bin, separate recyclable or organic materials from other waste, offering waste at the right place at the proper time for collection and cleaning the area around the house. Apart from individual responsibilities, people can be collectively responsible in more or less organized activities, like meetings, clean –up campaigns and awareness' rising activities (Subash, 2009).

### **2.1.9.1 Community-Based Enterprises**

Primary collection of solid waste is an important stage within waste management systems. Household wish their waste to be removed by means of reliable and affordable systems. Municipal authorities usually provide the primary collection service in areas where a local authority cannot provide the service household may pay for it, the informal sector provide the service and collects the payments. Informal sector can take many forms such as individual waste collectors, community groups, micro and small scale enterprises (Ellis et.al 1996).

## **2.2. EMPIRICAL LITRATURE REVIEW**

### **2.2.1 The Experience of Solid Waste Management in Addis Ababa**

#### **2.2.1.1 Description of the Study Area**

##### **i. Study Area**

Addis Ababa, which is the capital city of Ethiopia, was found in 1887 by Emperor Menellik II (and his wife). It is located at the central highlands of the country covering an area of 540 square kilometers, of which 18 square kilometer is rural. It lies between 2,000 and 3,000 meters above sea level. Despite its proximity to the equator, Addis Ababa enjoys a mild Afro- Alpine temperate and warm temperate climate. The lowest and the highest annual average temperature are 10<sup>0</sup>c and 25<sup>0</sup>c. The city annual rainfall is around 1200mm (SBPDA, 2004). It is the center for modern economic and social activities and the infrastructures are found relatively in better situation than other cities of Ethiopia. However, their development is too slow to meet the demands of the increasing population due to both natural growth and rural urban migration (Tadesse, 2004).

Most of the key urban problems currently prevailing in Addis Ababa have stemmed mainly from the pattern of development it followed throughout its history pilling up for many

years. The first attempt to sketch a modern master plan for the city was made in 1936 during the Italian incursion, almost half a century later from its foundation. Even thereafter, plans proposed for the city by different planner didn't go beyond the level of blue print. As a result the original settlement pattern still continues to dominate in the current structure of the city (SBPDA, 2004). Addis Ababa city is considered as a major metropolitan city by any developing country standard. Yet, Addis Ababa lacks some important environmental requirements, of which solid waste management is the major one. Currently, the population of the city is around 2.8 million whom are living in the 10 sub-cities and 99 *kebeles* divided for administrative purpose (CSA, 2007). Each sub-city has performed its own task based on the mandate given to the sub-city on a decentralization system.

*Kirkos* is one of the sub-cities which is found at the heart of the city and bounded by *Arada* from north, *Lideta* from north-west, *Nifas-Silk Lafto* from south-west, *Bole* from south-east and *Yeka* from north-east. *Kirkos* sub-city is divided into 11 *kebeles* and it holds some places which are suitable for investment. According to CSA (2007) the sub-city has a population of 220,991 of which 103,314 are males while the rest 117,677 are females whom resides in an area 14.66 sq.km. Although the sub-city serve as a seat for Africa Union (AU) and an office for ECA, the infrastructure of the city is poorly designed and most of the residents are living in a crowded and congested area which become one of the obstacle for giving services adequately.

Under this sub-city different national and international institution is found like AU, ECA, national palace, more than 16(sixteen) countries embassies and other international NGOs. There are also international and five stars hotels like Sheraton Addis, Helton, Intercontinental, etc ... Besides this, the existence of Exhibition center, Addis Ababa Museum, Meskel Square, National Theater, Addis Ababa Stadium have shown that the sub-city is center for social and economical exchange to takes place (Zekere Kirkos, 2009).

## **ii. The establishment of the sub-city and its social and economic affairs**

The sub-city of *kirkos* is established under the Addis Ababa City Administration proclamation No.1/1995 and 18/1997. The sub-city uses 3168 employees to carry out the responsibility given by the City Government Administration so that they can perform the

daily work effectively. Although the sub-city of Kirkos is center for economic and social affairs to takes place, it has the problems of unemployment, housing and infrastructure, sanitation as well as most of its peoples living at lower economic condition (Zekere Kirkos, 2009).

### **iii. Economic Feature of Kirkos sub-city**

In this sub-city trade and industry secretarial office 13,846 service givers, 521 industries, 2,997 trade organizations, and 24 farm based organizations are registered and doing their work. Even if these organizations are existed, the unemployment rate is too high. The sub-city administrative officials by taking this into consideration, currently they are creating fast and continuous job by cooperating and establishing micro and small scale enterprises (Zekere Kirkos, 2009).

### **iv. The sub-city's annual income**

Figure 1 The five year annual income of the sub-city

S.N	Year in E.C	Achieved	Planned	%
1	1997	35991000000	56700572100	47
2	1998	34701995400	26147963500	75
3	1999	28977000000	28765175644	99.27
4	2000	45651000000	39757197399	87
5	2001	69432000000	658980746.53	94

Source: Zekere Kirkos June 2013

### **v. Education in the Sub-City**

In this sub-city under all types of schools, that is, governmental, private, and public schools there are 56 primary, 17 secondary and 9 preparatory schools. When we are looking the number of students who are learning in those schools 31,115 are at the primary school

level, 8,598 are at secondary school level and the last 3,866 are at the preparatory school level (Zekere Kirkos, 2009).

### **Vii. Health and Health Related Infrastructure**

Currently the coverage of health service in *kirkos* sub-city is reached 34 percent and the health service is given by three health stations. In these three stations there are about 128 health professionals. In addition to this, there are 96 private owned health centers (Zekere Kirkos, 2009).

### **Viii. Environmental Protection**

The Kirkos sub-city's solid and liquid wastes as well as the noise disturbance that emanated from the factory, trade center, houses are very common and can be taken as the major problems since it is center for the city. When we look at the sub-city waste disposal, out of the total streets found in the sub-city about 245.83m<sup>3</sup> solid wastes collected and disposed by the sub city's solid waste management team worker. To do this and other solid waste management activity the sub-city has a total of 357 worker, that is, one sanitary man and one team leader, 8 driver and 15 driver assistant, 2 maintenance worker, 263 street cleaning worker and 67 container guard. Since solid waste management seeks an integrated effort, there are 49 private and 32 cooperative formally established micro and small scale enterprises whom are engaged in a door-to-door solid waste collection. Despite having these, the problem of solid waste cannot be solved (SBPDA, 2008).

### **2.2.2 Solid Waste Management in Addis Ababa**

The collection and disposal of solid waste is a persistent problem to the city. The daily waste generation of the city is 2014m<sup>3</sup> or 671 tones, where as the annual generated waste accounts to 787,305m<sup>3</sup>. Out of these municipal wastes 78.16 percent is being collected. The remaining 21.4 percent of the waste is left uncollected or disposed of through informal means in open spaces, ditches, rivers, drainage channels, and valleys as well as on the streets (SBPDA, 2008). This is mostly due to insufficient waste collection and also because of lack of public awareness. This waste pollutes water, soil and air, which could bring (cause) great public health and environmental impacts. Inadequate collection, storage and poor disposal practices in solid waste management serve as breeding sites for rats, flies, mosquitoes, cockroaches and other vermin which can act as vectors in transmitting disease. The solid waste accumulated and litters in urban areas attract feral dogs searching for food scraps and liquids (Zelege, 2002). In many cities, it is the poor areas which generally have the least adequate or no waste collection system at all. Most poor household have very limited space especially in high density and illegal settlements. This makes waste storage or transporting to a supervised dumpsite difficult. Many poor settlements are also on land sites to which access by motor vehicles is difficult (Desalegn, 1998).

Workers at the collection and disposal level of solid waste are most vulnerable to diseases and their safety well depends on the appropriateness of household waste collection. Waste collection from domestic is potentially dangerous operation and workers must be properly trained to minimize accidents and injuries. New recruits must be warned about potential dangers and given a practical demonstration on the techniques of lifting without strain.

#### **i. Collection, Transportation, and Disposal of Solid Waste in Addis Ababa**

##### **a. Collection**

Municipal waste collection in Addis Ababa is handled in four ways: door to door, block, container, and street sweeping and waste collection.

- ❖ **Door to door collection** – this collection system roughly covers a greater portion of the total solid waste collected in the city, particularly covering households living



along accessible streets. Waste in this case dumped on to trucks at a specific time on a given day in the week.

- ❖ **Block collection:** this system is almost similar to the door to door collection system. The difference is that a solid waste container is placed near the blocks and everybody living in the block put their wastes on it. Door –to- door service and block collection are mostly overlapping.
- ❖ **Container collection system:** - this is actually a communal collection system whereby large  $8\text{m}^3$  refuse containers are placed at accessible sites in the kebeles. Each household should carry their waste and dump on to the containers. There are some 512  $8\text{m}^3$  metallic containers distributed all over the city, to date. There are also additional 479  $1.1\text{m}^3$  metallic containers are used in hotel, airports, apartment and also in a place where it is difficult to use the  $8\text{m}^3$  metallic container.
- ❖ **Street cleaning and waste collection:**-waste deposited in the streets of urban area may be of three different types that are dust, litter and animal faces (Zelege, 2002). Street – sweeping accounts for 6% of the total solid waste generated.

#### b. Transportation of Solid Waste

The currently available trucks by the city are 22 Volvo, 25 Nisan, 10 Hino, 9 Rhino, 3 Iveco, and 2 Fiat. Despite a total of 71 trucks available in the city to lift the container and transport the collected solid waste to the disposal area, on average only 36 trucks of them works daily. The other trucks because of different reasons like the old age of the trucks, maintenance difficulties, lack of preventive maintenance, and negligence of drivers and delay of fees cannot work properly (SBPDA, 2008). The vehicles carry only a single container at a time to the disposal site. A trip is made to and from collection site only for a single container of maximum capacity of  $8\text{m}^3$  or 2160kgs. When one considers the cost of fuel and manpower for transportation per single strip, it is inefficient and not economical. Sometimes the trucks have no cover for waste container and it distributed the wastes along the roads and this can affect the environment.

### **c. Solid Waste Disposal**

The Reppi, nicknamed, “*koshe*” is the only dumping site which is located 13 kms away from the city center. This site has been giving service since 1968 and now it has become full of waste and the identification of another alternatives landfill is so essential. The present method of disposal is crude open dumping, hauling the waste by truck, spreading and leveling by bulldozer and compacting by compactor bulldozer. The present situation shows that there are settlements clustered around the site which makes the public health is at risk, on the one hand, and the newly constructed Ring Road is too close to, which affect its aesthetic nature in general, on the other hand. Moreover, the dumping site has no gas control mechanism for the gas generated from it and causes spontaneous pollution to the air and affect the health of the residence in the nearby.

### **d. Recycling of Solid Waste**

Presently, it is not obligatory to separate recyclable materials from trash in Addis Ababa and as a result, there is a little recycling awareness among citizens. Even when recycling exists, it is minimal, sporadic and accomplished in an informal and voluntary way. Even if, most foreign and indigenous investors shows their interest to recycle the waste still now less effort applied on it.

## **2.2.3 Legal framework of solid waste management**

Environmental right ,designated as the right to clean and healthy environment , ‘satisfactory environment’ or ‘adequate environment’ ,found both in international documents as well as in national constitutions, either in declaratory or formally binding context .As parts of this process, the 1994 constitution of Ethiopia incorporate a number of provisions relevant for the protection, sustainable use and improvement of the environment. Under article 44, it provides that all persons have the right to a clean and healthy environment and government and citizens shall have the duty to protect the environment. The incorporations of these important provisions recognize and uplifts environmental right to the level of fundamental human rights.

Not only at the federal level, a number of measures have also been taken at the regional level. According to the Charter of the Addis Ababa city Government, Proclamation No. 87/1997, article 3, the Government has a duty to formulate and execute economic and social development programs, administer land and other natural resources within the territory and conserve and develop the natural environment. In particular, the duty to conserve and develop the natural environment implies that the government is generally responsible to ensure the provision of solid waste collection and disposal services.

In conformity to this, the city Government of Addis Ababa has established the Addis Ababa Sanitation, Beautification and Parks Development Agency (SBPDA) with the objective to make the city naturally balanced, clean, green and favorable environment through the prevention of environmental Pollution since January 2003 (SBPDA, 2004).

The city government of Addis Ababa has endorsed a comprehensive regulation on waste management collection and disposal by regulation No.13/2004 and it is possible to amend the previous hygiene regulation No.1/1994 by harmonizing with the current situation make the City cleaned and its natural balance maintained. As per city's decentralization power delegation, 10 solid waste management team was established in the 10 sub-cities. All the solid waste management vehicles and equipment are distributed with established criteria.

## **2.3 Conclusion**

As we have seen above this chapter consists of concepts, definitions, theories and the experience of Addis Ababa solid waste management. In this literature part one can easily able to find the historical development of solid waste management, its classification, the various methods and systems how the problem can be minimized at the time of its generation or the mechanism how it can be controlled after being generated.

Since this research paper give more emphasis on the mechanism of controlling the generated waste, it tries to explain the various factor that cause the problem to be happen, the adverse effects that it can causes and the way how one can store, collect and dispose to manage the problems. Besides this, the chapter touches the different stakeholder who have due responsibility to alleviate the problem of solid waste. Based on these concepts and

definitions, the researcher tried to analyze the data obtained through questionnaire and interview in the next chapter.

## CHAPTER III

### 3. DATA PRESENTATION AND ANALYSIS

This chapter focuses on the presentation and analysis of the data collected through questionnaires and interview. Though the researcher distributed 300 questionnaires, the collected questionnaire were 287 (95.7 percent). Here in this chapter the researcher tried to present and analyze 287 questionnaires and the interview (6 MSEs and 4 *Kebeles* team leader) using tables, figures and percentages.

#### 3.1. Characteristics of the household respondents

Table 2 Characteristics of the household respondents

S.N	Item	Respondents	Numbers of respondents	
			Frequency	%
1	Sex	Male	139	48.4
		Female	148	51.6
		<b>Total</b>	287	100
2	Number of Family	1-4	115	44
		5-7	113	39.4
		8-10	46	16.1
		>11	13	4.5
		<b>Total</b>	287	100
3	Family monthly income	<300	56	19.5
		300-600	107	37.3
		601-2000	105	36.6
		>2000	19	6.6
		<b>Total</b>	287	100
		Illiterate	21	7.3
		1-8 grade	67	23.3

	Educational background	9-12 grade	121	42.3
		Certificate and diploma	62	21.6
		Degree and above	16	5.6
		<b>Total</b>	287	100

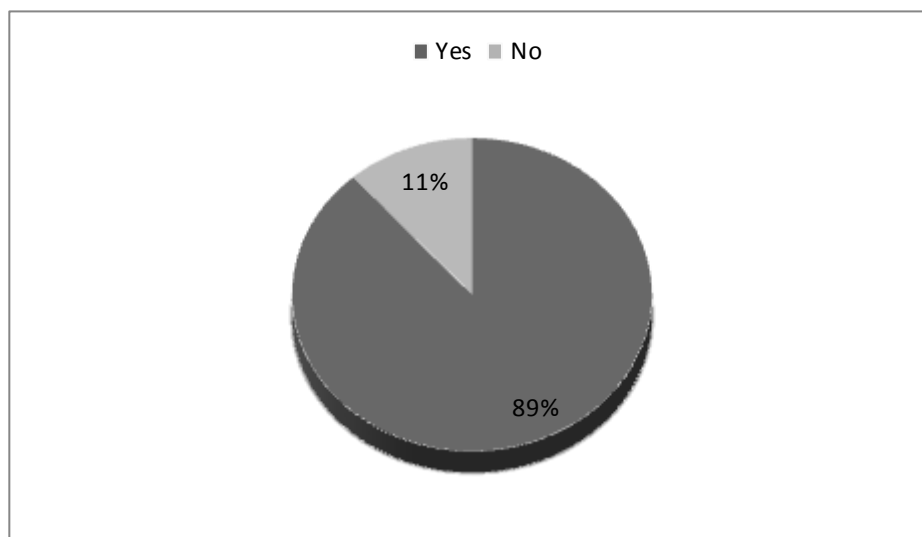
*Source:* study survey (2014)

As we can see from the table 2, out of the total respondents data collected from, 139 (48.41 percent) were males while the remaining 148 (51.6 percent) females. When we look at the number of family members the respondents had, 115 (44 percent) responded that they had families members between 1-4, 113(39.4 percent) between 5-7, 46 (16.1 percent) between 8-10 and the rest 13(4.5 percent) reported to have more than 11 family members. Based on this data, one can say that the majority of the respondents, which is about 60 percent, have family members 5(five) and above. In connection with this, Piere (2003) suggested that the growth of population is often associated with the problem of solid waste. Hence, it is essential to consider population as a factor while trying to propose solutions for the problem of solid waste.

Concerning the family monthly income of the respondents, 56(19.5 percent) said that they have family monthly income less than 300 birr, 107(37.3 percent) between 300-600 birr, 105(36.6 percent) between 601-2000 birr and the rest 19(6.6 percent) greater than 2000 birr. Here also, one can see that about 56.8 percent of the respondents have family income less than 600 birr. As to the educational status of the respondents out of the total respondents 21(7.3 percent) responded they are illiterate, 67(23.3 percent) between 1-8 grade level, 121(42.3 percent) between 9-12 grade levels, 62(21.6 percent) have certificate and diploma, and the remaining 16(5.6 percent) have degree and above.

## 3.2. Awareness of the respondents

Chart 1: Awareness of the household respondents



Source: Study survey (2014)

As it can be seen from the above pie-chart, out of the total respondents asked to identify whether they have any awareness about solid waste management, that is waste collection, separation, handling (storage) and proper disposal or not, 254 ( 88.5 percent) responded that they have the awareness while 33 (11.5 percent) responded that they do not have the awareness. There was also a question raised to the respondents who answered that they have the awareness to identify the means from where did they get these awareness, 145(57.1 percent) replied through mass media, 37(14.6 percent) of respondents are responded through *kebele* and *idir* meetings, 46(18.1 percent) answered that they have got the information(awareness) though informal relationships from their families, friends and relatives ,and the rest 26(10.2 percent) have got the information through different mechanisms (means ) such as from formal education ,training, books and from their day to day life. Although according to the data obtained most of the respondents replied that they have the awareness, the level of their awareness quite varies.

Table 3: Awareness about the advantage and the disadvantage of solid waste management.

S.N	Items	Reponses	Frequency	%
1	Do you have the awareness about the advantage of proper solid waste management	Yes	222	77.6
		No	65	22.4
		<b>Total</b>	287	100
2	Awareness about the negative consequences of poor solid waste management	Yes	271	94.4
		No	16	5.6
		<b>Total</b>	287	100

*Source:* Study survey (2014)

For the question raised to the respondents so as to identify whether they have any awareness about the advantage of proper solid waste management or not, 222 (77.6 percent) of the respondents responded that they have the awareness while 65(22.4 percent) do not have the awareness about its advantage. Among those respondents who have the awareness about its advantage, most of them replied that proper waste management could result in creating healthier environment, helps in keeping the beauties of the environment, create job opportunity for the jobless and serve as a resource for further manufacturing process .

In line with the advantage of solid waste management, the respondents were also asked to identify their awareness about the negative consequences or outcomes of poor solid waste management and 271(94.4 percent) replied that they have enough awareness about the consequences of poor solid waste management while 16(5.6 percent) do not have. Of those respondents who have the awareness about its negative consequences, most of them know that improper solid waste management can expose to different illness which are hazardous



for life, deplete resources, block sewerage line and makes the environment favorable for the breeding of flies and other insects that could bring diseases.

### 3.3 Habit of Solid Waste Collection

Table 4: Habit of solid waste collection at home

S.N	Items	Responses	Number of respondents	
			Frequency	%
1	Do you have the habit of proper solid waste collection in your home?		Frequency	%
		Yes	217	75.6
		No	70	24.4
		<b>Total</b>	287	100
2	If the answer Yes to question 1 above, what type of solid waste mostly you collected in your home?	Organic	8	3.7
		Inorganic	6	2.8
		Both	203	93.5
		<b>Total</b>	217	100

Source: Study survey (2014)

Table 4 Shows the result obtained from the total respondents responded for the question that tried to assess their habit of proper solid waste management at their home. 217(75.6 percent) answered that they have the habit while 70(24.4 percent) do not have. Of those respondents who have the habit of proper solid waste collection 8(3.7 percent ) collected only organic wastes like card boards, paper, plant residue, cloths and food residue, 6(2.8 percent) collected only inorganic solid waste like plastic, metals and the remaining 203(93.5 percent) collected both organic and inorganic solid wastes. On top of this, based on the observation and the interview made with the MSEs team leader, the researcher understands that even if both the combination of organic and inorganic solid wastes constitutes the largest percentages, most of its constituents are organic solid wastes.

Table .5. Reasons for improper solid waste management

Item	Responses	Number respondents	
		Frequency	%
What are the reasons for improper solid waste management?	Lack of awareness	29	41.4
	Negligence	26	37.2
	Lack of capacity	10	14.3
	Others	5	7.1
	<b>Total</b>		70

Source: Study survey (2014)

Regarding those respondents who don't have the habit of proper solid waste management, the respondents put different reasons for this problem. Of these reasons 29(41.4 percent) replied that lack of awareness, 26(37.2 percent) negligence, 10(14.3 percent) lack of capacity (economical and physical) and the rest 5(7.1 percent) gave other reasons like the life style and habit of the residents could not enable them to manage the solid waste they generated at their house. Consequently, these problems may lead them to dispose their wastes in open fields, river or canal side, along the road side and burning them in open air.

Table 6. Kinds of material used for solid waste collection

S.N	Items	Responses	Number of respondents	
			Frequency	%
1	What kinds of materials used for waste collection?	plastic festal	25	11.5
		bags "madaberia"	122	56.3
		Sacks	44	20.3
		baskets	20	9.2
		Dustbins	4	1.8
		Buckets	2	0.9
	<b>Total</b>		217	100

Source: study survey (2014)

Table 6 tells us about the kind of materials that the respondents used to store the solid wastes they collected at home until it is disposed of. 25(11.5 percent) collected in plastic festal, 122(56.3 percent) collected in bag (“Madaberia “), 44 (20.3 percent) collected in sacks, 20(9.2 percent) collected in baskets, 4(1.8 percent) collected in dustbins and 2(0.9 percent) used other materials like buckets. From this data one can understand that the residents use different material for collecting the solid wastes. Some of the material used for collecting the solid waste is uncovered which could be conducive for the breeding of insects and flies. Therefore, according to Diaz et al. (2007), it will be better if there is a standardization of material for collecting the solid waste at the household level.

### 3.4 Solid Waste Separation

Table 7 Habit of solid waste separation

S.N	Item	Responses	Number of respondents	
			Frequency	%
1	Do you have habit of separating solid wastes based on their type?	Yes	27	12.4
		No	190	87.6
	<b>Total</b>		217	100
2	If your answer is no to question 1 above, what will be the possible reasons?	Lack of awareness	56	29.5
		Negligence	45	23.7
		Shortage of temporary storage	46	24.2
		Shortage of time	25	13.1
		Others	18	9.5
	<b>Total</b>		190	100

Source: study survey (2014)

Based on the data obtained and presented in the above table 7, among the total respondents who have the habit of collecting solid waste in their house, 27 (12.4 percent) replied ‘ Yes’ for the question raised whether they have the habit of separating solid waste they generated based on their types in a temporary storage at the time of collecting the solid waste or not, and the rest 190 (87.6 percent) do not have this habit . This shows that almost all of the respondents in the study area do not have the habit (experience) of separating the solid waste based on their types and this can lead the resource recovery to be more complex. In line to this Cunningham and Saigo (1995) stress that the value ability of the generated waste material for resource if we separate the solid waste during its generation, but improper collecting and dumping habit making the separation expensive and sometimes impossible. When we look at the possible reasons why the respondents do not have the habit of separating ( sorting ) according to their type, 56 ( 29.5 percent) responded lack of awareness , 45 (23.7 percent) negligence, 46 (24.2 percent) shortage of temporary solid waste storage, 25(13.1 percent) shortage of time and the rest 18 (9.5percent) said different reasons like shortage of space to put the storage , lack of organization or individuals who accept the separated solid waste for other purpose could not enable the respondents to sort the solid waste at the time of generation. The finding revealed that the highest percentage (29.5 percent) of the respondents failed to do this because of lack of awareness, and indeed awareness creation campaign should be one of the fundamental solutions for the problem. Besides this, encouraging governmental and non-governmental body who have the interest to accept the separated solid waste and invest their money on it so as to produce different goods and to be benefited from its outcome.

### 3.5 Municipal Solid Waste Container

Table 8. Municipal’s solid waste container or on site storage

S.N	Item	Responses	Frequency	%
1	Is there a municipal on site storage or container in your surrounding?	Yes	120	41.8
		No	167	58.2
		<b>Total</b>	287	100
2	If your answer is yes to the question1 above, how far is it from your house?	Less than 100m	8	6.6
		Between 100m-200m	24	20
		Between 201-300	35	29.2
		Above 300m	53	44.2
		<b>Total</b>	120	100

Source: study survey (2014)

Based on the finding indicated in table 8 above for the question raised whether there is a municipal on site storage or not, 120 (41.8 percent) out of the total respondents replied that they have municipal on site storage or container which serve as a transfer station until the solid wastes are transferred to its final disposal place (at *Repi*) while 167 (58.2 percent) do not have the onsite storage around their house. Among those who replied there is municipal container around their surrounding 8(6.6 percent) replied that the container is 100m far from their house, 24(20 percent) said it is 100m-200m from the house, 35(29.2 percent) said it is between 200m-300m and the remaining 53(44.2 percent) said it is above 300m far from the municipal container. According to this finding even those respondents who replied there is on site storage in their surroundings 88 (73.4 percent) of them are far from the containers greater than 200mts. But Ramachandra (2006) recognized that it is advisable to place the containers 100-200m apart for economic reasons. If not, it may increase the chance of throwing and dumping the waste along the road sides and in

open spaces which can have an adverse effect on health, resource depletion and environmental pollution.

Table 9 Frequency of solid wastes Disposal

S.N	Item	Responses	Number of Respondents	
			Frequency	%
1	Frequency of solid waste disposal from home	Less than 3 days	79	27.5
		3-8 days	125	43.3
		9-15 days	55	19.2
		Above 15 days	28	9.8
	<b>Total</b>		287	100
2	Responsible body for removing the solid waste from home	House servant	21	7.3
		Children	72	25.1
		Household head	30	10.6
		MSEs	161	56
		Others	3	1
	<b>Total</b>		287	100

Source: study survey (2014)

Table 9 as shown above indicates that the time interval (frequency) that the collected solid waste is disposed of from the household is varied. Based on the finding out of the total respondents, 79 (27.5 percent) replied that less than 3 days, 125 (43.5 percent) replied that between 3-8 days, 55 (19.2 percent) responded that between 9-15 days and the remaining 28 (9.8 percent) said that above 15 days they will take to dispose the collected solid waste either directly by themselves or through micro and small scale enterprises to

the disposal place . As the finding shows more than 2/3 of the respondents that is 204 (70 percent) removed their household wastes with less than eight days from house. Ramachandra (2006) reinforce this idea by stating the advisability of removing solid waste from residential area within eight days after collection due to the presence of biodegradable materials that can cause bad smell and shortage of space.

When we come to the responsible body to dispose the solid waste 21 (7.3 percent) replied house hold servant, 72(25.1 percent) answered that children, 30(10.6 percent) responded that household head, 161(56 percent) replied micro and small scale enterprises, and the rest 3(1 percent) responded that other members like “daily laborers” or “wezader” are responsible to take the collected solid waste to the disposal place. According to this finding one can easily able to see that majority of the respondents have been becoming familiar in using the service provided by MSEs and in the long run through cooperative effort they will minimize this problem.

Table 10 Evaluation of the container

S.N	Item	Responses	Frequency	%
1	Evaluation of the <i>kebele</i> /sub-city in emptying the solid waste container in your surrounding	Extremely unsatisfied	36	30
		unsatisfied	40	33.3
		Moderate	35	29.2
		Satisfied	5	4.2
		Extremely satisfied	4	3.3
		<b>Total</b>	120	100
2	If the answer is extremely Unsatisfied or unsatisfied, what will be the reasons?	Shortage of crewman (worker)	6	7.8
		Shortage of container	20	26.4
		Administration problems	28	36.5
		Financial problems	10	13.5
		Other	12	15.8
		<b>Total</b>	76	100

As can be shown in the table 10 above out of the total respondents 36(30 percent) responded extremely unsatisfied for the role of the *kebele* or sub-city in emptying the solid waste container in their surrounding, 40(33.3percent) responded unsatisfied, 35(29.2 percent) responded moderately satisfied, 5(4.2 percent) replied satisfied and 4(3.3 percent) extremely satisfied. In general based on the finding one can see that above two – third (2/3) of the total respondents unsatisfied with the collection of the container when it is filled with the solid wastes. According to the data obtained the respondents put different reasons for this and 6( 7.8 percent) responded shortage of workers ( crewman ), 20(26.4 percent) shortage of vehicles, 28(36.5 percent) replied administration problem, 10(13.8 percent) answered financial problem and the rest 12(15.8 percent) answered that other reasons like negligence, workers lack of commitment to take the container in time make the collection of the onsite storage (container) difficult to the final disposal place which is located at “ *Repi*”.

Table 11 Reasons for the shortage of container

S.N	Item	Responses	Number of Respondents	
			Frequency	%
1	Reasons for the unavailability of the container	Shortage of Container	11	6.6
		Route problems	40	24
		Financial problems	21	12.6
		Administrative problems	67	40.1
		Others	28	16.7
	<b>Total</b>		167	100

Source: study survey (2014)

In table 8, it is already presented that out the total respondents 167(58.2 percent) responded that they do not have municipal on site storage or container in their surroundings . Here, the above table 11 shows the possible reasons why there is a



deficiency of containers in their surroundings. Of these 11(6.6 percent) responded that shortage of container, 40(24 percent) replied that route problems, 21(12.6) responded financial problems, 67(40.1 percent) answered that administrative problems and the remaining 28 (16.7 percent) have put different reasons like lack of accessible places for putting the container and the poor planned settlement of the residence made the distribution of the container to become uneven.

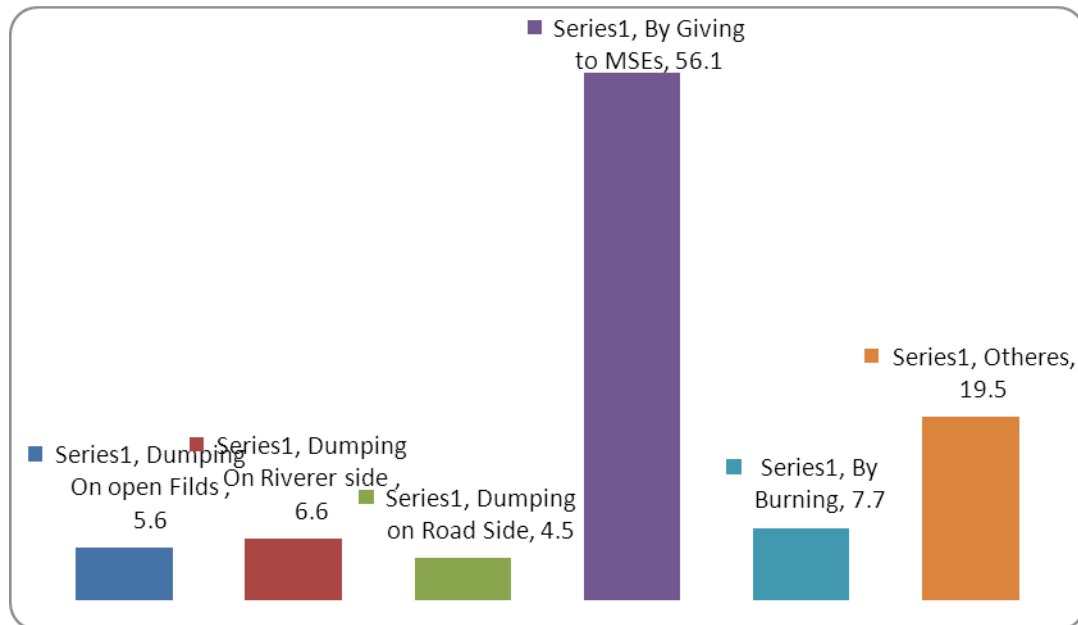
Moreover, the *kebele* /sub-city and micro and small scale enterprises team leaders strongly connected the cause of uneven distribution of the container in residential area with lack of accessible place during the interview session. In general as it is mentioned in the literature part, inadequate supply of waste containers and the longer distance that residents are expected to travel so as to dispose their waste in the container encourages the probability of using open areas and road sides dumping. Especially for economically weak and physically disadvantaged groups (old age and handicapped) the situation is high.

According to the interview held with the *kebele*'s solid waste management team leader, the containers placed in the community are based on the availability and accessibility of open spaces found in the *Kebele*. The intention of this is to put the community's refuse and unwanted materials in the container and to empty the container periodically when it is full of solid waste. In addition to the problem shortage of storage, the other problem with this method of solid waste handling is that refuse is blown out of the container by wind and spoil the environment. The areas around the container are usually heavily littered and often causing air pollution and destroy the aesthetic nature of the environment. Besides when the container is full of solid waste, mostly because of various reasons the containers are not removed frequently. And this may exposed many people who are living around the containers to different disease.

To prevent this, suitable skip (container) that can go with the settlement pattern of the environment is very essential. Besides this, the communities themselves should take responsibility for ensuring that all the refuse is correctly placed in the container and creating links with the solid waste management team and other organizations who are working on this area will be vital.

### 3.6 Ways of Removing the Solid Waste from House

Chart 2. Habit of waste removing from house



Regarding the question that the residents asked how they removed their household solid wastes since most of them do not have on site storage near to their residence, 16(5.6 percent) responded that they disposed on open fields, 19( 6.6 percent ) responded on river and canal sides, 13(4.5 percent) responded on street (road ) sides, 22(7.7 percent) responded that by burning, 161(56.1 percent) replied that giving to micro and small scale enterprise (MSEs) and the rest 56(19.5 percent ) said different responses like dumping in the nearby container, going far place where they can get containers to dispose the solid waste which is generated in their house. The implication that one can see from this finding is lack of sufficient containers around the household residence can encourage illegal dumping significantly. So, the concerned body in collaboration with other stakeholder should find solution that can go with in the contextual framework of the city.

### 3.7 Household Solid Waste Generation

Table 12 Household solid waste generation

Items	Responses	Numbers of responses	
		Frequency	%
How many bags of solid waste approximately do you put out each week?	<1/2 bag	102	35.5
	between 1/2-1 bag	164	57.1
	Between 1-2 bags	18	6.3
	Above 2 bags	3	1.1
<b>Total</b>		287	100

Source: study survey (2014)

Since it is not possible to measure the amount of solid waste each household produced per day with kilogram within the given period of the time, the researcher used a rough approximation by using bags or “*Madaberia*” to measure the amount of solid waste they produced in a weekly base. The table 12 above presented the data obtained from the total household respondents regarding to the amount of solid waste they generated in their house per week and 102 (35.5 percent) of the respondents replied that they produced less than ½ bags, 164(57.1 percent) responded between ½ -1 bag, 18(6.3 percent) answered that between 1-2 bags and the rest 3(1.1 percent) replied that they generated above two bags of solid waste in their home in a weekly base .

### 3.8. Service provided by Micro and Small Scale Enterprise

Table 13. Service beneficiary from Micro and Small Scale Enterprises.

S.N	Items	Responses	Number of respondents	
			Frequency	%
1	Do you get service from micro and small scale?	Yes	161	56.1
		No	126	43.9
	<b>Total</b>		287	100
2	If your answer is Yes to question 1, how much fee monthly you pay for the service monthly?	<10 birr	115	71.4
		10- 20 birr	43	26.7
		21-40 birr	3	1.9
		>40 birr	-	-
	<b>Total</b>		161	100

Source: study survey (2014)

When the researcher tried to assess the number of household that get the service rendered by micro and small scale enterprises in the study areas as shown in the table 13, 161 ( 56.1 percent) respondents responded that they get the service while 126 ( 43.9 percent) do not. When we are looking the amount of money that the beneficiary of the respondents pay for micro and small scale enterprises, 115(71.4 percent) replied that they pay less than 10 birr , 43(26.7 percent) pay between 10-20 birr and the rest 3(1.9 percent) pay between 21-40 birr. According to the household respondents the amount of fees the household pay for the service rendered is decided based on criteria like the quantity and type of the solid waste they generate, the distance they travelled to dispose the waste ,and the household pay this money on a monthly base. Attached to this, the micro and small scales enterprises team leaders during the interview session said that mostly the amount of fees that the household pay is determined based on the willingness and capacity of the household in accord to the criteria. Sometimes, the MSEs give free service for economically disadvantaged and handicapped people based on their own willingness.

### **3.8.1. Problems emanated from MSEs**

Despite the fact that the contribution of the micro and small scale enterprises in solid waste management is not doubttable, there are also certain problems faced up on them. Based on the question asked to the respondents to examine the various problems manifested on the MSEs, the researcher has got different problems. Among those problems unable to come on time, dropping of the solid waste on the streets when their vehicles filled with more than its capacity, disciplinary problems, negligence and disposing on open fields if the onsite storage is not available in the place on time can be taken as major problems . On top of this the residents have tried to forward the possible solution that they feel to make the service provide by MSEs in a better way. Of these the commitment of administrative officials, the community and other stakeholders as well as the resource needed for its accomplishment have a paramount importance.

### **3.8.2. The main problems faced on Micro and Small Scale Enterprises (MSEs)**

A. Lack of integration among them, with the sub-city and *kebeles* officials and as a result this creates an overlapping engagement and poor planned activities.

B. Most of the micro and small scale enterprises have financial problems and due to this they cannot provide the service adequately. In addition to this, the limited financial capacity inhibits them from having office in which most activities can be carried on.

C. Due to the fact that most of the sub-city's containers are found far apart and sometimes the nearby container may be full of waste, so the Micro and Small Scale Enterprises workers may be forced to travel long distance so as to get container which is emptied. Because of this long distance, some of the MSEs may throw the waste on open spaces.

D. There is lack of accountability due to lack of applicability of proper rules and regulations, especially when they collect the fee from the residents. Sometimes one of them collects the money without being assigned and this makes unnecessary complain among themselves and with customers.

E. Because of the wrong perception of the people about the engagement of the MSEs workers in waste management, most of the workers are feeling uncomfortable and as a result there is high tendency of labor turnover. In addition, though the works are risky and hard they have no life insurance. Even they do not get sufficient medical service when they are exposed to different diseases. Therefore, it is essential to support and coordinate these enterprises both from the side of government and other stakeholders like non-governmental organizations so as to eradicate these problems.

### 3.8.3 Evaluation of the Service Provided by MSEs

Table 14. Evaluation of the service provided by MSEs

Items	Response	Number of response	
		Frequency	%
How do you evaluate the service provided by micro and small scale enterprise?	Extremely satisfied	27	16.8
	Satisfied	32	19.9
	Moderately satisfied	78	48.4
	Unsatisfied	16	9.9
	Extremely unsatisfied	8	5
<b>Total</b>		161	100

Source: study survey (2014)

Regarding to the evaluation of the micro and small scale enterprises by the household about the service they rendered for the community are presented above in the table 15 and out of the total respondents 27(16.8 percent) responded that they are extremely satisfied, 32(19.9 percent) satisfied, 78(48.4 percent) moderately satisfied, 16(9.9 percent) unsatisfied and the remaining 8(5 percent) are extremely unsatisfied. This result revealed that about 85 percent of the respondents moderately and above satisfied with the service provided by micro and small scale enterprise ( MSEs). Despite the involvement of micro and small scale enterprise in solid waste management is a recent phenomenon in this country; they are bringing great change in the management of solid waste. Therefore, there has to be strong urges to encourage them from all concerned body so as to get what we dream.

### 3.9 Problems of illegal dumping

Table 15 Problems of illegal dumping and the involvement of the people

No	Items	Response	Number of Respondents	
			Frequency	%
1	Do you notice the problems of illegal dumping in your surrounding?	Yes	241	84
		No	46	16
	<b>Total</b>		287	100
2	If your answer is 'yes' to question 1 above, did you report the problems for the concerned body?	Yes	48	19.9
		No	193	80.1
	<b>Total</b>		241	100
3	If your answer is 'no' to question 2 above, what will be the reasons?	Lack of awareness	24	12.4
		Negligence	54	28
		Shortage of time	11	5.7
		Lack of immediate response from the concerned body	102	52.8
		Others	2	1.1
	<b>Total</b>		193	100

Source: study survey (2014)

The above table 15 shows that the observation of the residence in their surrounding regarding to illegal dumping of solid waste, and out of the total respondents asked 241(84 percent) replied that they noticed illegal dumping of solid waste in their surrounding while 46(16 percent) did not. Among those respondents who replied 'yes' only 48(19.9 percent) are reporting the problems to the concerned body where as the rest 193 (80.1 percent) did not report. According to the respondents, the reason why they did not report the problems, 24(12.4 percent) replied lack of awareness, 54(28 percent) replied negligence, 11( 5.7 percent) answered that shortage of time, 102 (52.8 percent) said that lack of immediate response from the concerned body and the remaining 2(1.1 percent)

have put different reasons like not to make their relationship with their neighbors hard, it is becoming more familiar with them (not a new phenomenon) and they like to inhibit them from reporting the illegal dumping of the solid waste that exists in their surroundings.

Based on the interview obtained from the Kebeles team leader and the researcher's observation for many people, the way to dispose of the solid waste is simply to drop it somewhere. Open, unregulated dumping, burning are still the common methods of solid waste disposal in the study area. The problems of this illegal dumping are worse especially in places where the housing settlement is poor and acceptable sites for waste disposal become more scarce as well as the economic capacity to pay for the micro and small enterprises is low.

Although there is a legal framework regulation in the Addis Ababa City Government, that is, regulation NO. 13/2004 article 4 about illegal dumping of the solid waste, the regulation is continuously violated due to weak enforcement of the law and less awareness by the people. According to the interview held with the *kebele's* solid waste management leader, the control of illegal dumping is problematic as most people considers illegal dumping socially unacceptable, and it usually occurs at night to avoid from being observed by the neighbors as well as law regulators. The type of waste dumped in the areas is basically domestic with high level of plant residue, and leftover foods. Animal body remains are also dumped on streets corners but there is no adequate service provided for removing the waste. Moreover, the illegal dumping of commercial and industrial refuse complicates its removal and adds risk to environmental damage.

The consequence of this illegal dumping adds an operating cost that goes beyond the capacity of the solid waste management team. The refuse dumped on open land or in the streets increases the population of rodents, vermin and flies. On top of this, the high summer temperature makes the waste to decompose, and they are easily emitting strong odors. Despite these problems, the efforts applied to curb these have been sporadic and have no proper enforcement.



### 3.10 Types of Solid Waste Management Options

Table 16 Type of solid waste management practice

Items	Response	Number of respondents	
		Frequency	%
Types of solid waste management mostly practiced by household respondents	Waste reduction	35	12.2
	Reuse / recycle	6	2.1
	Proper disposal	182	63.4
	Others	64	22.3
<b>Total</b>		287	100

Source: study survey (2014)

The table above 16 present the result obtained from respondents concerning to the question asked about the types of solid waste management that they mostly practiced. The finding shows above in table 16 out of the total respondents 35( 12.2 percent) replied that they mostly practiced the waste reduction/prevention method, 6(2.1 percent) mostly use the reuse and recycle methods, 182(63.4 percent) mostly used proper disposal methods and the remaining 64(22.3 percent) mostly used other methods like dumping in open field, river side and burning in open air. In this finding one can able to that the majority of the respondents , that is , 63.4 percent used proper solid waste disposal method while 2.1 percent of the respondents, which is the smallest, used reuse and recycling methods. Although in the hierarchy of sustainable solid waste management waste reduction is the preferable one, here it cannot go up more than 12.2 percent.

Recycling of the solid wastes is the least practiced by the respondents. As compared to the other methods, recycling needs more financial and technological advancement and this may be one of the causes for its poor practice in the community according to the sub-city team leader. During the data collection period, the researcher observed a marvelous beginning by the *kebele* 17/18 the so called “*Tena, kebena and Genefelie Enastida Association*” in recycling the solid waste materials. Because of this effort, they got reward from Addis Ababa City Government by being the winner of the 2009 among other association.

Moreover, the association also rewarded in France Paris by being champion in managing the solid waste and this can serve as a model for others.

### 3.11 Evaluation of the Habit of solid Waste Management

Table 17 Evaluation of the habit of solid waste management

S. N	Items	Extremely Unsatisfied		Unsatisfied		Moderate		Satisfied		Extremely Satisfied		I don't know	
		Frequency	%	frequency	%	Frequency	%	frequency	%	frequency	%	Frequency	%
1	Solid waste separation while collecting the waste	158	55	86	30	16	5.6	8	2.9	6	2.1	13	4.5
2	Collection of solid waste	80	27.9	88	30.7	78	27.2	35	12.2	3	1	3	1
3	Transportation of solid waste to transfer and financial disposal place	72	25	80	27.9	95	33	22	7.7	5	1.8	13	4.6
4	Proper disposal of the solid waste	99	34.5	64	22.3	62	21.6	46	16.1	16	5.6	-	-

Source: Study survey (2014)

### **i. Solid waste separation**

Solid waste separation is crucial for solid waste minimization and saving resource depletion. Out of the total respondents asked to evaluate the habit of solid waste separation in their surrounding 158(83 percent) responded that they feel extremely unsatisfied, 86(30 percent) unsatisfied, 16(5.6 percent) moderately satisfied, 8(2.9 percent) satisfied, 8(2.1 percent) extremely satisfied and the last 13( 4.5 percent) responded that they don't have any information to judge. From this, we can understand that there is little effort applied to sort the waste based on their types. According to the interview held with the Kebele team leader one of the reason for its poor accomplishments is lack of awareness by the people about the use of solid waste separation is the major one. Therefore, government, non-governmental and other stakeholders like *Idir* and forum should exert great effort in awareness creation to the community about the use of separating the solid waste based on their types. In addition to this, it will be better to give waste collection materials for those households who have material problems for putting the waste they collected based on their type.

### **ii. Collection of solid waste**

However, collection and disposal of household waste is a major concern for many cities in developing countries, the service provided for collection is unsatisfactory (Cunningham, 1995). In the above table 17, there was a question asked to the respondents to evaluate their level of satisfaction with respect to collection of household waste, 80(27.9 percent) replied extremely unsatisfied, 88(30.7 percent) unsatisfied, 78(27.2 percent) answered moderately satisfied, 35 (12.2 percent) satisfied, 3(1 percent) extremely satisfied and the rest 3(1 percent) responded that they don't have the information to evaluate the collection of solid waste in their surroundings.

### **iii. Transportation of Solid waste**

Transportation of the solid waste collected timely to transfer station or final disposal has paramount importance. But when we look at the evaluation of the residence about the transportation of solid waste in their surrounding either to on site storage ( transfer station ) or to final disposal place , 72(25 percent) are extremely unsatisfied, 80(27.9

percent) unsatisfied, 95( 33 percent) moderately satisfied, 22(7.7 percent) satisfied, 5(1.8 percent) extremely satisfied and the remaining 13(4.6 percent) are abstained themselves from evaluating the service rendered. From this one can understand that transportation service is weak and inefficient to satisfy the needs of residence.

#### **iv. Proper Disposal of the Solid Waste**

In table 17 above there was also a question raised to the respondents to identify their evaluation (outlook) about the proper disposal of household wastes in their surrounding and 99( 34.5 percent) replied that they are extremely unsatisfied with the habit of the respondents around them in disposing their wastes properly, 64( 22.3 percent) unsatisfied, 62(21.6 percent) moderately satisfied, 46(16.1 percent) are satisfied and 16(5.6 percent) extremely satisfied . This and table 4 tells us about the habit of the respondents and their surrounding in disposing the solid waste they generated. From this one can understand that proper disposal habit of solid waste is poor and a considerable amount of the waste end up in open dumps, burning in open air and the like. As a result, it can bring adverse effects on the aesthetic nature of the environment, productivity and economic development of the country. Although dumping and burning strategies remove waste from its source, they are not sufficient or desirable long-term responses to the growing problem of solid waste accumulation in urban areas especially as the waste stream becomes increasingly composed of inorganic and toxic solid waste. Therefore, urban authorities must face that there are limits to the number of resources human beings can extract and process in relation to the rate at which the natural environment can absorb the increasingly large amounts of waste being generated by humans. The concerned body must confront the environmental and social problems associated with bury and burn waste strategies and move away from a waste disposal mentality, in which waste is buried and burned, and toward a material management mentality, in which waste is reduced, reused, and recycled.

### 3.12 Major Constraints that Hamper Effective Solid Waste Management

Table 18 Major challenges that inhibit the solid waste management

	Items	Highly disagree	%	Disagree	%	Moderately agree	%	agree	%	Highly Agree	%
1	Economic condition of the residence	72	25.1	43	15	48	16.7	67	23.3	57	19.9
2	Lack of awareness by the society	16	5.6	54	18.8	43	15	67	23.3	107	37.3
3	Administrative problems	14	4.9	21	7.3	54	18.8	75	26.1	123	42.9
4	Poor community participation and weak involvement of stakeholder	8	2.9	21	7.3	38	13.2	107	37.2	113	39.2
5	Poor infrastructure	24	8.4	46	16	35	12.2	78	27.2	104	36.2
6	Low technology and shortage of material	14	4.9	40	13.9	45	15.7	99	34.5	89	31
7	Shortage of skilled manpower	56	19.5	94	32.8	35	12.2	46	16	56	19.5
8	Population growth	22	7.7	45	15.7	43	15	64	22.3	113	39.3
9	Others										

Source: study survey (2014)

### **3.12.1 Economic Constraints**

#### **i. Economic condition of the residence**

In the above table 18 there was a question asked to identify whether economic condition of the residence has a negative effect on the management of solid waste or not. Of the total respondents 124 (43.2 percent) answered that they agree with that economic (financial) condition of the respondents have vital role in determining the management of solid waste, 48 (16.7 percent) moderately agree and 115 (40.1 percent) are disagree. As we have seen clearly from the table above nearly half of the respondents agree with the idea that economic (financial) condition of the residence have an impact on the management of the solid waste. Lower economic condition can impede the management of solid waste due to the lack of capacity to pay for Micro and small scale enterprises which engage in giving door-to-door solid waste management service. In contrary to this, Pinderhughes (2004) argue that as nations and cities become wealthier and more urbanized, people become more affluent and consumption oriented as a result more solid waste is produced and thrown away. Hence, based on the findings one can say that economic (financial) condition of the dwellers can significantly affect the way of their waste management.

#### **ii. Financial capacity of the Sub-City**

The operating budget for the management of solid waste in *Kirkos* sub-city for the entire service is 5,000,000 (five million) Ethiopian Birr which is expected to cover the full cost of vehicles fuel, maintenance cost, equipment cost, labor and medical cost, uniform and other waste management materials, promotion and awareness creation cost, etc... Based on the secondary data obtained from the sub-city and the interview held with solid waste management team leader, the researcher noticed that the allocated budget currently is not sufficient enough to remove the accumulated solid wastes and provide a sustainable service to all areas within the sub-city. According to the interview held with the sub-city solid waste management officials the following are key obstacles in budget allocation:

- Solid waste management service is not recognized as a priority service by the municipality councils who are responsible for budget allocation.

- The increment of solid waste generated in volume which is much above the growth rate of the city. As such their service costs have increase at a rate that is higher than predicted and allocated budget.
- The unplanned settlement patterns of the residence needs extra budget to collect the waste which the municipal councils did not observe while allocating the budget.

### **3.12.2 Institutional Capacity Constraints**

#### **i. Administration problems**

In table 18 presented the result obtained from the question raised to the respondents to know whether administrative problems existed in that area affect the management of the solid waste or not. Depending up on this question, more than 2/3 of the respondents, that is, 198(69 percent) agreed with this assumption, 54(18.8 percent) moderately agree and 35(12.2 percent) disagree. According to Phelps et al. (1995 cited in Ramachandra, 2006) solid waste management to be successful, it requires a wide spectrum of workforce in keeping with the demand of the system. The administration should play the key role in facilitating and coordinating the stakeholder, enforcing the law, etc... but lack of capacity and poor commitment of the administration has made the system to be poor. Of course, based on the information from interview with the team leader as well as from the researcher personal observation there is some improvement in the management of the solid waste as well as in creating the awareness of the people than the previous. But even this improvement cannot compete with rapid urbanization growth and technological advancement which are bringing the solid waste problems.

#### **ii. Low technology and shortage of materials.**

For the question asked to the respondents whether low level of technology and shortage of materials affect the management of solid waste or not, the respondents replied as shown in table 20,188(65.5 percent) agree, 45(15.7 percent) moderately agree and 44(18.8 percent) do not agree with the lack of technology, shortage of materials as a contributory factor for the problems. The finding clearly shows that the contribution of the low level of technology and shortage of materials can be taken as a cause for the existence of the problem. In the

same way the team leader at the *kebele* and sub –city level agreed with this and they suggested that the low level of technology and shortage of materials have direct relationship with budget allotted for the waste management. The budget can go to the maintenance of vehicles, the purchase of equipments, fuel and labors costs. The unfavorable financial situations hinder the purchasing power of equipment and vehicles and this situation is further worsened by the acute shortages of foreign exchange.



Figure 2. Types Vehicles and Container at the Sub –city Level

Sub-city	Population	Number and types of Vehicles						Total	Number and types of container		Total
		Volvo	Nisan	Hine	Rhino	Iveco	Fiat		8m <sup>3</sup>	1.1m <sup>3</sup>	
Arada	358,611	3	3	2	1	1	-	10	79	96	175
Addis Ketema	431,399	4	3	1	1	1	-	10	51	13	64
Lideta	361,554	2	2	1	1	-	1	7	82	63	145
Kirkos	406,916	3	3	1	1	-	-	8	92	120	212
Yeka	386,001	-	3	1	1	-	-	5	30	26	56
Bole	352,833	3	2	1	1	-	-	8	38	65	103
Akaki-Kaliti	239,628	1	2	1	1	-	-	4	25	-	25
Nifas-silk Lafto	398,129	2	2	-	-	1	-	6	44	49	95
Kolfie – Keronio	339,186	1	2	1	1	-	-	5	33	15	48
Gulele	375,631	3	3	1	1	-	-	8	25	29	54
Total	3,650,889	22	25	10	9	3	2	71	499	476	975

Source: SPBDA (2014)

In kirkos sub-city, although there are about 8 (eight) trucks for transporting the solid waste to the final disposal places, only 2(two) trucks, one Nisan and one Rhino compactor is giving the service currently. The other six trucks cannot give the service because of the old age of the trucks, maintenance difficulties, lacks of preventive maintenance, negligence of drivers, etc...

Besides the trucks, most of the communal containers are uncovered and that cannot be protected from rain and sun that make the solid waste to cause smell pollution and disturbance of human activities by exposing them to different diseases. Moreover, the settlement pattern of the town makes difficulty to place the communal container near

to the residents as a result people travel long distance to use the container for disposing their wastes in it. Therefore, if containers that suited with the settlement patterns are designed and distributed among the residence, it will minimize the problems at least partially.

### **iii. Lack of skilled man power**

As in all organization qualified and enough number of personnel management is essential to an efficient and high quality of waste collection system. In the table 18 there is a result obtained from respondents for the question asked whether lack of skilled manpower engaged in the management of solid waste have put problems or not, 102(35.5 percent) respondents are agree, 35(12.2 percent) are moderately agree and 150(52.3 percent) are disagree. According to the data obtained from SPBDA (2008) there are only two personnel at the sub-city level (one team leader and one sanitary) who have a relative qualification related to environmental management. The others team leader at the *kebele* level do not have qualification related to environmental health. Moreover, during the interview session the sub-city team leader assured this and he said that most of the personnel (team leader) are not qualified with fields related to environmental protection. But, through training by the sanitation, Beautification and Parks Development Agency (SBPDA) and other organizations, there is an effort in improving their qualification.

### **3.12.3 Infrastructural Constraints**

According to the result obtained and presented in table 18, out of the total respondents asked whether the infrastructure of their surrounding has posit problems on solid waste management or not, 182(63.4 percent) respondents agree , 35(12.2 percent) moderately agree and the remaining 70(24.4 percent) do not agree with that of their environmental settlement structure as a challenge for the problems of solid waste management . This finding tell that majority of the respondents considered their surrounding environment had laid down its own effect for the problems of solid waste management. This idea strengthen by the SBPDA study undertaken in 2004 which says most of the key urban problems currently prevailing in Addis Abba have stemmed mainly from the pattern of development it followed through history pilling up for many year. Ramachandare (2006) also stated

that, in urban areas where the layouts of streets are narrow makes service by vehicles very difficult and often impossible. On top of this, the interview response obtained from *kebele* and sub-city team leader and the researcher personal observation assured that most of the settlement in *kirokos* sub-city are haphazard and which are more worsened as the population increases. Lack of this formally developed street grid and infrastructure makes it difficult and sometimes impossible for micro and small scale enterprises to use their carts and the sub-city trucks to pick up the wastes.

The situation is more worsen due to the concerned official do not give due attention to the situation. Under these conditions, the solid waste remain uncollected and builds up in the immediate area surrounding homes and as a result the areas becomes homes to disease carrying out rodents and insects.

### **3.12.4 Social Constraints**

#### **i. Lack of awareness by the society**

The above table 18 shows that the result obtained from the question raised to household respondents so as to identify whether lack of awareness by the society had brought adverse impact on the management of solid waste or not, 70(24.4 percent) are disagree, 43(15 percent) are moderately agree and 174(60.6 percent) are agree with the lack of awareness by the society as one of the challenge faced in the study area. Besides the data presented, the researcher observed that public awareness on the management of the solid waste is generally low. Because of this low awareness, community participation in solid waste management is minimal. According to the interview with the *kebele* and sub-city team leader, although there are some attempts have been trying by the government like awareness creation through media, establishment of environmental protection clubs in school settings, joint coordination of the team leader in the *kebele* with *idir*, citizen forum, increasing the participation of micro and small scale enterprises, etc ... ,it cannot erase totally the common believe that the residents have, that is, the responsibility of environmental protection management should lies with the government. Of course these days there are some undeniable changes regarding to the awareness of the society as compared to the previous but what the problems is, the changes are gradual. Indeed, there

should be a strong effort that government should exert with the collaboration of others in order to bring tremendous change in the minds of the people.

ii. Poor community participation and weak involvement of stakeholder.

Based on the information obtained and showed in table 18 regarding to the community participation and the involvement of stakeholder is solid waste management , 220( 63.4 percent) respondents agreed with the poor community participation and weak involvement of stakeholder in their surrounding with respect to solid waste management, 38(13.2 percent) respondents moderately agree and the remaining 29(10.2 percent) are not taking this as a reason for its poorly managed . From this finding we can understand that the poor management of solid waste is manifested as a result of less community participation and weak involvement of the stakeholder, and hence creating a conducive environment for active participation of the community and stakeholders is critical. In line to this, the study undertaken in Patan (1996) argued that individual and families should assume responsibility for their own health and welfare and for those of community developments by contributing their own capacity in a way that could bring development.

iii. **Population Growth**

Based on the result obtained and presented in table 18 as to the question forwarded to the respondents to examine whether population growth has put problems in the management of solid waste or not in their residence, 177(61.6 percent) of the respondents answered that they are agreed , 67(23.4 percent) are disagree and 43( 15 percent) are moderately agree. From this result one can easily understand that population growth in the study area is one of the major contributory factor for the ineffectiveness of the system. Moreover, Enda Ethiopia (1999) reinforcing this idea by stating the increase in population growth in urban areas resulted in concentration of people followed by the generation of wastes.

### 3.13 Evaluation of the overall solid waste management

Table 19. Evaluation of the overall solid waste management in *Kirkos* Sub-City

S.N	Items	Responses	Number of respondents	
			Frequency	%
1	Evaluation of over solid waste management.	Extremely unsatisfied	70	24.4
		Unsatisfied	62	21.6
		Moderate	139	48.4
		Satisfied	11	3.8
		Extremely satisfied	5	1.8
	Total		287	100

Source: Study survey (2014)

As to the overall solid waste management in the study area there was a question raised to the respondents to evaluate its status, 70(24.4 percent) respondents replied that they are extremely unsatisfied, 62(21.6 percent) unsatisfied, 139(48.4 percent) moderately satisfied, 11(3.8 percent) satisfied and the rest 5(1.8 percent) extremely satisfied with the overall solid waste management rendered for them. The data showed that about 271(94.4 percent) respondents are moderately and below satisfied by the overall solid waste management in *kirkos* sub- city. This implies there is great home work that should be done by all concerned body.

### 3.14 Solution suggested by household respondents to curb the problems

To curb the problems existed and listed above, the respondents forwarded the possible solution that they fill. Among these:-

- Increasing the role of stakeholder in these area
- Increasing the number of vehicles and the service given to the community.

- Raising the awareness of the people through different awareness raising mechanisms like educating the people about the use of solid waste prevention, reuse, recycling, and composting, rather than throw it.
- Ensuring the commitment of the Government, the people, Non-Governmental Organization (NGO) by making them to fill responsible

### **3.15 Problems encountered during data collection**

One of the major problems during the study period was lack of information especially from households at the time of data collection. The respondents are not easily voluntarily answered to sensitive questions like income, number of families, etc... Similarly, some respondents replied something irritating response. The other problem, which the researcher faced during the data collection, was lack of availability of secondary documents (data) or report of the sub-city which is related with the status of the solid waste management that has vital role for the accomplishment of the study. In addition to this, the researcher has got difficulties in getting the sub-city and the *kebeles* as well as the micro and small scale enterprises team leader because of the meeting continuously held related to new management system, that is, Business Process Re-engineering (BPR) .

Besides the data collection problems, there was a problem of getting reference books to elaborate the concepts and theories of solid waste management .Even most of the available books and journals found in Addis Ababa University are old and outdated.

### **3.16 Conclusions**

As the researcher presented and analyzed in this chapter, it is possible to see that the management of solid waste still falls below the required level. Although government and some private institutions including community based organizations (CBOs) have tried to solve the problems, still now due to various reasons it could not be improved.

The rapid increment in population growth and technological advancement, the lack of financial and institutional capacity of the solid waste management in the sub-city, the poorly designed settlement patterns of the sub-city together with the low awareness of the

residence how to handle and manage the waste they produced, lack of responsibility and poor commitment of all the stakeholders have put the problem to continue. Moreover, most of the people throwing and dumping the solid waste in the nearby field and hence this may also have great contribution for the prevailing of this problem. Since the management of solid waste seeks the cooperation and coordination of all the stakeholders; each person should be responsible for its management.

## CHAPTER IV

### 4. CONCLUSIONS AND RECOMMENDATIONS

#### 4.1 Conclusions

The previous chapters provide information about of solid waste management, its practice and the role of the stakeholder in alleviating the problem. The concepts and definition presented in the introduction and literature part which helps the reader to know more about the solid waste management. In addition, the experience of solid waste management in Ethiopia especially in Addis Ababa mentioned in the literature part which can give more insight to the reader. Moreover, the data collected both from primary and secondary sources in Kirkos sub-city are presented and analyzed in the previous Chapter which shows the challenges, practice and opportunities of solid waste management. Here, based on the previous chapters and discussions made, the researcher finalize all the finding in the following brief and precise points.

- Awareness of the public regarding to proper waste management is still too weak. Especially on issues like waste separation, reuse, recycle and other wastes management techniques, the communities do not have sufficient awareness which resulted in poor accomplishment.
- There is inadequate collection coverage of solid waste in the study area. Although most residents living in receive a waste collection service, the service mostly does not extend to the older housing areas in which the settlement patterns are poorly designed and to the disadvantaged groups (physically and economically). Based on the finding currently about 25 percent of the household solid waste are not collected due to various reasons like lack of awareness, financial problems , etc... and as a result it brings negative impacts upon the environment, health, and resource depletion.
- Almost all of the respondents in the study area do not have the habit (experience) of separating the solid waste based on their types and this may lead the resource



recovery to be more complex. The finding revealed that the highest percentage (64 percent) of the respondents failed to do this because of lack of awareness, and indeed awareness creation campaigns should be one of the fundamental solutions for the problem.

- Even if it is believed that solid waste management is an integrated approach which needs the involvement and active participation of other stakeholders besides government like non-governmental organizations, the community and community based enterprises such as Micro and Small Scale Enterprises(MSEs) but still practically the participation of stakeholders in the study area is found at its infant stage. As it is known the active participation of the community in the collection of solid waste system especially in separating the waste based on their type is a prerequisite for its success, there is less involvement and participation of stakeholders.
- The present situation with respect to on-site storage varies from one area to another. In most cases, there is a deficiency of on-site storage mainly due to lack of free space to put the container (on-site storage). Moreover, the existing on-site storages are insecure and unsatisfactory which impede effective collection of the system and resulted in health and environmental problems. Most residents with no proper storage bins disposed their wastes on open fields, road sides, etc...Apart from the environmental and health problems, the inefficiency of collection system are resulted in aesthetic problems.
- Although it is obvious that for effective solid waste management system, sufficient amount of material and personnel are a determining factor, the institutional capacity of the sub-city and *kebeles* office have a shortage of materials and human resource so as to run the system. Besides, the officer has loose coordination with other stakeholders and this contributes for its ineffectiveness. In addition to this, due to poor enforcement of the regulatory bodies, the existing law of solid waste management is continuously violated by the residents.

- Age and condition of waste collection vehicles are not in the right position due to various reasons. A lack of financial resource is one of the factors which lead to poor maintenance of vehicles and equipment. Due to the old age of the existing vehicles used for collection service, they have got numerous breakdown and high maintenance costs as a result the collection systems became poor.
- Most of the residents' settlement of the study area is haphazard which laid an obstacle for easy collection of household wastes. Especially, this poorly planned settlement have cause great problems for micro and small scale enterprise whom collect the solid waste on a door-to-door base by using small vehicles and carts. Due to lack of access road in this poorly planned settlement, the micro and small scale enterprises could not drive their manually pushed carts.

## **4.2 Recommendations**

Based on the finding and the conclusion made, the researcher come up with the possible solutions that may curb the existing problems.

- To increase the collection system and brings significant change in solid waste management, strengthened awareness creation campaign will have a pivotal role. To implement this, coordinating and working together with different stakeholders like media, *kebele*, *idir*, school clubs, NGOs and other associations by building their capacity has vital role. Since solid waste is one of the biggest problems which threaten the life of people, educating the people about its devastating effects and the means through which the problems can easily be handled is essential. Especially, educating the people about waste prevention, separation and recycling can help the community by saving them from its expected negative outcome and as the same time saves their resources that can be an additional income to the family.
- Expanding and modernizing the collection and transferring system as much as possible have also significant contribution. Since the use of modern equipment and vehicles facilitate the development and effectiveness of the system, it is beneficial to have these within the capacity.

- Due to poor enforcement of the law, the regulation is continuously violated by people. Hence, working jointly with other regulatory bodies can have vital role in minimizing the problems
- Providing support to encourage individuals and companies operating in the field of waste collection, separation and recycling by giving incentives in addition to free of tax and assisting them to market their products locally can be a motivational factor and at last this would result in better management.
- Establishing the staff with well trained and sufficient number of workforce aside to building the financial capacity, which can minimize the administrative problems and the service rendered, is essential.
- One of the biggest problems observed in solid waste management is the problem of accessible road which can facilitate the collection system and hence working jointly with the city infrastructural office will help in constructing the road where the problems occurred.

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## **Appendix A Questionnaire for household respondents**

### **Dear Respondents:**

I am a postgraduate student at the school of graduate studies in Indra Gandhi National Open University. I am conducting a research entitled “The status of solid waste management in Addis Ababa.” and this questionnaire helps me to gather data for the completion of my thesis/research work. So, your kindly cooperation in answering the questionnaire would help me for the successful completion of my thesis/research. Your name is not required and everything that you say will be kept confidentially.

Kebele \_\_\_\_\_ House NO. \_\_\_\_\_

### **I . General Information**

1. Sex Male  Female

2. Martial Status

1 Married

2. Widowed

3. Single

4. Divorced

3. How many family members do you have?

1. 1-4  3. 8-10

2. 5-7  4. Greater than 10

4. How much is your family monthly income?

1. Less than 300

3. 600-2000

2. 300-600

4. Greater than 2000





11. What materials do you use to collect the solid waste in your house?

1. Plastic Bags

3. Basket

2. Sacks

4. Dust bins

5. Specify if any anther \_\_\_\_\_

12. Do you have the habit of separating the solid waste based on their type during collection?

1. Yes

2. No

13. If your answer to question No. 2.3.4. is no, what will be the reasons?

1. Lack of awareness

3. Shortage of container

2. Negligence

4. Shortage of time

5. Specify if any other \_\_\_\_\_

14. Is there municipal /private on site storage or container in your surrounding?

Yes

No

15. If your answer to question. No. 14 is 'Yes', how far the container from your house?

1. Less than 100m

3. 200m-300m

2. 100m-200m

4. Above 300 m

16. If your answer to question No14 is no, what will be the reasons?

1. Shortage of Container

2. Route problem

3. Financial Problem

4. Administrative problems

5. Others

17. How often do you remove the collected solid waste from your house?

1. Daily

3. 6-8 days

2. 2-5 days

4. Above 8 days.

18. Who is responsible to dispose the collected solid waste from the house?

1. House Servant

4. Micro and small scale enterpris

2. Children

5. Specify if any other \_\_\_\_\_

3. Household head

19. How do you evaluate the performance of the sub-city/Kebele to transport the container from transfer station to the disposal area?

1. Extremely unsatisfactory

4. Satisfactory

2. Unsatisfactory

5. Extremely satisfactory

3. Moderate

6. No response

20. If your answer to question 19 is “extremely unsatisfactory” or “Unsatisfactory” what will be the reasons?

1. Shortage of vehicles

4. Route problem

2. Shortage of crew size

5. Financial problem

3. Administrative problem

6. Specify if any other \_\_\_\_\_

21. How do you dispose the solid waste collected in your house?

1. dumping in open fields

4. Burning

2. dampening a river side

5. Taken by waste collectors

3. Dumping along the road

6. Specify if any other \_\_\_\_\_

22. How many bags of solid waste approximately do you presently put out each week?

1. Less than ½ bag   3. 1 - 2 bags
2. b/n ½-1bage   4. Above  
2bags

23. Do you get services form micro and small scale enterprises?

1. Yes   2. No

24 If your answer to fraction no. '23 is' yes', how much fee monthly you pay for the service they rendered?

1. Less than 10 birr  3. 20-40 birr
2. 10-20 birr  4. Above 40 birr

25. What are the basis/criteria to pay the fees?

1. Number of bags  3. Specify if any other  
\_\_\_\_\_
2. Type of wastes

26. How do you rate the services that you get from micro and small scale enterprises?

1. Extremely unsatisfactory  4. Satisfactory
2. Unsatisfactory  5. Extremely satisfactory
3. Moderate   6. No  
response

27. What are the problems that you observe from micro and small scale enterprises?

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---



---

28. What do you suggest to reduce the problems above?

---

---

29. Do you notice problems with illegal dumping in your neighborhood or at any specific location within the *Kebele*?

1. Yes   2. No

30. If your answer to question 29 is 'yes', did you report the problems for the concerned body?

1. Yes   2. No

31. If your answer to question 30 is 'no' what will be the reasons?

1. Lack of awareness  3. Shortage of time
2. Negligence  4. Lack of immediate response from concerned body
5. Specify if any other \_\_\_\_\_

32. Do you have awareness about the consequences of poor solid waste management?

1. Yes   2. No

33. If your answer to question 32 is 'yes', please specify the consequences. \_\_\_\_\_

---

34. Do you have awareness about the opportunity that you get from proper solid waste management?

1. Yes  2. No

35. If your answer to question no. 34 is 'yes', please specify the opportunity

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36. Is there a solid waste disposing truck service, in your surrounding/*Kebele*?

1. Yes

2. No.

37. If your answer to question No. 36 is 'yes', how do you evaluate the service they rendered?

1. Extremely unsatisfied

4. Satisfied

2. Unsatisfied

5. Extremely satisfied

3. Moderate

6. No response

38. Rate your evaluation of solid waste management in your surrounding or kebele. (use this rank 1-extremely unsatisfied, 2-unsatisfied, 3-moderate, 4-satisfied, 5-Extremely satisfied, 6-I don't know)

Solid waste management		6	5	4	3	2	1
1	Solid waste separation						
2	Collection of solid waste						
3	Transportation of solid waste						
4	Proper Solid waste Disposal						

39. Which solid waste management techniques do you mostly practiced in your home?

- 1. Waste prevention
- 2. Reuse/Recycle
- 3. Proper waste disposal
- 4. Others

40. What are the various problems encountered that lead to inefficient solid waste management in kirkos sub-city? (Use this rank. 1-higly disagree,2-disagree, 3-moderate, 4-agree, 5-highly agree,)

	Problems	5	4	3	2	1
1	Economic condition (financial problem)					
2	Lack of awareness by the society					
3	Weak administration					
4	Poor community participation and weak involvement of stakeholder					
5	Poor infrastructure					
6	Low technology and shortage of materials					
7	Lack of skilled manpower					
8	Cultural influence					
9	Rapid population growth <input type="checkbox"/>			<input type="checkbox"/>		

41. Specify if other  \_\_\_\_\_

42. What do you suggest to alleviate these problems?  \_\_\_\_\_

---

43. How do you evaluate the overall solid waste management in *kirkos* sub-city?

1. Extremely unsatisfied

4. Satisfied

2. Unsatisfied   
satisfied

5. Extremely

3. Moderate

6. No response

**Thank you**

## **Appendix B Interview question for Micro and small scale enterprises (MSEs)**

This interview question helps me to assess the status of solid waste management in kirkos sub-city. The interview is used only for academic purpose and every thing that you say will be kept confidentially.

1. To which micro and small scale enterprises (MSEs) do you belong?
2. What kind of solid waste management service your enterprises provide?
3. What are the various problems your enterprise faced while providing the solid waste management services? (From the residents, from the solid waste Management team)
4. What measure your enterprise take to reconcile the above problems?
5. How do you evaluate the institutional capacity of your enterprise? (in material, labour, etc.)

Is there any other institution that supports your effort? If yes, what kind of support your enterprises get from them?

6. What kind of support the solid waste management team provide to your enterprise?
7. How do you evaluate the role of micro and small scale enterprises (MSEs) in solid waste management in this kebele/sub-city?
8. How do you evaluate the overall result obtained in solid waste management in this Kebele/sub-city?
9. What should be done to increase the service in a better way?



**Appendix C Interview question for Solid waste management Team (SWMT) in Kirkos Kebeles and Sub-City**

This interview question helps me to assess the status of solid waste management in Kirkos sub-city. The interview is used only for academic purpose and every thing that you say will be kept confidentially.

1. How does your office evaluate the overall status of solid waste management in this Kebele/sub-city?
2. What are the major challenges/constraints that hinder the effectiveness of the solid waste management service rendered in this Kebele sub-city?
3. What do you suggest to minimize the above constraints?
4. What is the various solid waste management service that you provide for the community and for different stakeholder?
5. How do you evaluate the institutional capacity (material, human resource, etc . . .) and organizational structure of your office?
6. How do you evaluate the implementation of the rules and regulation of solid waste management in Kirkos sub-city?
7. How do you evaluate the role of different stakeholder in providing the solid waste management service in this kebele/sub-city?
8. What problems your office faced from stakeholder and what measures are taking to minimize the problems?
9. How do you evaluate the community participation in solid waste management?
10. What are the problems your office face by the community and what measures are taken to reduce the problem?

## **Chapter One**

1	Introduction-----	1
1.1	Background of the study-----	1
1.2	Statement of the Problem-----	4
1.3	Objective of the Study-----	6
1.4	Significance of the Study-----	6
1.5	Scope of the Study -----	7
1.6	Limitation of the Study-----	7
1.7	Methodology of the Study -----	8
1.7.1	Study Area and Study Period-----	8
1.7.2	Study Design -----	8
1.7.3	Source of Data and Tools of Data Collection -----	8
1.7.4	Sampling Procedure -----	9
1.7.5	Sample Size -----	9
1.7.6	Data Analysis -----	10

## **Chapter Two**

2.	Theoretical Literature Review -----	9
2.1	Historical Development of Solid Waste Management -----	9
2.2	Classification of Solid Waste -----	10
2.3	Solid Waste Management (SWM) System -----	12
2.3.1	Waste Generation -----	13

2.3.2 Waste Storage -----	13
2.3.3 Waste Collection-----	14
2.3.4 Transfer and Transport-----	16
2.3.5 Processing -----	17
2.3.6 Recycling-----	17
2.3.7 Waste Disposal-----	18
2.4. Waste Composition -----	
20	
Reference	

## **Dissertation proposal**

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Title of Dissertation; The assessment of solid waste management a case of kirkos sub city

### **CERTEFICATE OF APROVAL**

I hereby certify that the proposal for the dissertation entitled “The assessment of solid waste management a case of kirkos sub city” by Edan Amdebrhan has been prepared after due consultation with me. The proposal has my approval and has, to my knowledge, the potential of developing into a comprehensive dissertation project. I also agree to supervise the above-mentioned dissertation till its completion

Signature of Academic supervisor

Name Elias Brhanu

Designation

Address -----

-----

## CHAPTER ONE

### 1.1 Introduction

In the past, Africa was considered as rural, but now a day there is a progress towards urbanizations. Many countries are going through rapid urbanization with their attendant problems including the expansion of urban slums, unemployment, inadequate water supply and poor sanitation (Senkoro, 2003). As urbanization continues to take place, the management of solid waste is becoming a major public health and environmental concern in urban areas of many developing countries. The concern is very serious particularly in the capital cities, which are often the main gate ways to the countries for diplomatic, business and tourism activities.

Today the questions of urban waste management represent some of the major challenges facing urban managers, as a consequence of their effects on human health, sustainable development, and urban finance. Earlier, waste management in African cities has been perceived solely as a technical, organizational, and financial operation, but currently the realization is dawning that waste management gives leverage for power of the highest order.

According to Charles et al., (1995), wastes are material perceived to have little or no value by society's producers or consumers and nearly all human activities produce wastes. Among those wastes, solid waste is one that is generated during the acquisition of raw materials, refining and manufacturing process, and when products are used by consumers.

The problem of solid waste is often associated with the trend of urbanization and the growth of populations. Urbanization and technological advancement particularly having negative impacts on the physical environment, and the society is faced with menace of waste heaps dumped indiscriminately on the streets, neighborhood corners, urban streams, public open spaces and other strategic locations in the built environment (Piere, 2003).

A typical solid waste management system in developing countries displays an array of problems including low collection coverage and irregular collection services, crude open dumping and burning, burning without air and water pollution control, breeding of flies

and vermin, and the handling and control of informal waste picking or scavenging activities. These public health, environmental and management problems are caused by various factors which constrain the development of effective solid waste management (WHO, 2008).

In Addis Ababa, which is the capital city of Ethiopia, modern economic activities, social and infrastructural services are found relatively in a better situation than other cities of Ethiopia. However, the existing socio-economic and infrastructural service of Addis Ababa is slow to meet the needs of the increasing population from time to time due to both natural growth and rural urban migration (Enda Ethiopia, 1999).

According to Enda Ethiopia (1999), the increase in population growth in urban areas resulted in concentration of people followed by the generation of wastes. Together with the development of cities and increase of population, the amount of waste disposal is increasing from time to time and outpaced the financial and manpower resources of municipalities to deal with provision and management of services.

The vast amount of solid waste is generated in the highly populated areas, with virtually no on-site storage available, is often left outside the house, blocking paths and roads. Among those populated urban area, the poor and complete inadequacy of solid waste management is a major environmental problem in Addis Ababa (End Ethiopia, 1999).

In some cases, wastes are hazardous and require special handling or treatment in order to prevent serious harms from humans or ecosystems. In addition to solid wastes, human activities generate liquid and gaseous by-products which often exceed the assimilative capacity of the natural environment.

No matter what type of waste is being considered, individuals, organizations, and governmental bodies have a responsibility to find ways to minimize waste generation ,control harmful waste stream and dispose of waste in a manner which protects human health and minimizes environmental degradation (Charles et .al 1995) .

As part of this process the 1994 Constitution of Ethiopia article 44 incorporates a number of provisions for the protection, sustainable use and improvement of the environment.

Based on the constitution, the Addis Ababa city government issued regulations and established the necessary institutions. In accord to this the City Government of Addis Ababa has endorsed a comprehensive waste management regulations and policy of solid waste management. To boost the system the SBPDA empowered the sub-cities solid waste management team so as to lead them in a better way in managing the sub-city's solid waste..

Moreover, the policy of solid waste management incorporates integrated solid waste management system among different stakeholders. Due to this currently the involvement of private sector in municipal solid waste management is increasing, and today there are about 616 Micro and Small Scale Enterprises (MSEs) engaged in solid waste collection and disposal in Addis Ababa (SBPDA, 2008). According to Getachew (2007) Micro and Small Scale Enterprises solid waste collection activity is contributing a lot to the collectors themselves, to the environment (beneficiaries) and to the municipality at large by creating job opportunity to the jobless, by creating a clean and disease free environment, reducing workload of municipality, fuel consumption and vehicles maintenance cost

Despite the involvement of different actors in solid waste management and improvement of legal provision is increasing, the problem of solid waste is going worse from to time in addis abeba. Based on the different researches, out of the ten sub-cities Kirkos is the one and congested area that is believed to generate large amount of solid waste which can bring public health and environmental problems. Hence, this paper tries to assess solid waste management in kirkose sub-city.

## **1.2 statement of the problem**

Human activities create wastes and it is the way these wastes are handled, collected and disposed of, which can pose risks to the environment and to the public health. In urban areas, especially in the rapid urbanizing cities of the developing world, problems and issues of Municipal Solid Waste Management (MSWM) are of immediate importance. Most governments have acknowledged this; however, rapid population growth overwhelm the capacity of most municipal authorities to provide even the most basic services (Zurbrugg, 2003)

Addis Ababa is one of the developing cities which face a critical problem in solid waste management. According to the study undertaken by Yibeltal (1997), among the major cities in Ethiopia, environmental problems are highly felt in Addis Ababa which is an international center, the capital city and the pole of high concentration in industry, commerce and transport activities. In Addis Ababa as the number of inhabitants increasing from time to time, less effort was applied in improving the collection systems of solid waste (Sewagegne, 2007).

Currently, the solid waste generated per year in the city is estimated to be 787,305 m<sup>3</sup> of which about 78 percent (615,335m<sup>3</sup>) municipal solid waste is collected and disposed of, while about 22 percent (171,969m<sup>3</sup>) of the waste generated dumped illegally on open grounds, course of rivers and sewer lines (SBPDA, 2008). Consequently, this can bring unacceptable health situation, loss of resources and affect the attractiveness of the environment which could be beneficial to the society as well as to the country at large.

Although waste collection creates job opportunities for the jobless, most waste collectors do not have access to proper safety and health care services. The temporary storages are not well protected and it could bring hazardous health problem to the community as well as to waste collectors. Moreover, there is also a problem of transferring the stored wastes from on-site storage to waste disposal place on time.

It is obvious that proper waste management save resources by reducing waste generation or converting the accumulated wastes through different mechanisms like recycling, composting or proper disposal. According to Tadesse (2004) the community lack of awareness how to dispose the wastes they generate could not enable them to prevent or save the resources. In addition, the service for collection of wastes are inadequate, inefficient and lacking which resulted in the accumulation of waste on open lands, in drains and in the living areas of many people, causing a nuisance and environmental pollution.

To curb this problem, the Addis Ababa City Government issued regulation on waste management collection and disposal by regulation No.13/2004 which prohibits people from disposing waste along roads, avenues, rivers, ponds, and other sites. However, the



regulation is continuously violated by people due to alternative means and lack of awareness for disposing the solid wastes (Tadesse, 2004).

Besides, to improve the solid waste management, the city administration has transferred the service provision of solid management to the Addis Ababa City Sanitation, Beautification, and Parks Development Agency (SBPDA) since January 2003, with the objective to make the city naturally balanced, green and favorable. The agency has been collecting the solid waste based on the decentralized system of the ten (10) sub-cities through established waste management teams. Out of the ten sub-cities, this study focuses on *Kirkos* sub-city which has a crowded and congested area where the population living in and that may bring problems of solid waste management.

Despite many research conducted on Addis Abeba municipal solid waste management, the research could not come across any attempt that specifically assess the solid waste collection activity in *kirkos* sup-city. Hence, the researcher will be strongly believes that identifying the existing status of solid waste management in this sub-city will lay good ground for its improvement. In line with this, the following basic questions will be raised to be answered in the course of study .

- How do people of *Kirkos* sub-city and waste collectors of the Addis Ababa city Government collect and dispose solid wastes of the sub –city?
- What does the institutional capacity of the waste collector of the *Kirkos* Sub-city look like?
- What problems are encountered during solid waste collection and disposal at the *Kirkos* sub-city?
- What consequences are faced due to the problems related to inadequate solid waste collection and disposal at *Kirkos* sub-city?

### **1.3 Objective of the study**

The general objective of the study will be focus on assessing and analyzing solid waste collection in the *kirkos* sub-city.

To this end the following specific objective were formulated by the researcher;

- To assess how the community and waste collectors collect and dispose solid wastes at *Kirkos* sub-city.
- To assess the institutional capacity of the *kirkos* sub-city that helps to provide the service for the community.
- To examine the various problems encountered during solid waste collection and disposal at *Kirkos* sub-city.
- To assess the consequence of poor solid waste collection and disposal at *Kirkos* sub-city.
- To forward the possible intervention strategies based on the findings.

#### **1.4 Significance of the study**

The sound management of waste among environmental issues is a major concern in maintaining the quality of the environment; especially in achieving environmentally sound, economically viable and socially desirable development. Proper waste management has significant contribution in minimizing waste, creating job opportunities and optimizing recourses. However, the main significance of this study will be for academic purpose, it also could be helps in giving insight for different stakeholders to participate and benefit from its outcomes. Beside this, it will be enables policy makers to revisit their policy about solid waste management. Moreover, it will serve as a springboard for further study in the area.

#### **1.5 Scope of the study**

Since there are different categories of solid waste management, this study will be focused on household solid waste management with particular emphasis on the collection process.

In order to cope up with the shortage of time and financial constraints, the study will be mainly focused on one sub-city of Addis Abeba, that is, *krkos* sub-city, it is selected purposive based on the population settlement pattern in which they are living in a crowded

and congested area that believed to generate large amount of solid waste, centre for the city, holds many national and international institution like the AU, ECA, embassies of different countries , five star hotel and National Palace which needs special attention in waste management.

The reason why a researcher delimits the scope of the study only to kirkos sub-city is that the researcher is well aware of the area.

## **1.6 Methodology of the study**

In this study, the researcher selected kirkos sub-city purposively as a study area. This is because this sub-city has a crowded and congested settlement in which the resident live in and this helps the study will to get a relatively clearer picture about problem of the solid waste management. Moreover, the researcher is more familiar with the sub-city.

### **1.6.1 Study design**

The study will employ both qualitative and quantitative research approaches the target population used for this study will be the dwellers of kirkos sub-city. Moreover, the researcher using a descriptive study designs to show the status of solid waste collection among the residents of kirkos sub-city.

### **1.6.2 Sources of data and tools of data collection**

The study will employ both primary and secondary data sources. The primary data will be collected using questionnaire and interview. Before administering the questionnaire, it will be translated into Amharic version to make the communication easier. For this purpose, the researcher will hire four data collectors who will took intensive training on how to collect data before starting to collect it. Moreover, observation will also be used to triangulate the data collected by the questioner and interview. The secondary data will be gathered from published materials which are available in the form of books, journals, articles, internet sources, proclamation, policies, reports and guidelines.

### **1.6.3 Sampling procedure**

This study will be conducted on a community-based urban population and hence, households will be used as the sampling unit for the study. Two stage sampling procedure will be used in order to select sample from the study area. At the first stage, the sample kebeles will be selected and thus random sampling (lottery method) will be used. At the second stage, in order to identify the eligible populations, lists of household with housing number which will be obtained from selected kebeles will be used for the selection of the specific household included in the study and the number of households of the sample size in each kebele will be allocated by applying proportionate to size and the ultimate sampling method. In each selected households only one eligible respondent (usually household head) will be taken. When the household head did not present in the house, other available members of the family replaced him/her. The household survey alone does not lead to sufficient understanding of the realities of solid waste management in the study area. Hence, another stakeholder will be included. Among the stakeholders, micro and small scale enterprises (MSEs) are the one whom are engaged in sanitation and solid waste management, and they will be randomly selected and interviewed. Moreover, the solid waste management team at the selected kebeles and sub-city levels will also be interviewed.

### **1.6.4 Sample size**

A total of 300 household from the selected four kebeles will served as the sample size for the study. The sample size is determined by its convenience to the researcher due to time and financial constraints. Moreover, from a total of 21 micro and small scale enterprises found in the four kebeles, the researcher will select six (6) of them as a sample based on simple random sampling method using the lottery method technique.

Table1: *Kebeles* and Micro and Small Scale Enterprises (MSEs) Sampled

<b>Selected sub-city</b>	<b>Sampled <i>kebeles</i></b>	<b>Number of household in the four <i>kebeles</i></b>	<b>Sample of household in the four <i>kebeles</i></b>	<b>Number of MSEs in the four <i>kebeles</i></b>	<b>Sampled MSEs from the four <i>Kebeles</i></b>	<b>Sampled Kebeles team leader</b>
<i>Kirkos</i> sub-city	05/06/07	4665	89	2	1	1
	13/14	4595	88	3	1	1
	17/18	3541	67	8	2	1
	15/16	2919	56	8	2	1
Total		15720	300	21	6	4

*Source:* Kirkos Sub City administration report (2014)

### **1.6.5 Data analysis**

The analysis of the study is descriptive that combines qualitative and quantitative data. After the necessary information gathered, the data will be analyzed and presented using different statistical tools such as tables, graphs and percentages that could reflect the true nature of information collected from respondents.

## CHAPTER II

### 2. THEORETICAL LITERATURE REVIEW

#### 2.1 Historical Development of Solid Waste Management

Solid waste often called the third pollution after air and water pollution arises from various human activities and is normally discarded as useless. It consists of the highly heterogeneous mass of discarded materials from the urban community as well as the more homogenous accumulation of agricultural, industrial and mining wastes (Rao, 1996).

Solid waste management may be defined as:

The discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal of solid wastes in a manner with the best principles of public health, economics, engineering, conservation, and that is responsive to public attitudes (Thobanoglous et.al 1977).

From the days of primitive society, humans and animals have used the resources of the earth to support life and threw their wastes into the streets for animals to eat or dumped it into areas in close proximity to where it was produced in streams, streets, rivers, open pits, oceans and vacant land areas. In early times as compared to the present, the disposal of human and other wastes did not have a significant problem, for the population was small, the amount of land available for the assimilation of wastes was large and the vast majority of waste generated was composed of organic matter that decomposed rapidly in the open air (Pinderhughes, 2004 and Techobanaglous et. al 1977).

Of course, problems with the disposal of wastes can be traced from the time when human began to congregate in tribes, villages and communities and the accumulation of wastes become a consequence of life. Littering of food and other solid wastes in medieval towns the practice of throwing wastes into the unpaved streets, road ways and vacant lands led to the breeding of rats, with their attendant fleas carrying the germs of disease, and the outbreak of plague. The lack of any plan for the management of solid wastes led to the

epidemic of plague, the Black Death, which killed half of Europeans in the fourteenth century and caused many subsequent epidemic and high death tolls. According to Techobanaglou et.al (1977), it was not until the 19<sup>th</sup> century that public health control measure becomes a vital consideration to public officials who began to realize that food wastes had to be collected and disposed of in a sanitary manner to control the vectors of disease.

Today, the environment is being polluted, as never before by the accumulation of solid wastes. Fundamental process associated with urbanization and industrialization have been developed with little concern for their environmental effects, resulting in governments, industries, business, and consumers generating greater amounts of waste which are inorganic and toxic (Ellis.1968 and Pinderhughes, 2004). The manner in which these materials are discarded contributes to the pollution of the whole environment- the air, the water and the land.

The problem associated with the management of solid waste in today's society are complex because of the abundance and diversity of solid wastes, the expansion of squatting in urban areas and increasing the number of population, and the shortage of finance for solid waste management services in many large cities. (Techobanoglous, 1993). Therefore, municipalities, environmental scientists and other stakeholders should work very hard not only to minimize but also to reuse and recycle the waste materials so that they could make money from it and also conserve the natural resources.

## **2.2 Classification of Solid Waste**

Solid wastes consists of both the organic waste materials ,composed primarily of biodegradable materials like wood, human and animal matter, paper ,etc...and the inorganic waste materials composed largely or completely non-biodegradable materials (Pinderhughes,2004). Solid waste, thus, encompass, both a heterogeneous mass of wastes from urban community as well as a more heterogeneous accumulation of agricultural, industrial and mineral wastes. While wastes have little or no value in one setting or to the ones who wants to dispose them, the discarded wastes may gain significant value in another setting (Ramchand, 2006).

Adequate information about the types and composition of solid wastes as well as the rate at which wastes are generated or disposed are essential for the design and operation of the functional elements associated with the management of solid wastes. Solid wastes may be classified on the basis of source of generation, types, content, moisture and heating value, etc .... In this literature we used source based types as explained by Ramchandra (2006) in his book entitled “Management of Municipal Solid Waste”.

### **Source – based classification**

Historically, the sources of solid waste have been consistent, dependent on sectors and activities and these include the following:

- **Household wastes:** also referred to as residential or domestic waste. These categories of solid waste are the consequences of household activities. It includes: old clothing, retired appliances, packaging and reading materials lefts, etc...
- **Commercial:** this refers to wastes consisting of leftover food, glasses, metals, ashes etc..., generated from stores, restaurants markets, hotel, auto- repair shops, medical facilities, etc...
- **Institutional:** this mainly consists of paper, plastic, glasses, etc... generated from educational, administrative and public building such as scrolls, colleges, offices, prisons, etc...
- **Municipal :** this includes dust , leafy matter, building debris treatment plant residual sludge ,etc ... generated from various municipal activities like constructions and demolition, street cleaning ,landscaping etc...
- **Industrial:** this mainly consists of process wastes, hazardous wastes etc ... due to industrials activities.
- **Agricultural:** this mainly consists of spoiled food grains and vegetable, agricultural remains litter etc....generated from fields, woods, vineyard, farms, etc...



## **2.3 Solid Waste Management (SWM) System**

Solid waste management system (SWM) is associated with the control of waste generation ,its storage, collection, transfer and transport , processing and disposal in a manner with the best principles of public health, economic, engineering , conservation, aesthetics, public attitude and other environmental considerations (Techobanoglous et.al 1977). The SWM processes differ depending on factors such as economic status (example, the ratio of wealth created by the production of primary products to that derived from manufactured goods, per capital income, etc...),degree of industrialization, social development (example, education, literacy, health care etc...) and quality of life. In addition, regional, seasonal and economic differences influence the SWM processes (RamChandra, 2006). These warrant management strategies that should be economically viable, technically feasible and socially acceptable

A solid waste management system refers to a combination of various functional elements associated with the management of solid wastes in the community at minimal costs, while preserving public health and ensuring little or minimal adverse impacts on the environment. The functional elements that constitute the system are:

### **2.3.1 Waste Generation**

Wastes are generated at the start of any process and thereafter at every stage as raw materials are converted into good for consumption (Ramchandra, 2006). Waste generation encompasses those activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal. What is important in waste generation is to note that there is an identification step and the step varies with each individual (Techobanogous, 1993).

The type and quantity of wastes generated in particular urban areas is determined by many factors including population density, economic prosperity, differences in manufacturing production and processing activities. Among these factors economic prosperity is the most salient (WB, 1999 as cited in Penderhughes, 2004). As nation and cities become wealthier

and more urbanized, and people become more affluent and consumption oriented, more solid waste is produced and thrown away.

In contrary to this, low income countries have less to throw away and are more likely to reuse, recycle and restore goods that wealthier nations and communities would discard. Yet, despite the fact that people in developing countries generate less waste, cities in developing nations face severe waste accumulation problems due to rapid increase in population, urban density and changes in consumer behavior.

Many of the generated waste materials would be valuable resources if they were not mixed with other garbage. But, poor collecting and dumping processes mix and crush everything together; making separation an expensive and sometimes impossible task (Cunningham and Saigo, 1995). The sources of waste generation determine quantity, composition and waste characteristics. Wastes are generated from household, commercial areas, industries, institutions, street cleaning and other municipal services (Ramachandra, 2006).

### **2.3.2 Waste Storage**

Storage is a key functional element because collection of wastes never takes place at the time of their generation. The heterogeneous wastes generated in residential areas must be removed within eight days due to shortage of storage space and presence of biodegradable materials (Ramchandra, 2006). The cost of providing storage of solid wastes at the household level normally is borne by the households or apartment owner in the case of individuals, or by the management of commercial and industrial properties. Solid waste storage on streets and open spaces are of primary importance because of the aesthetic consideration, public health and economic condition (Tchobanoglous et al, 1977). Some of the options for solid waste storage are plastic waste containers, dustbins (of household), large solid waste storage (for institution and commercial areas or servicing depots) etc ... These storages vary in size, form and materials.

The design of an efficient waste collection system requires careful considerations of the type, size and location of container at the point of generation for storage of wastes until they are collected. However in many countries there are fewer attempts in standardizing the storage. While single family households generally use small containers, residential unit

commercial units, institutions and industries require large container. Smaller containers are usually handled manually whereas the large, heavier ones require mechanical handling. Containers classified into two categories depending upon their mode of operation.

**1. Hauled containers:** - these containers used for the storage of wastes to be directly transferred to a processing plant, disposal site for emptying before being returned to either their original location or some other location.

**2. Stationary containers:** - these containers used for the storage of wastes remain at the point of generation except for occasional short trips to the collection vehicle.

### **2.3.3 Waste Collection**

The functional element of collection includes not only the gathering of solid wastes, but also the transporting of solid waste after collection to the location where the collection vehicle is emptied which may be a transfer station (i.e., intermediate station where wastes from smaller vehicles are transferred to large ones and also segregated) or final disposal area. Collection of solid wastes in urban areas is difficult and complex because, the generation of residential and commercial industrial solid waste is a diffuse process that takes place in every home, every apartment building and every commercial and industrial facility as well as in the streets, parks and even in the vacant areas of every community.

As the generation patterns become more diffuse and the total quantity of wastes increase the materials that are needed for waste collection become more complex (Techobanoglous, 1993). Efficient solid waste collection and transportation are essential part of the overall solid waste management programs since collection and transportation of solid waste activities constitute about 75% of the total cost in most developing countries (Rao, 1996).

The Collection of solid waste depends upon the number of waste containers, frequency of solid waste collection, types of waste collection services and the condition of routes. Typically, solid waste collection is provided under different arrangements ranging from municipal service to contract services and under different forms of contracts. Despite the fact that a wide range of methods and equipment is used for the collection of wastes in

developing countries, the collection system still is found at an infant stage (Diaz et al. 2007).

As Ramachandra (2006) stated, some of the major factors that could affect solid waste collection are the following:

**a. Collection point:**-this affect solid waste collection system components such as labor force and solid waste storages (number, size and types) which ultimately control the cost of collection. The collection point depends on the place where from which solid wastes are generated and it may be residential, commercial or industrial.

**b. Collection frequency:** - climatic condition and the settlement pattern of the locality as well as the type of containers (plastic, metals, etc...) and cost determine the collection frequency solid waste. Besides climates, the number of solid waste container on site also determines the collection frequency.

**c. Storage container:** - proper container selection can save waste collection energy, increase the speed of solid waste collection and reduce labor force. Container should also be durable, easy to handle, economical and resistant to corrosion. While selecting solid waste containers for residential solid wastes the following should be considered:-

- Efficiency: - the containers should help maximize the overall collection efficiency.
- Convenience: - the container must be easily manageable both for the residents and collection crew.
- Compatibility: - the container must be compatible with collection equipment.
- Public health and safety: - the container should be securely covered and stored.
- Ownership: - the municipal ownership must guarantee compatibility with collection equipment.

**d. Collection crew:** - the optimum crew size for a community solid waste management services depends on the availability of labor, solid waste collection methods and the condition of the routes by which solid waste transported to the deposal area. The size of

collection crew also depends on the size and type of solid waste collection vehicle used, space between collection points, solid waste generation rate and collection frequency. An effective collection crew size and proper workforce management can influence the productivity of the collection system.

**e. Collection route:** - the collection programs must consider the route that is efficient for collection. An efficient routing of collection vehicles helps to decrease costs by reducing the labor expended for collection. Proper planning of collection route also helps conserve energy and minimize working hours and vehicle fuel consumption.

**f. Transfer stations:** - a transfer station is an intermediate station between final disposal area and collection point. If the disposal site is far from the collection area, it is justifiable to have a transfer station, where smaller collection vehicles transfer their loads to large vehicles, which then haul the waste long distance. The unit cost of hauling solid wastes from a collection area to a transfer station and then to a disposal site decreases as the size of the collection vehicle increases.

#### **2.3.4 Transfer and Transport**

Transfer and transport refer to the means facilities and appurtenances used to transfer of solid wastes from relatively small collection vehicles to larger vehicles and to transport them over extended distance sites (Techobanoglous et.al, 1977). The functional element of transfer and transport involves two steps:

- iii. The transfer of solid wastes from the smaller collection vehicles to the large transport equipment and
- iv. The subsequent transport of solid wastes, usually over the long distances to the disposal sites.

#### **2.3.5 Processing**

Processing techniques are used in solid waste management system to improve the efficiency of operations, to recover resources, conversion products and energy (Techobanoglous, 1993). Processing is required to alter the physical and chemical

characteristics of solid wastes for energy and resource recovery and recycling (Ramchandra, 2006)

### **2.3.6 Recycling**

Solid wastes contain significant amounts of valuable materials that reduce the amount of waste to be collected and at the same time would yield significant salvage and resale income (Rao, 1996). Recycling includes various techniques, equipment and facilities used to improve both the efficiency of disposal system and recovery of usable materials and energy. Recycling is perhaps the most widely recognized form of source reduction involving the process of separating, collecting, marketing and ultimately using a material that would have otherwise been discarded. Recycling in general involves the reuse of secondary materials as a supplement to or wholly in place of virgin materials in the separation of various goods. Whether or not the material is used to produce the same goods which will recycle depends on the technical, economic and aesthetic considerations (James and Edward, 1993). Although it alone cannot solve a community municipal solid waste management problem, it can divert a significant portion of waste stream from disposal in land fill and combustion (Ramchandra, 2006).

Recycling has a lot of direct and indirect significance for the society and UNHCR (1994 cited in Ramchandra, 2006) grouped its significance into the following three areas:

**a. Economic significance:** -Although economic assessment of waste recycling is a difficult task to quantify, some of the economic benefits are: cost reduction, employment creation, energy saving, improve health care and save the money allotted for medical service, etc....

**b. Environmental and health significance:** - the volume of solid waste increases rapidly because of population growth and economic development. At the same time the composition of solid waste is also changing and leading to waste production with more recyclables materials. Thus, recycling helps to facilitate effective solid waste management in the following ways:

- **Improved environment:** the environmental pollution may be due to its effect on other urban infrastructure. Recycling reduces the volume of the solid waste that has to be finally dumped, and thereby reducing the pollution at the waste disposal site.
- **Natural resource conservation:** recycling lowers our demand on natural resource there by making use of more and more recyclable solid wastes in industrial products, which will relieve the tremendous pressure on these precious resources (Cunningham and Saigo, 1995).

c. **Social significance:** people engaged in waste collection activities are normally of low social and economic standing. This is especially true with scavengers, which is evident from persisting poor life of their living and working conditions. The improved recycling activity will increase the economic value of the solid waste and will reduce waste scavenging activity by providing opportunity for scavengers to switch to a more socially acceptable occupation. In short, institutionalized recycling programmers will help to scavenging and transform it to an economic enterprise.

### **2.3.7 Waste Disposal**

Disposal is the ultimate fate of all solid waste, be it residential wastes, semi-solid wastes from municipal and industrial treatment plants, incinerator residues, compost or other substance that have no further use to the society (Techobanoglous, 1993). The process of selection of the right solid waste disposal method is a complex one due to the heterogeneity of the urban solid waste, the disposal method should be selected in such a way that provide opportunities for recycling of materials, if possible, and should not pollute the air, the ground water, the surface water or the land (Rao, 1996). According Rao (1996) several disposal methods are being used in the various parts of the world and the most prominent of these are: open dumping, sanitary land filling, incineration and composting;

#### **v. Open Dumping**

For many people, the way to dispose of waste is to simply drop it someplace. Open, unregulated dumps are still the predominant method of waste disposal in most developing countries (Cunningham and Saigo, 1995). The open dumps cause public health problems by

encouraging the breeding of flies, rats, mosquitoes and other pests. They also become a source of objectionable odors and cause air pollution when the solid wastes are burned in order to reduce their volume and conserve space (Rao, 1996).

#### **vi. Sanitary Landfill**

Over the past fifty years most American and European cities have recognized the health and environmental hazards of open dumps. Increasingly, cities have turned to landfills, where solid waste disposal is regulated and controlled. To decrease smells and litter and to discourage insect and rodent, landfill operators are required to compact the waste and cover it every day with a layer of dirt (Cunningham and saigo, 1995). Sanitary land fill may be defined as a method of disposing waste without creating nuisances or hazards to public health and the operation is carried out without environmental damage (Rao, 1996).

#### **vii. Incineration**

As urban authorities confront the problem of public opposition to landfill, as landfill space becomes increasingly difficult to find as a result of the increasing value and cost of land located within and on the periphery of urban areas, and as garbage continues to accumulate, waste planners and managers are increasingly proposing solid waste incinerators as clean , efficient waste disposal systems that reduce municipal solid waste accumulation and are an alternative to unattractive, overflowing landfills that poison water supplies and are increasingly unpopular with local residents ( Pinderhughes, 2004). Solid waste incinerators are designed to burn and sterilize waste and reduce the volume of material requiring final disposal. Conventional municipal incinerators can reduce waste volume as much as 80 percent to 95 percent (Tammemagi 1999 cited in Pinderhughes, 2004).

Although most waste management planners have become convinced that incineration should be an important part of their city's waste disposal infrastructure, it can lead to air pollution unless the plant is designed, equipped and operated to comply with air pollution standards (Rao, 1996). Incinerators do not eliminate waste; they change the form of solid waste into toxic ash and hazardous air emissions, spreading hazardous contamination



worldwide, contaminating air, soil, and water, and adding fly ash to a solid waste accumulation problem that has already reached crises proportions (Africano, 2003 cited in Pinderhughes, 2004).

#### **viii. Composting**

Many cities rather than bury this valuable organic material they are turning it into useful product through composting biological degradation or break down organic matter under aerobic (oxygen –rich) conditions. The organic compost resulting from this process makes a nutrient-rich soil amendment that aids water retention, slows soil erosion and improves crops yield (Cunningham and Saigo, 1995).

### **2.4 Waste Composition**

Information on the composition of solid wastes is important in evaluating alternative equipment needs, systems, management programs and plans (Techobanglous et.al 1977). Waste composition varies with the socio-economic status within a particular community and cultural behavior. Waste composition also depends on the moisture content, density and relative distribution of municipal solid wastes (Ramchandra, 2006).

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