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Assessment of solid waste generation and composition in Woreda three in Lideta Sub city, Addis Ababa

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ACCRONOMY

AACGSBPDA Addis Ababa City Government Sanitation and Beatification Parking Development Agency

EPA: Environmental Protection Authority.

EPHTI: Ethiopia Public Health Training Initiative.

OECD: Organization for Economic Co-operation and Development

SWM: Solid Waste Management.

SW: Solid Waste

SBPDA: Sanitation, Beauty, Parking and Development Agency

TALG: Transparent Accountable Local Government.

UNCHS: United Nation Centre for Human Settlement.

UNEP: United Nation Environmental Authority.

USEPA: United States Environmental Protection Agency.

WRI: World Resource Institute.

MSWM: Municipal Solid Waste Management

UNDP: United Nations Development Program

UNEP: United Nations Environmental Program

WHO: World Health Organization

ABSTRACT

Data on solid waste generation rates and waste composition are the basic information to plan and implement solid waste management systems. Households of Woreda three in Lideta sub-city like other developing country towns have poor solid waste management. Hence this study has been conducted to investigate the generation rate, physical composition of Households solid waste and the attitude of the households towards solid waste management practices. The study was conducted from December 01/ 2009 to December 21/2009 E.C on randomly selected 81 households, which are expected to represent all categories of income levels (Low, middle and high income levels) of woreda three in the sub-city. The weight of daily wastes generated from those sampled households was measured and then sorted in to its components and the weight of each component was also recorded using materials like: Balance scale, hand protective plastic gloves, mouth & nose mask, Plastic bags and plastic sheets. Questioners were also distributed among the household for assessing demographic and Socio Economic Characteristics of Respondents. The findings of this study showed that averagely low, middle and high socio-economic level households generate 0.95kg/HH/day,1.18kg/HH/day and 1.44kg/HH/day of Solid waste respectively. The statistical analyses indicate a significant difference in average quantity of solid waste generated per the three socio-economic levels of households ($p<0.01$).Results of analysis of waste compositions also showed that high contents of organic waste (64%) followed by Recyclable waste (18%) and Combustible waste (12%) was generated. The survey analysis also showed that illegal solid waste disposal in open spaces is common practice in the study area and some of the main reasons raised by the respondents were the inappropriate placement and insufficient number of communal containers. Therefore, based on the generation rate and composition of solid wastes investigated in Woreda three of Lideta sub-city, there should be integrated solid waste management system which combines a range of solid waste treatment options because of large proportion of the generated wastes is either compostable or recyclable.

Keywords: Characterization, Quantification, Recycling, Solid Waste, Analysis method, Standard of Living.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

From the days of primitive society, humans have used the resources of the earth to support life and dispose of wastes. In early times, the disposal of solid wastes including all solid materials that the processor no longer considers of any sufficient value to retain did not pose a significant problem, because the population was small and the amount of land available for the assimilation of wastes was large (Tchobanoglous et. al ., 1993) . Although emphasis is currently being placed on recycling and fertilizer value of solid wastes, the farmer in ancient times probably made a bolder attempt at this. Indication of recycling may still be seen in the primitive, yet sensible agriculture practices in many of the developing nations where farmers recycle solid wastes for fuel or fertilizers values (Alemayehu, 2007).

In every urban center, huge quantity of solid waste is generated during various activities. These wastes are to be stored, collected, transported, processed and disposed of in an environment friendly manner, so as to keep the city neat and clean. Moreover, as the system handles huge quantities of solid waste, it is necessary to have detailed information on quantification and characterization of solid waste for proper handling of solid waste at different stages of the system. Presently, majority of Municipal Corporations/ Councils do not weigh their waste but the quantities are estimated on the basis of number of trips of trucks which carry the waste to disposal site. Moreover, the solid waste management system is not planned or executed rationally due to non-availability of authentic or relevant information on waste generation. As the solid waste quantities are increasing in all cities and towns due to urbanization and industrialization, these have raised concerns about the economic viability and environmental compatibility of the current waste management methodologies. The rapid urbanization that has been taking place during the 20th century virtually transformed the world into communities of cities and towns facing a big challenges on environmental issues in which most of them have to be addressed at international level (Smith, 2010). Among those environmental issues solid waste management is a critical one because as long as humans have been living in settled communities, solid waste generation has been unavoidable and critical issue both in developed and

developing nations. As a result, solid waste management became a worldwide agenda at United Nation conference on environment and development in Rio de Janeiro in 1992 with a great emphasis on reducing waste and maximizing environmentally sound waste reuse and recycling at first step in waste management (UNEP, 1996). A well planned and managed urbanization process introduces a society to a new modern way of life, an improved level of awareness, new skills, learning opportunities, and so on. On the contrary, rapid and unmanaged population growth coupled with poor urban management system is turning the cities into places of misery by damaging the environmental quality. As a matter of fact many of the cities in developing countries possess this. Besides, high population pressure along with poor sanitation facilities and waste management systems are becoming a threat for the health of dwellers cities (Solomon, 2007).

Dealing with the environmental costs in rapidly growing economic development, urbanization and improving living standards in cities have led to an increase in the quantity and complexity of generated waste, representing a phenomenal challenge (UNDP, 2004). This is particularly true in the area of solid waste management at the household level. The rapid increase in urbanization in cities has resulted in an increased volume of waste generation. While cities are generating an ever-increasing volume of waste, the effectiveness of their solid waste collection and disposal systems are declining.

In Ethiopia, alike other developing countries, the increase of solid waste generation is resulted from rapid urbanization and population booming. The amount of solid waste in Addis Ababa and other fast growing areas in the country has been increasing over time, largely attributed to rapid population growth rate (Dawit and Alebel, 2003). The same authors indicated that from the total solid waste released by the population in the city, about 50-60% was collected and the rest was unattended. Recently the municipality has increased its coverage to about 85% (AACG-SPBA, 2005). Solid waste is generated during the acquisition of raw materials, during refining and manufacturing process and when products are used by consumers. Problems with the disposal of wastes can be traced from the time when humans first began to congregate in tribes, villages and communities, and the accumulations of waste became a consequence of life (Sangho et al., 2007). According to SBPDA(2003) about 40 percent of solid waste which is dumped on the street and drainages contributed a lot in breeding insects, rodents ,vectors and spread of disease (Zurbrug,2003). Demographic dynamics, socio- economic changes and consumption patterns are the main factors that affect the municipal solid waste management system which is seriously affecting the

environment and the health condition of the community in Woreda three of Lideta sub-city. Therefore, this research is intended to identify and analyze the characteristics, quantity and solid waste management practice at household level of woreda three in the sub-city.

1.2 Statement of the problem

Informal solid waste disposal accounts for a large and still growing percentage of the population of the cities of the developing world.

Much of the solid wastes from homes, offices and municipal wastes end up littering road sides, floating in lakes and streams, and collecting in ugly dumps. When the wastes are put in to open dumps, they ruin the attractiveness of the surrounding areas and would potentially endanger the healthy environment necessary for human existence. Ecological phenomena such as water and air also attributed to improper management of solid wastes (Monroe, 1997).

One of the most difficult problems facing humans today is the disposal of solid wastes. The solid wastes generated in Woreda three of Lideta sub-city simply disposed on the road side, play station and waterway area unknowingly or carelessly without characterizing the waste and sorting into hazardous and non-hazardous, recyclable and non-recyclable etc… The responsible body, sanitation and beautification team has not yet conducted a survey to estimate the quantity of solid waste generated in Woreda three in lideta sub-city. According to Ato Abdulsemed Mahammed, the department head of the sanitation, beautification and park development of Woreda three administration, they used 0.223 to estimate the quantity of solid waste in the Woreda, which is developed by World Health Organization (WHO) for east African Cities. Hence absence of recent knowledge about the quantity and the characteristics of solid wastes generated at household level for SWM system of Woreda three in Lideta sub-city was another problem for the measures that are being taken by the municipal organ of the Sub-city.

As stated above poor management of solid waste have a devastating impact up on the environment. Unless the responsible body timely aware of the impact of improper management of solid waste and decide to take the necessary measures to tackle the problem, damages on the environment due to uncontrolled solid waste management activities aggravate endangering the safe and healthy existence of the residents. In the same manner, it was observed that little attention is given by the community to realize management of solid wastes. In addition to poor community awareness, the

local authorized body also gives less attention about the consequences of inappropriate SWM of Woreda three in Lideta sub-city.

1.3 Objective of the study

The main objective of this thesis is to evaluate the solid waste composition and generation rate of Woreda three in Lideta sub-city at household levels as well as to investigate its operational processes.

The specific objectives of this study are to;

- Identify the common types and characteristics of the solid wastes generated by the Households of Woreda three in the sub-city.
- Quantify the amount of waste generated per household per day.
- Investigate the households' solid waste handling system practiced in the study area.
- Investigate the existing SWM practices in the area.
- Identify the factors affecting the SWM system at the area.
- Identify the possible solutions towards the adoption of safe and effective SWM Mechanisms in study area.
- Investigate disposal site selection and its management.

1.4 Research questions

- What are the common types and characteristics of the solid waste generated by the households of Woreda three in the sub-city?
- How much solid waste is produced per day by the households in the study area?
- How the households handle the solid waste generated at home?
- What do the existing SWM practices of woreda three in Lideta sub-city look like?
- What are factors affecting the SWM system of the study area?
- In what ways the problem of solid wastes is reduced in the study area?
- How the disposal site is selected and how it is managed?

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 The concept of solid waste and its generation

Wastes are materials that are not prime products (that is products produced for the market) for which the initial user has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose. Wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, and other human activities. Residuals recycled or reused at the place of generation are excluded (Wilson et al, 2006).

Solid wastes include putrescible wastes, garden wastes, uncontaminated bio solids, and clinical and related wastes (including contaminated waste) only where sterilized to a standard acceptable to the department of health (EPA, 1996). Solid wastes are characterized by a great mixture of substances, including fine dust sander, metal, glass, hard board, textiles, putrescible vegetable materials and plastic. Such qualitative of wasted materials can cause serious disposal system. Collection service is the removal of refuse from collection points to final disposal site. It is the most expensive part of solid waste management as compared with other operation and management procedures (Kebede et al, 1993).

Modernization, technological advancement and increase in global population created rising in demand for food and other essentials. This has resulted to rise in the amount of waste being generated daily by each household (Sha'Ato et al, 2009). Every year billions of tons of waste are generated by human beings. Disposal of these unwanted materials are considered as a huge environmental problem with many dimensions. Making the environment unclean with waste products is pollution. Any kind of waste can cause pollution. Waste products can pollute the air you breathe and the water you drink (UNEP, 1999). Waste generation encompasses activities in which materials are identified as no longer being of value and area either throws away or gathered together for disposal. Knowledge of the qualities of SWs generated, separated for recycling, and collected for further processing or disposal is a fundamental importance to all aspects of SWM. It is important to have the waste generation information, amounts and composition collected, as this may have a major impact on the planning process (Hall, 1994).

On a global scale it is difficult to report waste because countries have different definitions of waste and what falls into waste categories, as well as different ways of reporting. Based on incomplete reports from its parties, the Basel convention estimated 338 million tons of waste was generated in 2001 (UNEP, 2009). For the same year, OECD estimated 4 billion tones from its member countries (OECD, 2006). Despite these inconsistencies, waste reporting is still useful on a small and large scale to determine key causes and locations, and to find ways of preventing, minimizing, recovering, treating and disposing waste. Waste minimization is a process of reducing waste produced by individuals, communities and companies, which reduces the impact of chemical wastes on the environment to the greatest extent. Household level of proper segregation of waste; recycling, reuse, process and product substitution e.g. use paper bag instead of plastic bags significantly minimize the amount of waste to be generated (Moeller, 2005).

The need for expansion and sitting of waste treatment and disposal facilities is increasing worldwide. There is now a growing market in the trans-boundary movement of waste, and although most waste flows between countries goes between developed nations, a significant amount of waste is moved from developed to developing nations (Ray, 2008).

2.2 Solid waste management

Waste management is referred to as the proper and correct handling of waste products at the lowest cost and with minimum destruction and pollution to the environment. Improper management of waste has caused numerous cases of contamination of surface and soil water and the atmosphere and threatens the health of the exposed populace. Therefore there is a need to manage waste to reduce the threat to the environment and to the populace (Sha'Ato et al, 2009), SWM may be defined as a discipline associated with the control of generation, storage, collection, transfer and transport, processing, and disposal of solid wastes in a manner that is in accordance with the best principle of public health economics, engineering, conservation, and that is also responsible to public attitude (TALG, 2008).

Solid Waste Management is any of the work and programs to eliminate, collect, recycle, or landfill solid waste. This program includes efforts to reduce waste and reduce materials, as well as recycling, composting, trash collection, land filling and incineration. Solid Waste Management in developing countries tend to pay little attention to the issue of reducing organic wastes which make up from 50% to 90% of the total waste generated (PAN,2008). While the quantity of solid wastes generated

by society is increasing, the composition of waste is becoming more and more diversified with increasing use of packaging materials made of both paper and plastic,(Karanja, 2005).

If wastes have high proportion of organic matter, the possibility of composting and biogas regeneration as means of handling wastes is a better mechanism than incineration, reuse and recycling (Cointreau, 1992). Moreover, using incineration as a means of waste disposal has been mostly negative experience due to environmental pollution. Procurement of recycled content supplies and equipment and education are also part of SWM (UNEP, 1999). In its scope SWM includes all administrative, financial, legal, planning and engineering functions involved in solutions to all problem of solid waste. The solutions may involve complex interdisciplinary relationship among such fields as political sciences, city and regional planning, geography, economics, public health, sociology, demography, communications and conservation, as well as engineering and materials science (WHO, 1999).

The nature and operation of solid waste management varies significantly from nation to nation. Distinctions of such are not limited to the national scale however, and can be seen at the city and neighborhood level. Regardless of scale, these differences are to some extent attributable to prevailing socio-economic, financial, legal and political variables at the level. There is a clear requirement to reconcile the need for more effective waste management with the constraints that are faced by local municipalities or national governments (Michael, 1995). Most local governments and urban agencies have, time and again, identified solid waste as a major problem that has reached proportions requiring drastic measures. Three key trends observed were respect to solid waste are increase in sheer volume of waste generated by urban residents; change in the quality or make up of waste generated; and the disposal method of waste collected, by landfill, incineration etc. (Sango et al, 2007).

Solid waste management is not an isolated phenomenon that can be easily compartmentalized and solved with innovative technology or engineering. It is particularly an urban issue that is closely related, directly or indirectly to a number of issues such as urban life styles. Resource consumption patterns, jobs and income levels, and other socio-economic and cultural issues. All this issues have to be brought together on a common plat form in order to ensure a long term solution to urban waste (Sandra, 1995). It is apparent that making accurate decisions about municipal SWM issues can be a complex task. Both long term and short term plan is needed to get a balance of cost effectiveness and environmental benefit (Yeuan, 2000).

If elimination of wastes is not possible through pollution prevention, then waste management must be accomplished through application of another series of measures reduction, reuse, recycling, recovery, treatment and responsible disposal (UNEP, 1994). There is a whole culture of solid waste management that needs to be put in place from the micro level of households and neighborhood to the macro levels of city, state and nation, The general assumption is that solid waste management should be done at the city level, and as a result, solutions tried out have been essentially end of pipe (‘’end-of-pipe‟ refers to finding solutions to a problem at the final stage of its cycle of causes and effects). In the case of urban solid waste, it means focusing on solid waste disposal rather than solid waste recycling or solid waste minimization. But this approach essentially misses the forest for the trees, in attempting piece- meal and ad hoc solutions to solid waste problems, instead of taking a long term holistic approach (Tchobanoglous et al, 1993).

2.3 Types and sources of solid wastes

Knowledge of the sources and types of solid wastes, along with the data on composition and rate of generation, is basic to the design and operation of the functional elements associated with the management of solid wastes. The source of solid wastes is dependent on the socio-economic and technological levels of the society (Monroe, 1997).

Table 1 Different sources and types of solid wastes. (Source; EPHTI, 2004)

No	Source	Typical waste generators	Types of solid wastes
1	Residential	Single and multifamily dwelling	Food waste, paper, card board, plastics, textiles, wood, glass, metals, ashes, special wastes and household hazardous wastes
2	Industrial	Light and heavy manufacturing, fabrication, construction site	Housekeeping wastes, packaging, food wastes, construction and demolition Materials, ash and special wastes
3	Commercial	Stores, hotels, restaurants, Markets, office buildings	Paper, card board, plastics, wood, glass, food waste, special wastes.
4	Institutional	Hospitals, prison government center	Same as commercial
5	Construction and Demolition	New construction sites, Road repair, demolition of Buildings, renovation site.	Wood, steel, concrete, dirt etc
6	Municipal services	Street cleaning, beaches, Land scarping, parks and other recreational areas.	Industrial prose wastes, scrap materials, Off-specification product, slag tailings.
	All of the above should be included as "municipal solid waste"		
7	Agriculture	Crops, orchards, vine yards Dairies, feedlots, farms.	Spoiled food wastes, agricultural wastes, Hazardous wastes (pest sides)

Pollution is not directly transferred from land to people, except in the case of dusts and direct contact with toxic materials. Pollutants deposited on land usually enter the human body through the medium of contaminated crops, animals, food products, or water. Land pollution can also damage terrestrial ecosystems, resulting in the deterioration of the conservation on and amenity value of the environment (Medina, 2002).

Open dump sites are a major problem to the environment, especially on the air that the people inhale. Dump sites emit obnoxious odors and smoke that cause illness to people living in, around, or closer to them. Dump sites may be a source of airborne chemical contamination via off site migration of

gases and the particles and chemicals adhering to dust, especially during the period of active operation of the site (Marshal, 1995).

In a number of community health surveys, a wide range of health problems, including respiratory symptoms, irritation of the skin, nose, and eyes, gastrointestinal problems, psychological disorders, and allergies, have been discovered, Dump sites closer to residential areas are always feeding places for dogs and cats. These pets, together with rodents, carry diseases with them to nearby homesteads (Dolk, 1997).

A major environmental concern is gas released by decomposing garbage. Methane is a by-product of the anaerobic respiration of bacteria, and these bacteria thrive in landfills with high amounts of moisture. Methane concentrations can reach up to 50% of the composition of landfill gas at maximum anaerobic decomposition (Sandra, 1995).

The incinerated solid wastes contribute to the air pollution; buried, it contributes to the water pollution problem and takes up land and space; if it is dumped at sea, it diminishes marine resources and may even wash up on beach. We have waste problem because our socio-economic system fails to take in to account some of the most basic ecological principles governing material cycles. This flow ultimately piles up and causes problems on the environment (Mandefro, 2005).

Health and safety issues also arise from improper SWM. Insect and rodent vectors are attracted to the waste and can spread diseases such as cholera and dengue fever. Using water polluted by Municipal Solid Waste for bathing, food irrigation and drinking water can also expose individuals to disease organisms and other contaminants. Open dumping sites of municipal solid wastes and the wastes discharged thereby maintains a vicious cycle including these; Degrades water and soil quality, Cancer, Resulted in high algal population in rivers and sea, Nausea and vomiting and etc.. (Shaato et al, 2009).

If Solid wastes are not managed properly, there are many negative impacts that may result (Michael, 1995), Such as;

- The open burning of waste cause air pollution; the products of combustion include dioxins which are particularly hazardous
- Uncollected wastes degrade the urban environment, discouraging efforts to keep streets and open spaces in a clean and attractive condition.

- Polluted water (leachate) flowing from waste dumps and disposal site can cause serious pollution of water supplies.
- Methane (one of the main components of land feels gas) is much more effective than carbon dioxide as a greenhouse gas leading to climate changes.

The location of waste treatment and disposal facilities often has an impact on property values due to noise, dust, pollution, unsightliness, and negative stigma. The informal waste sector consists mostly of waste pickers who scavenge for metal, glass, plastic, textiles, and other materials and then trades them for a profit. This sector can significantly alter or reduce waste in a particular system, but other negative economic effects come with the disease, poverty, exploitation, and abuse of its workers (Wilson et al, 2006).

Decomposition of organic compounds by microorganisms is a common phenomenon. Most organic materials, such as food, wood products, or other remnants of plants, decay, and finally return to the environment in the form of simple compounds, such as carbon dioxide, water, or ammonia. Surprisingly, this phenomenon starts to create significant economic and environmental problems when landfills sites overflow with plastic (Mustafa, 1993).

2.4 Functional elements of solid waste management program

The activities involved with management of solid wastes from the point of generation to final disposal have been grouped in to six functional elements. They are: waste generation, on-site handling, storage and processing, collection, transfer and transport, processing and recovery and disposal.

Table 2 Description of the functional elements of solid waste management (Source; EPHTI, 2004)

Functional element	Description
Waste generation	Those activities in which materials are identified as no longer being had value and are either throw away or gathered together for disposal.
On-site handling, storage and processing	Those activities associated with the handling, storage, and Processing of solid wastes at or near the point of generation
Collection	Those activities associated with the gathering of solid wastes and the handling of wastes after collection to the location Where the collection vehicle is emptied
Transfer and transport	Those activities associated with (1) the transfer of wastes from the smaller collection vehicle to the larger transport equipment and (2) the subsequent transport of the wastes, usually over long Distance to the disposal site.
Processing and recovery	Those techniques, equipment and facilities used both to improve The efficiency of functional elements and to recovery usable Materials, conversion products, or energy from solid wastes
Disposal	Those activities associated with ultimate disposal of solid wastes Including those wastes collected and transported directly to a Landfill site, semi-solid wastes (sludge) from waste water treatment plants incinerator residue compost, or other substance from the Wires solid waste processing plants that are no further use.

2.5 Collection of solid wastes

Households of high income and single dwelling units generate an average dry refuse of three kilograms per day, while the low income and compound dwelling units generate about five kilograms. Of the five kilograms of refuse in the low income units, garbage constitutes four point two five kilograms (4.25kg), and rubbish constitutes zero point five kilograms (0.5kg). The waste invariably consists of items like vegetables and tuber remains (Freduah, 2004).

Municipal governments are usually the responsible agency for solid waste collection and disposal, but the magnitude of the problem is well beyond the ability of any municipal government. They need help that, In addition to other levels of government, businesses and the general community needs to be more involved in waste management. More and more, governments are realizing that they cannot handle waste management alone. To respond to the call, many progressive companies are working as equal partners with governments in developing comprehensive waste management programs (Daniel, 1999).Collection program demands special vehicle for different types of wastes, experienced people to manage and administer, more specialized machineries, or simple hand tools and man power, monetary fund's to be used for fuel, salaries and maintenance (Tchobanoglous, et al, 1993).

Generally, all low and middle income countries have a high percentage of compostable organic matter in the urban waste stream, ranging from 40 to 85 percent of the total. Local governments should minimize residential waste collection frequency to a maximum of twice per week, which is adequate from a public health perspective, but requires social acceptance. Citizens should be encouraged to place their waste in containers that enhance collection efficiency (Daniel, 1999).

The generation of residential, commercial and industrial waste is a defuse process that takes place in every home, every apartment building and every industrial and commercial facilities as well as in the streets, parks, offices, institutions, and vacant lots of every community (EPHTI, 2004). Waste accumulate at the pit head, garbage in the dust bins of domestic consumer and then at municipal rubbish dump cause hazards to human health, harm to living resources and ecological system (Kebede, et al, 1993).

Local governments should focus primarily on residential waste collection, especially from poor and densely polluted areas, and empower the private sector to pick up waste from non-residential

sources. Commercial, institutional, and industrial waste collection can usually be self-financing. Local governments should license private haulers to generate revenues and to ensure proper collection and disposal (Daniel, 1999).

As compared to high income countries, municipalities in low and middle income countries allocate the majority of their solid waste management budget to collection and transportation services. Final disposal costs are minimal because disposal is usually accomplished through open dumping (Sinha, 1993).Different types of collection services are given to residential, commercial and industrial areas. Collection services for residential areas depend up on the type of dwelling (low rise, detached, attached, high rise apartment etc.) (Justine, 1993).

The most common types of residential collection services include the following;

1. **Curb**: in this system the home owner is responsible for placing container to be emptied at the curve (road side) on collection day and for returning the empty container back to his house.

2. **Alleys**: this is collection of waste from the alley ways beside houses who take the container to the collection vehicles could be arranged between the owner of the house and the collection crew (the organization).

3. **Set-out**: waste containers are set-out from the home owner's property by additional collection that goes with the collection vehicles. The owner of the house is responsible for returning the empty containers to their storage location.

4. **Backyard/Set-out-Set-back**:- collection crew that goes with the collection vehicle are responsible for taking out stored waste from the dwelling units and other activities related to collection. It is the only satisfactory system in which the householders do not get involved (Aarne, et al, 2002).

2.6 Solid waste management (SWM) planning

Recently, it has become better known result the earth faces several environmental challenges such as acid rain, ozone depletion, climate changes, loss of biodiversity, toxic and hazardous wastes and pollution of water to name a few. These problems led to a more limited accessibility of natural resources, which support human activities and economics (Guy, 2000).

Planning is an important first step in developing public understanding of the need for solid waste management facilities. Planning in the field of solid waste management may be defined as the process by which community needs regarding waste management are measured and evaluated and workable alternatives are developed for presentation to decision makers. Planning of SWM is both exciting and challenging, because most of the technical, environmental economic, social and political factors and the interrelationship that are involved, are not fully understood (TALG, 2008). In case where a state or federal mandate requires a plan, such as mandated waste diversion goals, it is necessary to add monitoring activities to the frame work (Aarne, et al, 2002).

2.7 Effective management of solid waste

A SWM system is a continuous maintenance system. To keep the service running, continuous participation of the community receiving the service, is required. Solid waste generated at household level should be managed so that zero or minimum community waste is generated. That is:-

A. Segregation at household level that, Household waste should be stored out or segregated at the source i.e. at household level.

B. Treatment/management of biodegradable household level waste. Effects should be made to treat the segregated biodegradable waste at household level by adopting any one of the following technologies and reuse the treat products; Composting, Vermin composting and Biogas plants

C. Management of household level in non-biodegradable waste, that some of the sorted out non-biodegradable waste are of recyclable type (UNICEF, 2008).

Waste which cannot be composed, reused or recycled may be disposed at community level at landfills following appropriate procedure. Treatment of community level biodegradable waste once they segregated was collected at the community level, the biodegradable waste may be treated by adopting any of the following technology options; composting, vermin composting and biogas plant. Treatment of non-biodegradable waste; the non-biodegradable waste may be further sorted in to various categories (e.g. plastic, paper, metals, cloth etc). Those which are recyclable may be sold or recycled at the community level by adopting suitable technologies (UNICEF, 2008).

In economically effective SWM system money can often be saved with more efficiently designed collection routes, modifying vehicles, and with public education. Environmental policies such as pay

as you through can reduce the cost of management and reduce waste quantities. Waste recovery (that is, recycling, ruse) can curb economic costs because it avoids extracting raw materials and often cuts transportation costs (Carlsson, 2005).The location of the dump sites should be properly planned and managed to avoid risks to human health and the environment, at large.

To carry out integrated solid waste management, local governments need partners. National governments must reduce the externalities of waste by considering measures such as full cost accounting, package deposits, manufacturer responsibility, and extended product care. The general community, which is probably the most important stakeholder in waste management activities, must also actively, participates in the solutions by modifying their behavior patterns (Daniel, 1999).

2.8 Reuse and recycling of non-biodegradable solid wastes

Recycling is the process by which waste otherwise destined for disposal is collected, reprocessed or remanufactured and used to make a product, while reuse is the process by which waste otherwise destined for disposal is cleaned or repaired for use, for the purposes of prolonging the original product lifetime prior to treatment or reprocessing (EPA, 1996).

Recycling of plastic in all type of solid waste in the urban areas has become a major cause of concern due to;

- Pollution of surface waste

- Random burning and their cause of air pollution problem

There is no proper collection or disposal system of plastic waste. In spite of composting, reuse and recycling, some waste remains untreated which requires final disposal, either by incineration or by land filling. Incineration is technology where waste is burnt in especially engineered machine hold incinerator. Incineration is not simply burning, but complete combustion. Incinerators are considered to be causes of air pollution. This is not viable option for waste management. A landfill is a properly designated area and used for the disposal of non-bio-degradable and bio-degradable wastes (Hall, 1994).

The engines of waste recovery and recycling in the poorer countries includes scarcity or expense of raw materials, the existence of poverty, the low wages of workers, and the large markets for used

goods and products. Waste have a value, for compost, the majority of municipal wastes in dump sites as well as materials recovery could be utilized in developing countries (Joseph et al, 1993).

2.9 Factors affecting SWM system and solution measures

A lot has been said, written, and demonstrated about the inadequacies in solid waste management and its associated problems. The decomposition of waste into constituent chemicals is a common source of local environmental pollution. This problem is especially acute in developing nations. Very few existing landfills in the world's poorest countries would meet environmental standards accepted in industrialized nations, and with limited budgets there are likely to be few sites rigorously evaluated prior to use in the future (Sha'Ato et al, 2009). In developing countries, the main motivations for waste reduction are frequently related to legislation, environmental protection, and the scarcity of sites for landfills. Urban centers which do not have effective collection and disposal systems should not devote resources to developing waste reduction measures until adequate waste management systems are in place (Feleke, 2015). According to the United Nations Conference on Human Settlement report, one third to one-half of solid waste generated within most cities in low- and middle- income countries, end up as illegal dumps on streets, open spaces, and waste lands (UNCHS, 1996). A major obstacle to the provision of latrines in some urban areas is the small size of the plot allocated for the purpose. Lack of knowledge on the part of householders, unaffordability of household toilets, and several other factors are the main cause of lack of household latrines. Also lack of adequate sanitary facilities results in indiscriminate dumping of refuse and defecation at places not designated for such purposes. Ignorance, negligence, lack of law to punish sanitary offenders, and low level of technology in waste management are the major causes of waste management problems. Awareness should be created among residents to manage household refuse and educate them on the hazards that ill-disposed waste could pose to the environment and to themselves (Freduah, 2004).

Waste generation increases with population expansion and economic development. Improperly managed solid waste poses a risk to human health and the environment. Uncontrolled dumping and improper waste handling causes a variety of problems, including contaminating water, attracting insects and rodents, and increasing flooding due to blocked drainage canals or gullies. In addition, it may result in safety hazards from fires or explosions. Improper waste management also increases greenhouse gas (GHG) emissions, which contribute to climate change. Planning for and

implementing a comprehensive program for waste collection, transport, and disposal along with activities requires careful planning, financing, collection, and transport (USEPA, 2002).

There is no single solution to the challenge of waste management. The waste management process is usually framed in terms of generation, storage, treatment, and disposal, with transportation inserted between stages as required. Hence, a combination of source reduction, recycling, incineration, and burring in landfills and conversion is currently the optimal way to manage solid waste (Freduah, 2004). Cultural derivatives, beliefs, perceptions and attitudes are learned response sets. They can therefore be modified or changed through education. These points to the fact that people unconcerned attitudes towards solid waste can be changed for the better through education (Agbola, 1993).By focusing on the production process, examining where wastes are generated, and exploring how they can be reduced, even simple measures, such as separating wastes so that they can be reused more easily, using different raw materials or replacing non- biodegradable products with biodegradable ones, can help achieve large waste reduction results. It also dictated that the greater part of present waste arises not because the producer does not want it, but he fails to use it, or at least use it in such quantities that waste in inevitable (Gourlay, 1992).

Pulverization and grinding are means of reducing the volume of waste, or they are used to prepare refuse for final disposal processes. It is also further stated that in some instances a threefold problem could be overcome by the use of composting. Thus, the feeding of impoverished soils, disposal of large portions of the refuse, and the disposal of sewage sludge can be realized through composting (Freduah, 2004).

CHAPTER THREE

Materials and Methods

3.1 Study site

The study was conducted in Addis Ababa City Administration which is administered by city council and organized into ten sub cities and 116 Woredas, (Addis Ababa city Administration Integrated Land Information Center, 2014). Amongst the ten sub cities found in this City Administration, Lideta is one of the sub-cities inside which Woreda three on which the research was conducted is found. Lideta sub-city is situated in the center of Addis Ababa, boardered from North by Addis Ketema sub-city, from south by Nifas Silk Lafto sub-city, from east by kirkos sub-city and from west by Kolfe Keranyo sub-city. At present, the sub-city is divided into 10 Woredas (out of which Woreda 3 is the target of this study).Currently the total area of the sub-city is 918.41 ha. Out of this, only 277.77 ha which is accounting for 30.17% is used for residential while the remaining area is used for social infrastructures and services. The residential area of the sub-city is found to be consolidated and compact except for few developments found along the boundaries of the proximity to Nifas silk Lafto and Kolfe keranyo sub-city. Geographically,Woreda three is located at 6°26'46.8" north latitude and 2°20'53" east longitude; the household size is estimated to be 3578. The Woreda covers an area of 58.36 hectare with an average population density of 459.39 per hectare. The choice of this Woreda three offers the advantage for the present study, that generally there are three distinct standard of living styles or socio-economic levels (Low, Medium and High) are present in this single study area on which the research is conducted.

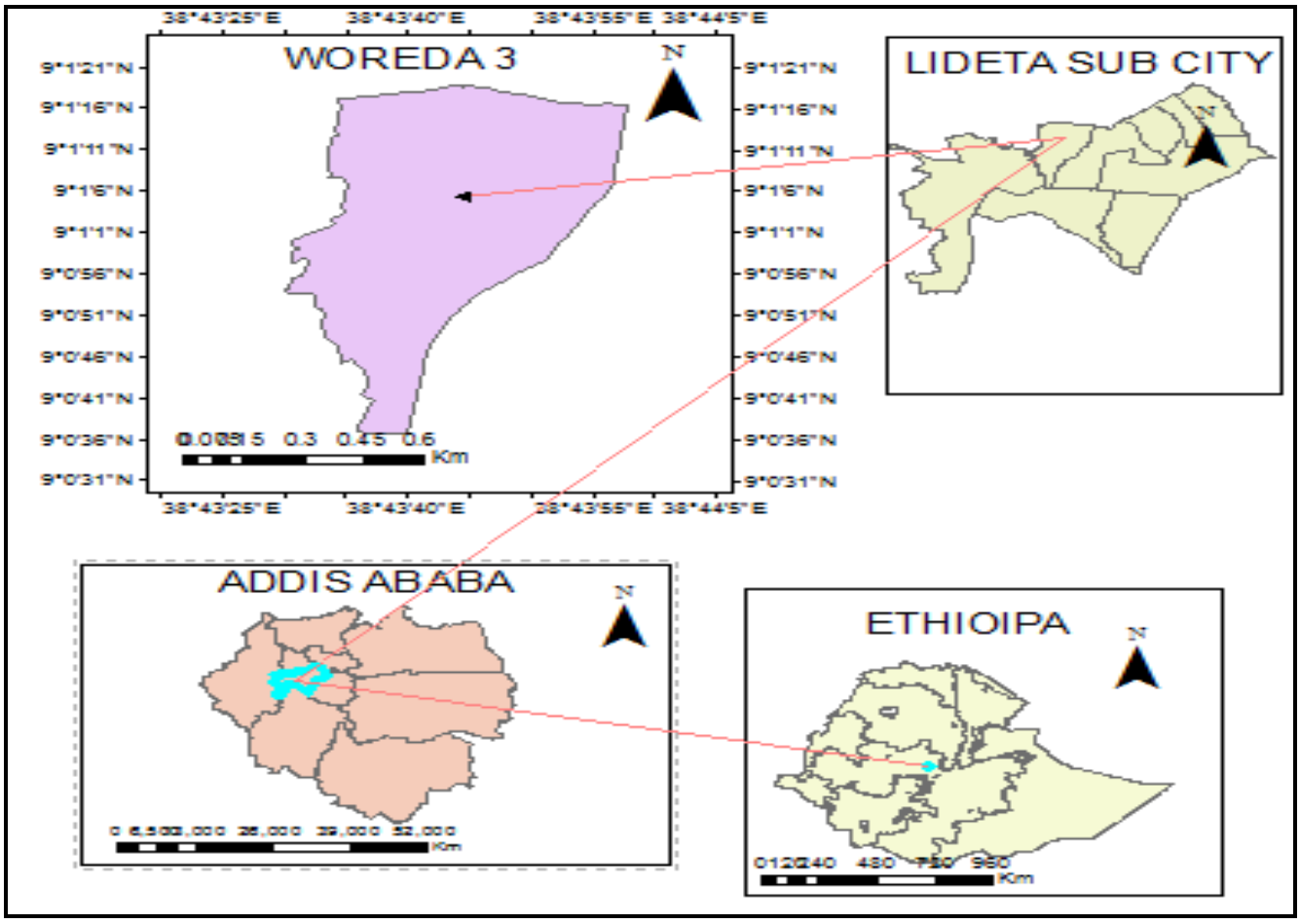


Fig 1 Map of Woreda Three of Lideta Sub-city in Addis Ababa.

3.1.1 Topography and drainage

From the elevation map we can see that Woreda three of Lideta sub-city is characterized by a homogenous type of topography with insignificant elevation difference.The altitude the sub-city ranged from 2291 to 2424 meters above sea level which has a range of 133 meters.

The general slope orientation is measured as percentage rise classified in to six different ranges. The most dominant slope category in Lideta sub-city ranges between 5-10% and occupies 41% of the sub-city total area. The second largest slope class in the sub-city ranges between 2-5%, which is 33.63% of the total area. The remaining slope classes occupy only 24.37% of the total area of the sub-city. From this information it can be concluded that the sub-city inside which the study area is found has flat to undulating slope.

3.1.2 Demographic characteristics

The study area is characterized by repaid population growth similar with other parts of Ethiopia. According to the central statistical authority, currently, the total population of the Lideta sub-city is 214,769 out of which four hundred fifteen (415) targeted households of Woreda three was on which the study was conducted. (Source: Woreda three Administration of Lideta sub-city). Accordingly, the dominance of Low income households is high, while High income households are much smaller as to the questionnaire response showed. This indicates that the study area is highly characterized by low income community.

3.2 Methods

3.2.1 Cross sectional design.

A mixed approach (both quantitative and qualitative approaches) were used in the study, for it was a very explanatory method on investigating the amount of solid waste generated and their characteristics at household level and its problems behind improper waste disposal. Characterizing and quantifying of solid wastes of the sampled household's generated at each household levels per day by using hand balance. According to the methodology recommended for solid waste characterization (Sharma and McBean, 2007), thirty samples are adequate. But it is not a case for this research with sample size of eighty one and Sampling is carried out for seven days of a week for three consecutive weeks to account for daily variations. The selected households to be sampled was consulted before commencement of sampling and obtained their consent for the study purpose.

3.2.2 Sample size and sampling techniques

To get reliable data providing the necessary information required for answering the research questions of the study and for the achievement of the intended objectives of the study, probability sampling technique which is used to select sample households/respondents of the survey from the target households of the owner of the house was employed in the study. A field survey of collecting data by going house –to- house of the households to characterize and quantify the solid waste generated by them using daily data record sheet. A door- to-door targeted questions to the head of the households or the spouses were conducted from December 01/ 2016 to December 21/2016.

A total of four hundred fifteen (415) households are living in the study area, which were the targeted households of the survey.

A sampling technique (formula), which was developed by using Taro Yamane (Yamane, 1973) with 90% confidence level to determine sample size (n) with the desired degree of precision for general population, was used and presented as follows.

$$n = \frac{N}{1+N(e)2} \quad n = \frac{415}{1+415(e)2} \longrightarrow n = \frac{415}{1+415(0.1)2} = 81$$

Where :

n= sample size required =81

N = Total number of households in the study area = 415

e = allowable error (%) =10%

Therefore, n=81 was the minimum sample size of housing units for reliable results. Therefore, results of 81 households' solid wastes were analyzed; which is sufficiently enough according to the sample size calculated above. The generation rate per day per capita of the survey area is estimated as.

$$Per\ capita\ waste\ generation = \frac{Weight\ of\ MSW\ generated\ at\ household}{Total\ number\ of\ persons\ in\ the\ household \times Total\ number\ of\ generation\ days}$$

total waste collected within twenty one days divided by the multiplication of total population of the sampled households and total number of generation days as shown Below:-

3.2.2.1 Identification of households

To identify participatory households according to their socio-economic levels, all the eighty one households were stratified in to three income level groups, low, medium and high-income groups accordingly. Stratification of the sampled households into three income level groups was done by discussion with Woreda officials and personal observations of building materials, finish work and Fees Paid to electricity and water consumption, Since there was lack of data on income level of the households of the study area while stratification have been made. Additionally, questionnaires were designed carefully to obtain all the necessary information such as sex of householder, educational level of householder, family size, family's income, households waste handling system, households

waste disposal system, etc. from sampled households. Households which were categorized under low income (the poor) were those who leave in slum areas and congested living rooms. Moreover, some information collected from different surveys of Woreda three within which the study was conducted, were taken into consideration. After the house numbers of the housing units of the studied area were collected, the participating houses were identified using their respective house numbers after intensive survey.

3.2.3 Sources of data

To achieve the intended objective of the study, relevant data required for this study was collected from both primary and secondary sources. In order to get firsthand information about the problem under the study, data was collected from primary sources particularly from randomly selected sampled households through field survey and questionnaire. Households of the study area were also asked regarding their observations on the frequency of disposal of solid waste containers by the sanitation and beautification team, how the residents use containers and the problems of the placements.

Moreover, secondary data providing relevant information to this study was obtained from different documents related to the issues under study and those found in the municipality of Lideta sub-city and in the health office of the sub-city. In addition, published materials and other relevant materials were revised to obtain secondary data. Simply to obtain sufficient and reliable information required for the achievement of the intended objectives of the study from both primary sources and secondary sources.Field observation was also employed for understanding households' solid waste handling practices, illegal dumping, solid waste collection and transportation systems and disposal site facilities of the woreda . Photographs were taken during field observation for 'hotspot' waste dumping sites, and illegal SWM practices across the Woreda.

3.2.4.1 Collection and sorting of wastes

After grouping (stratification) of households have been made, they told to be cleaning out their compound to avoid the SW collected and stored before the data started to be collected and then the next day Plastic bags labeled with their house number were distributed for each of the eighty one (81) households selected for sampling, the next day early in the morning the collected solid wastes weighed and taken in to sorting site and then providing another plastic bags with the same label for the same households was given to collect and prepare the solid waste generated for the next day, this

process of actual collection and sorting of wastes from the participated households has been conducted for seven days of the three consecutive weeks. Household wastes were sampled and routed to the sorting site daily after waste generated from each household was weighed daily. The total waste produced by each household was collected seven (7) days a week, for a period of three weeks in order to have an average result of the whole days of the three weeks, in cases of differences in waste generation between days. The collection was done by three hand push cart. One cart is assigned to Low standard of living style of households, the other two each assigned to medium and high standard of living style. Every morning these carts bring data to one strategically selected working sites. At this site there were three enumerators who sorted the wastes into different types of components on a white plastic sheet stretched on the ground and then weighed according to their characteristics and recorded all the necessary data. After sorting the wastes in to its components, the weight of wastes was measured with hand balance (weighting scale). This process continued for all waste components for three weeks of twenty one days. After recording weight of wastes, it was dropped in to big Sacks through which it was finally transferred to nearby waste container (temporary disposal site). Major waste components sorted out are: food wastes, paper, textile, plastic, cardboards (Carton), wood, textile, miscellaneous metals, glass, ash and dust/ sweepings.Lastily those of the identified waste compositions were grouped in to five major groups accordingly. In these categories, Kitchen wastes and bone/meat products were grouped as **Organic wastes**, Packaging Wastes like plastics, glass bottles, Paper and Carton and Metal wastes were grouped as **Recyclable Wastes**, Electronic Equipment's and Drug/Medicine products were grouped in **Hazardous Wastes,** Whereas Wood products, Cherkacherk/Textile and dipper and modus Wastes were grouped in **Combustible waste** groups. Wastes not categorized in any of the above groups including were evaluated as **others**.

3.3 Method of data analysis and presentation

On the basic of the data that was collected from both primary (from sampled households through field survey) and secondary data sources (from key informants and published and unpublished materials) it was analyzed and interpreted in accordance with the nature of the data collected directly and replied by respondents. And the data was summarized by a descriptive statistics using tables, graphs and figures. The quantitative data mainly obtained using close-ended questionnaire was analyzed by simple descriptive statistics like percentage, average and etc..., and the result was summarized in the form of table and graph. The qualitative data /perception, opinion, attitude etc.)

Mainly obtained using open ended questionnaire including the observation was analyzed, described and interpreted in the form of narration.

After the whole efforts attempted above have been made, it was endeavored to identify the prevailing problems, comments and suggestions forwarded concerning the problem understudy and improvements that needs to be made over the problem in order to tackle the major cause of the problem and ensure safe and environmentally sound solid waste management system. Data were verified and entered into an electronic database and analyzed statistically through the SPSS (Statistical Package for Social Science), version 20. Pearson's chi square ($x^{2)}$) test was used to compare the three socio-economic levels of households with the quantity of SW that they generate per day. The average waste generated by the three different levels called Low, Medium and High households was calculated for low, medium and high-income levels. Results were compared whether the average waste generation rate was the same for each socio- economic level or not. The relationship between the number of persons in a household and the waste generation rate was described with correlation. Moreover, the household waste components were analyzed and compared based on socio-economic levels. The percentage composition of fractions by household income is presented using tables and graphs.

3.4 Materials and Instruments

During the study time the following listed materials and equipment's were used like:- Hand protective plastic gloves; to protect hand from direct contact with dirt, mouth & nose mask; to protect one from bad smells and inhalation of any fumes, balance scale; for weight measurement of collected sample waste, plastic sheets; to ensure no loss of waste during sorting, different type and color plastic bags; for the collection of solid waste from each sampled household daily and video cameras; for capturing pictures of the working process

3.5 Ethical Issues

The current researcher, first of all, has received a recommendation letter from his department and taken to those to whom it my concern to be supported while conducting the research for the sake of informed consent; met a gatekeeper of the sampled households and discussed on some ethical considerations with them. Having mutual agreement on the given issues, the researcher recruited the data collectors and enumerators. For the sake of security of the individuals, the responses of the participants mainly of sampled households were used without the individuals' names. The data collected through the questionnaires, surveys and observations were used to triangulate the validity of the information.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Results

4.1.1 Demographic and Socio Economic Characteristics of Respondents

4.1.1.1 Sex of the respondents

Table 3 below showed that sex of the households or respondents. In general, male respondent member is found to be higher than females; nevertheless there is no considerable difference in number of headship in both sexes. The survey indicated that, out of the total 81 respondents 58 (72 percent) were males while 23 (28 percent) were females. Sex of households has an influence on the process of municipal solid waste management in respect to labor division. Most of the time females were engaged in the process of residential waste collection and disposal.

Table 3 percentage of m male and female household heads/respondents

	Characteristics of respondents (Sex)	Frequency	Percentage (%)
1	Male	58.00	72.00
2	Female	23.00	28.00
3	Total	81.00	100.00

4.1.1.2 Educational Status

The majority of the respondents have low educational background that 15% of the respondents do not read and write as per the response on the questionnaires, Six percent (6%) of the respondents can read and write but did not attend formal education. Twenty (20%) and sixty point four (46%)

percent of the respondents graduates from 1-8 and 9-12 grades respectively. The remaining 13% of the respondents are certificate and above.

Table 4 Educational Level of the respondents

	Educational Level	Frequency	Percentage
1	No Education	12.00	15.00
2	Basic Education	5.00	6.00
3	Elementary	16.00	20.00
4	High School	37.00	46.00
5	Higher Education	11.00	13.00
6	Total	81.00	100.00
7		.	.

4.1.1.3 Household Size

Table 5 shows the household size in the study population in which average household size is 5.42. It is used as a measure of crowdedness of population and has great implication on solid waste generation and collection. In the table below nearly half of the sample households are found to have 4-6 members. 26 percent of the households have got 1-3 members. The remaining 33 percent of the households have more than 6 members.

Table 5 Household size of the respondents

	Household Size	Frequency	Percentage (%)
1	1-3	21.00	26.00
2	4-6	33.00	41.00
3	>6	27.00	33.00
4	Total	.	100.00

4.1.1.4 Households average monthly Income

Information on the income of the household heads was very difficult to obtain due to different reasons such as low level of education which culminates fears of being taxed, inability to keep the record of their sales and the majority are not fixed and their income is not regular. However as per the respondents' response, table 6 below shows that majority of the respondents (26 percent) earned monthly income 1501-2000 and 23 percent of them earned between 1001-1500 birr. About 21 and 17 percent of the respondents earned >2000 and 501-1000 birr respectively, While, 6 percent of them were included under those who earned less than 500. The remaining 7 percent belongs to those who did not mention their monthly income.

Table 6 Average monthly income of the households

	Monthly Income (Birr)	Frequency	Percentage (%)
1	Less than 500	5.00	6.00
2	501-1000	14.00	17.00
3	1001-1500	19.00	23.00
4	1501-2000	20.00	26.00
5	>2000	17.00	21.00
6	No mentioned	6.00	7.00
7	Total	81.00	100.00

As to the information gathered from the sampled households of study area through questioners, majority of them live in the Woreda three under studied for more than twenty years as per their response.

4.1.2 The quantity of Solid Waste generation .

Accordingly, average wastes generated by the three different levels of households called low, medium and high income levels of the study area was measured and illustrated in table below.

Table 7 Solid waste generation rate of sampled households

As to the result obtained, the solid waste generation of the sampled households whose socio-economic level become low ranges between 0.24-2.04 kg/hh/day, with a mean of 0.95kg/hh/ day, for medium standard living style of the sampled households it ranges between 0.32-2.31 kg/hh /day, with a mean of 1.17kg/hh /day and the solid waste generation rate for high standard of living style of sampled households ranges between 0.32-2.48 kg/hh/day, with a mean of 1.44 kg/hh/day. This verifies that on average solid waste generation is higher for high socio-economic level groups of the household, however not considerable than medium level categories.

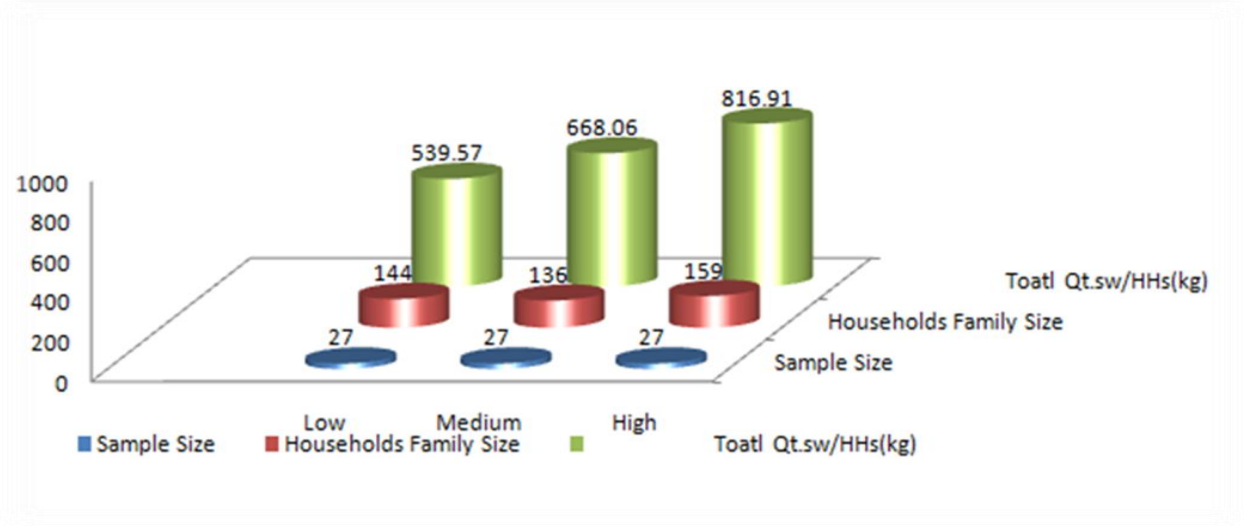


Fig 2 Graph Showing Relationship between the three socio-economic levels and their waste generation quantity by Correlation.

4.1.2.1 Per capita generation rate

The overall average per pita generation rate for the three of socio-economic levels was calculated and shown as the following tables.

Table 8 SW generation rate per day per household and per day per capital

	Level	Low	Medium	High	Total/Average
1	Total in kg	539.60	668.10	816.90	2024.60
2	No. of HH	27.00	27.00	27.00	81.00
3	Population	144.00	136.00	159.00	439.00
4	kg/HH/day	.95	1.18	1.44	1.19
5	kg/ca/day	.18	.23	.25	.22

Then as the table in the above shows, study result from 81 sampled households gave waste generation rate of 0.18 kg per capita per day, 0.23 kg per capita per day and 0.25 kg per capita per day for low, medium and high living standard respectively. On average for the three levels, it would be 0.22 kg capita-1 day-1 with standard deviation of 0.1.

Comparisons of the quantity of waste generation for the three levels using graph and pie chart

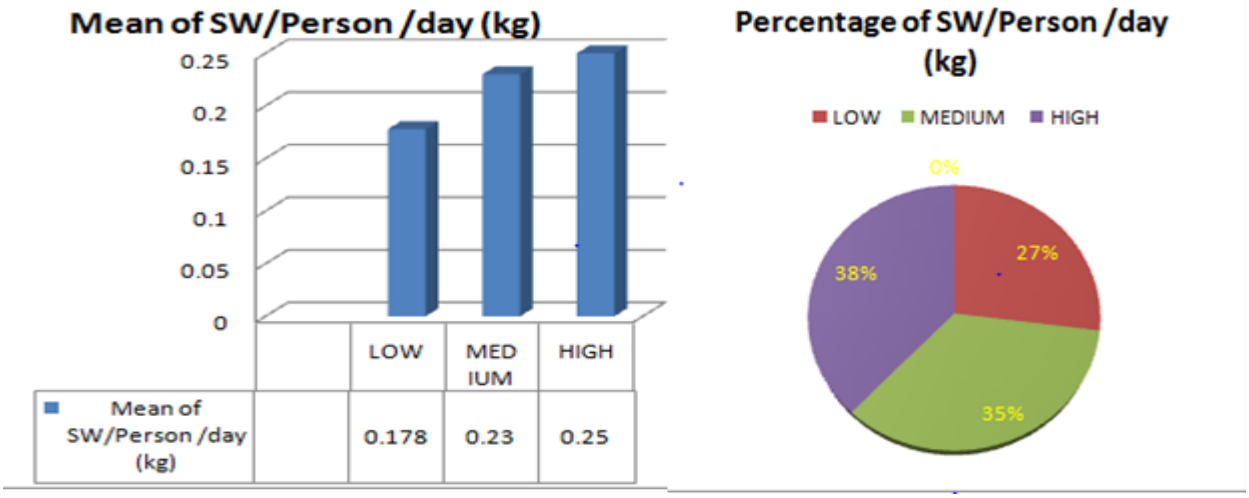


Fig 3 Mean and Percentage of SW per person per day per kilogram.

4.1.2.2 Solid Waste Generation Rate per capita in a Week, Month and Year

In determining how much waste generated per capita in a week, month and year, the Following results can be obtained.

Table 9 Solid Waste Generation Rate per capita in a Week, Month and Year

Socio-economic levels	Time period		
	Week	Month	Year
Low	1.26kg/cap/week	5.4kg/cap/month	65.7kg/cap/year
Medium	1.61kg/cap/week	6.9kg/cap/month	83.95kg/cap/year
High	1.68kg/cap/week	7.2kg/cap/month	87.6kg/cap/year

4.1.3 Characteristics of Solid Wastes

In this study in order to identify the major types of solid wastes found in the study area, Characterization of the solid waste generated by the sampled households has been made through

Sorting the solid wastes collected daily and then the major characteristics of solid wastes of the study area identified would be presented using table and graph as follows

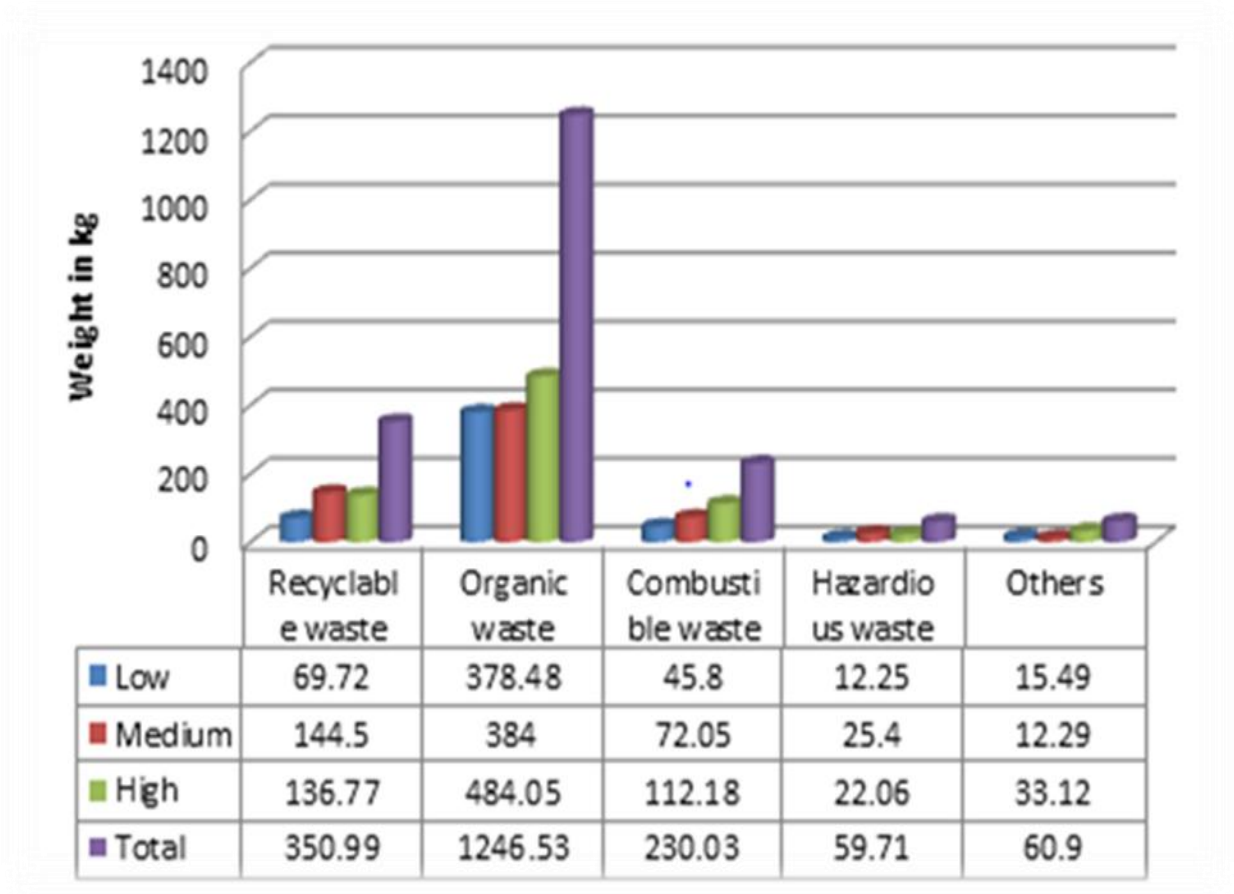
Table 10 The average weight in Kilogram of the major types of solid wastes generated per day.

	Components of Solid Wastes	Low(kg)	Medium(kg)	High(kg)
1	PET	0.52	1.36	1.47
2	HDPE	0.41	0.14	0.45
3	PVC	0.01	0.01	0.03
4	LDPE	0.28	0.63	0.83
5	PP	0.47	0.71	0.83
6	PS	0.48	1.39	1.15
7	Glass Bottles	0.19	0.75	0.65
8	Paper and Carton	0.62	1.46	0.72
9	Metals	0.33	0.43	0.39
10	Kitchen Wastes	17.89	18.06	22.58
11	Wood products	0.56	0.42	1.05
12	Construction material	0.44	0.37	1.38
13	Cherkacherk/Textile	0.66	1.12	1.75
14	Electronic Equipment	0.33	0.93	0.76
15	Dipper and modus	0.96	1.89	2.53
16	Drug/Medicine Product	0.26	0.28	0.29
17	Bone/Meat products	0.13	0.22	0.47
18	Unclasified material	0.30	0.21	0.19
Min	PVC	0.01	0.01	0.03
Max	Kitchen Wastes	17.89	18.06	22.58
Sum		24.84	30.39	37.53

Where:

PET - Polyethylene terephthalate
HDPE - High Density Polythene
PVC - Polyvinyl Chloride
LDPE - Low Density Polythene
PP - Polypropylene
PS - Polyester

As it can be seen from the above table, the analysis on the dominant type of solid waste, that is "who generate what" based on the households of socio-economic level was identified. There are variations as to major items of solid waste generated by the households with respect to their levels. In general the 18 characterized waste compositions given above were grouped in to five major groups accordingly .This five major identified groups includes **Organic wastes**, **Recyclable Wastes**, **Hazardous Wastes, Combustible waste and others which are** Summarized below in Graph and pie chart.



	Recyclable waste	Organic waste	Combustible waste	Hazardious waste	Others
Low	69.72	378.48	45.8	12.25	15.49
Medium	144.5	384	72.05	25.4	12.29
High	136.77	484.05	112.18	22.06	33.12
Total	350.99	1246.53	230.03	59.71	60.9

Fig 4 Quantity of the five major groups of the eighteen types of SW.

There is a significant difference in composition of solid waste generated per the three levels of households at $p<0.01$. The Low level households had organic 73%, Recyclable 13%, Combustible 9%, as main constituents of Solid waste. Medium Level households had organic 60%, Recyclable 23%, Combustible 11%, as main constituents of Solid waste where as High Level households had organic 61%, Recyclable 18%, Combustible 14%, as main constituents of Solid waste Components.

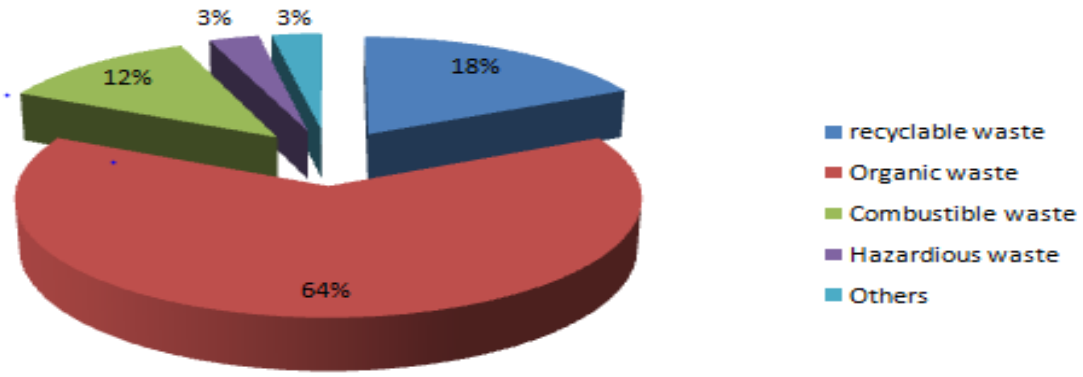


Fig 5 percentages of the five major groups of SW in the study area.

As it was indicated in the above pie chart, organic wastes constitute 64 % of the total household wastes by weight being generated from all of the surveyed households. Next to organic wastes as indicated in the pie chart above, Recyclable waste accounts for 18%, which are followed by Combustible Wastes (12%), hazardous Wastes (3%) and Others (3%) respectively.. In summary, SW in the study area has an average recyclable, Organic and combustible content of 94 %, where recyclable waste could include: plastic, paper and carton, metal and glass, which provide a significant potential for waste recovery. Other advantageous alternatives include compost or energy recovery via anaerobic digestion that would reduce landfill waste and possibly collection and transportation costs. Source separation of waste to achieve this through use of different waste containers is the promising practice if those of the residents were willing to separate their waste.

4.1.4 Solid Waste Management Practice: Collection and Disposal systems

In this study, for about the materials that the households used to store the daily generated solid waste in their houses, the following results obtained accordingly.

Table 11 the type of solid waste storage material used at home of sampled household

	Type of Solid waste Storage materials	Frequency	Percent
1	Local baskets	11.00	13.50
2	Sack	49.00	60.50
3	Plastic bag	15.00	19.00
4	Others	6.00	7.00
5	Total	81.00	100.00

The result has shown that the storage materials vary from household to household as revealed above, that about 60 percent of the respondents used sacks to store solid waste as storage materials. 19 percent of the respondents use plastic bag and over 13 percent of them use local basket as storage material. The rest of the respondents use various methods of storage such as whole, plastic basket etc. The interval of days solid waste stayed at home before disposing into the municipality container or any open reserved site would be gathered and shown in the table below:-

Table 12 solid waste stayed at home before disposal

	Number of days	Frequency	Percent (%)
1	One	5.00	6.50
2	2-4	25.00	30.50
3	5-7	35.00	43.00
4	8-10	11.00	13.50
5	>10	5.00	6.50
6	Total	81.00	100.00

As the information gathered from the sampled households of study area and indicated above, only 6.5 percent of the households dispose their waste daily, 30.5 percent of the households used to remove their waste once per 2-4 days, about 43 percent of the respondents used to dispose their waste once per 5-7 days. The remaining 20 percent used to dispose greater than a week. One of the

reasons for the late disposal of the waste for most households is the distance and limitedness of the open waste disposal area preserved by the municipality of the sub-city.

For the fact that identifying the person who gives disposal service to the preserved open land disposal area. 5, 18, 30 and 47 percent of the households respectively dispose by their children, house servants, informal waste collectors and Micro and small scale enterprise. Here nearly half of the solid waste collection and disposal service is provided by Micro and small scale enterprise.

4.1.5 Commonly Practiced Solid Waste Disposal Systems

In view of the availability of solid waste containers or preserved site for temporarily disposing their solid waste, about 40 percent of the sampled households do have an access to the temporarily disposal of open site while the remaining 60 percent of the respondents do not have an access for solid waste disposal site. In order to realize the target of the study regarding the identification of the common disposal system dominantly practiced by the community of the study area, and to examine the disposal methods commonly practiced by the community in relation to their impact both on the surrounding environment and on the health of the community of the study area, a question was forwarded for those sampled households. The response of those households on the major solid waste disposal methods practiced by them has been illustrated using the underlying table below.

Table 13 Practice of solid waste disposal to temporarily preserved area

	Item Choices	Frequency	Percentage (%)
1	Damp on road side	36.00	44.00
2	Damp on open field	32.00	40.00
3	Burn in my compound	10.00	12.00
4	Damp in to open ditches	3.00	4.00
5	Total	81.00	100.00

Of the different method of solid waste disposal system commonly practiced in the study area from the sampled households, 36(44%) of them responded as they use road side dumping site to dispose their wastes, 32(40%) of the respondents indicated they are using open field dumping of wastes, from the remaining sampled households 10(12%) of them practice open burning in their compound and 3(4%) of them used damping in to open ditches. The above information indicates road side dumping and open field dumping of wastes have been extensively used in most parts of the studied

areas. The respondents also responded that, they all pay fees for the solid waste disposal service they get together with water consumption.

4.1.6 Households Response to rules and Regulation and appropriate solid waste management

A question was forwarded to sample households regarding the hygiene regulation of Woreda three of Lideta sub-city in order to assess to what extent the regulation is known and implemented by the residents of the study area. About 58.5% of the respondents replied that they do not know the presence of the regulation. The remaining 41.5% confirm that they knew the regulation. This implies that the majority of the respondents are unfamiliar with the regulation. There is a wide information gap between the dwellers and responsible bodies.

In investigating the efforts made by the municipality and the sanitarians of the sub-city or Woreda administration to aware the dwellers through education campaign regarding how to store, collect and dispose solid waste in a manner that do not affect the public health and the environment. About 60% of the respondents attended lesson through Woreda meeting, health station, radio and television and posters and photographs. However, about 40% of the respondents did not get awareness education regarding proper solid waste management.

4.1.7 Households' Response to solid waste Reuse and Recycling

Accordingly, about 62.5% of the respondents do not use the solid waste for any purpose as per the response. The rest of the respondents 37.5% replied that they used some of their solid wastes for kuralew(a person who collects used materials for reuse and recycling) and Lewach (exchange by a material).

4.1.8 Factors affecting SWM system

The information obtained from the sampled households revealed that some of the factors affecting the SWM system of the study area are lack of appropriate skilled man power in the area to coordinate SWM activities, appropriate disposal site , absence of labor engaged in daily removal of solid wastes generated from each households in the study area, absence of materials/equipment's to collect the waste in different parts of the area are challenges in affecting the sanitary of the studied area by making it ugly and smelly even though the households of the study area pay some fees for SW disposal service that they get from the municipality. The other challenge was the municipality didn't work a lot on community mobilization regarding SWM system.

4.1.9 Suggested Solutions to Make SWM System Environmentally Friendly

As to the response gained from most households indicated, a lot is expected from the administration of the sub-city to make the SWM of the study area environmentally friendly. The large portion of households responded that it is the weakness of the municipality and lack of responsible body assigned with the task of coordinating SWM system of the study area properly as a primary cause for the poor management of solid waste observed in the sub-city. They also suggested that assigning such a responsible body is also a primary solution for the problem. The sampled households also suggested that the municipality of the sub-city needs to employ workers for the daily removal of solid wastes generated from the households.

4.2 Discussion

Information about the quantity of solid waste generation at household level is very important for determining any subsequent activities such as storage, collection, transportation and final disposal of solid waste. Accordingly, for sampled households, about 96.5 kg (0.0965 tone) and 35222 kg (35.22 tone) of solid waste generated daily and annually respectively. However, this figure does not include solid waste generated from various sources in the studded area that is industries, institutions, street sweeping, business areas such as shops, hotels, restaurants, etc. As to the quantity of SW generated per households per day for those of the three socio-economic levels in the result section revealed, the generation rate seems to be responsive for the income category but none responsive to the household size. This might be due to some limitations since waste generation rate can also be affected by many other factors other than income and family size.

The finding is comparable with that of similar studies conducted at different areas of developing countries. It is well known that per capital income level and solid waste generation rates have direct relationship (Wells, 1996). Households that have better life standard use more consumption materials than low-income households do, through which they generate higher wastes. The per capita generation rates of solid waste in this study have some variation in figures when it is compared with other studies. For example the total generation rate of solid waste generated by one person on a daily basis would be 0.140 kg/ca/day in jimma town according to Dereje (2012) and 0.1kg/capita/day with the standard deviation 0.056 according to Yitayal (2005) for the study result from 197 sampled households conducted on domestic solid waste quantity and composition analysis in Arada Sub-city, Addis Ababa. So that it is highly recommended that similar study for Woreda three of Lideta sub-city should be taken place with considerable factors, i.e. season, budget and number of participants to minimize variation of the result.

Study of waste composition is also an important step in selecting strategy for waste management. It affects the density of the waste, the proposed methodology of disposal and it is also necessary for examining reuse, reduction and recycle of waste. As a result of the weight of the characteristics of solid wastes indicated, the percentage share of unclassified material of wastes like Mirror, ash, dust, grasses or chefe has decreased from 0.3kg to 0.19kg as the households' living standard increases. But the reverse is true for the case of kitchen wastes and meat products and some other components of solid wastes generated per the three socio-economic levels. However there is no definite relationship between the generation of plastic waste and other some components of solid waste with the three socio-economic levels of households understudied.

Studies showed that large portion of solid wastes of developing countries is food wastes (Tchobanoglous et al., 1993), which is one of the components of organic wastes. For example, food waste accounts 59.17 % by weight of the total wastes in Arada Sub-city, Addis Ababa (Yitayal, 2005), 36% in Makurdi-Nigeria, (Sha'Ato et al., 2007), 40.7% in Guadalajara, Mexico (Perez et al., 2001). According to the characteristics tried to be differentiated, the solid wastes of woreda three in lideta sub-city, in addition to accommodating organic wastes at large percentage (64%) of the total households waste which is nearly comparable with other findings like above, it comprises a wide spectrum of refuse categories like plastics, paper, cartons and packing cases, wood pieces, fruits and vegetables, food refuses, metals, glass, textile refuses, leaves, stones and construction materials etc.

To make solid waste management practice sustainable, an integrated way of solid waste management system should be practiced in the process of storage, separation, reuse, and recycling of wastes. In the study area as to the response from respondents revealed that, solid waste is mostly stored in temporary containers such as plastic bags, sacks (joniya), basket and others. The type of waste storage used by households has great impacts on solid waste management. Those persons that use plastic buscket as a waste storage, minimizes solid waste generation by increasing service duration of the storage, (Samuel, 2006). While those who use non-durable storage will not get long service from the storage, rather they pay costs for disposal of the storage as a waste. So the types of storage materials used by households have impacts on waste management at home. Those households who used durable storage materials such as water tight, easy to clean, provided with a light cover and well protected against rain and rodents can minimize the negative impacts of improper handling of solid wastes such as bad smell, breeding of insects which in turn is a cause for various types of diseases such as malaria, diarrhea, respiratory diseases.

Solid waste separation and storage determine the feasibility of recycling and composting in an economically and environmentally sustainable manner which plays a pivotal role in the waste management system. Moreover, it determines the quality of the recovered materials and their market values.

However, households of the study area do not separate waste to be convenient for various purposes such as reuse, recycling and treatment. This could be due to lack of awareness about reuse, recycling and absence of industries that process recyclable solid wastes. Since waste storage and segregation determine the feasibility of recycling and composting in an economically and environmentally sustainable manner, it plays a vital role in MSWM system. It also significantly influences the quality of the recovered materials and in turn the quality of the recycled products and their market value.

Moreover, there is cultural bias about waste handling which is considering wastes as a useless output. The high proportion of food wastes by weight in solid wastes may also affect the effort of segregation in general and recycling in particular.

The length of time solid wastes have been made to stay at home in the temporary storage before it is disposed to the container or reserved site prepared by the municipality of the sub-city is also important variable to appraise the solid waste handling system of the residents. So as to the result revealed that, the majority of the respondents used to dispose once per five to seven days which is very late.

Composting of organic waste makes available nutrients for soil replenishments and reduces amounts of waste to land filled (Karanja, 2005). However, the information obtained from the target households indicates composting was rarely practiced by the community of the study area due to different factors indicated under factors affecting SWM of the study area. It was the sum total of those factors that made solid waste management activity to be one of the deep rooted problems of the study area, providing the city ugly appearance and bad smell, in addition to its major damage on the environment and health of the residents. Open dumping is one of the commonly practiced solid waste disposal system of woreda three in Lideta sub-city indicating mainly lack of sanitary landfills sites. Open burning which is also another practice is the most unacceptable method of disposal of solid waste. That the low temperature burning of plastics and PVC emit highly toxic gases such as dioxins and nitrous oxides to the atmosphere. Open dumping is uncontrolled and scattered deposit of wastes at a site. It leads to acute pollution problems, fires, high risk of disease transmission and open access to scavenger animals. It is not a scientific way of waste disposal because open dumping is an uncovered site used for disposal without environmental controls (Mohammed et al, 2012). Although both open dumping and open burning are environmentally able to cause a serious pollution in the air we breathe and water we drink and soil and land degradation, So regarding the communal disposal system of the study area, the information obtained from sampled households and key informants makes open dumping and open burning are the two dominantly practiced disposal methods of the study area.

Landfill should be designed, located and operated based on national, international guidelines, environmental impact analyses, and environmental friendly which take into consideration the accurate climate date precipitation, evaporation, temperature, and wind direction beside the location from residential areas and the groundwater level.

It must also be recognized that good engineering and management of a landfill can be used to maintain a perennial water deficit within the landfill by maximizing runoff and minimizing

infiltration into the waste (Abu et al., 2009). But the open dumping sites of the study area were not taking in to account the topography of the area, the natural environment of the surrounding and the health condition of the nearby residents.

Generally, based on the information obtained from various sources magnified, lack of environmentally effective and efficient solid waste disposal methods, the dominance of environmentally hazardous solid waste disposal methods and the need for rapid solution measures to change those environmentally hazardous solid waste disposal methods in to safe and scientifically advisable ways of disposal methods before causing unmitigated damage to the surrounding environment of the study area and health condition of the residents. Unscientific and ordinary Land filling is the common practice for solid waste disposal in many developing countries (Sha'Ato et al., 2009). However, it were not only the information obtained from different sampled households, but also, the field survey made revealed lack of Sanitary Landfill Sites in the study area. Roadside solid waste disposal system would be the dominant practice observed in Woreda three of Lideta Sub-city.

Another point to be discussed is that, Households of the study area did not get any awareness from the responsible body through education campaign regarding how to store, collect and dispose solid waste in a manner that do not affect the public health and the environment. Another issue that investigated is that more than fifty percent (62%) respondents did not reuse and recycled the solid wastes generated from their home.

Factors affecting the SWM system of the study area revealed the existence of the following major factors beside the poor management of the Sub-city and Woreda administration.

- **Institutional Factors**

Lack of proper plan to realize effective and efficient SWM activities from the municipality and inability of this office and other institutions to set financial structures and to provide the necessary materials and equipment's used for safe solid waste disposal, in addition to the weakness of the municipality to work in cooperation with the community on the issue of SWM are some institutional factors behind the poor SWM of the study area.

- **Technical Factors**

The information obtained from sampled households indicated that most community of the study area are practicing open burning and open dumping as a major disposal methods. This indicates as more attention is not given on recycling and resource recovery as a common practice. In addition the location of solid waste disposal sites of the sub-city also indicates as no focus made on the environmental impacts of solid waste, because there are youth recreation centers around dump sites.

As a result it is possible to mention technical factors as another cause of SWM problem of the study area.

- **Social Factors**

The response of sampled households strongly reflected the poor awareness of the community about the close relationship existing between solid waste and their environment and their health. This was due to the fact that little effort made by concerned body to give health and environmental education so as to create awareness among the people. Therefore, in addition to Institutional and Technical factors, Social factors are other factors behind the SWM problem. It is the proper handling of this task which is often taken as an indicator of the successfulness of urban reform. Public services delivery has been failing in developing countries for a long time. The expectation was that decentralization and private sector participation in developing countries would improve service delivery, which has often not happened (Dijk, 2006). Similarly, the information obtained from different sources of this study revealed the weakness of the local administrations to effectively manage the solid wastes generated from the studied area. Developing countries face uphill challenges to properly manage their Waste managment with most efforts being made to reduce the final volumes and to generate sufficient funds for Waste management (EPA, 1999). In the same manner, in Lideta sub-city of Woreda three, the mandated body to undertake the SWM activities of the sub-city, i.e. the municipality of the Sub-city, was unable to discharge its responsibility effectively to run the activities of SWM on sustainable basis. Households so suggested the following measures as a solution for the SWM problem of their residents. Those suggested solutions are; the municipality must prepare sufficient solid waste disposal sites, must provide solid waste disposal container in their surroundings, and must employ labor engaged with the removal of those wastes to solid waste disposal sites. From the sampled households, some of them also stressed, it is not only the duty of the municipality to take the necessary measure to make it environmentally sound, but also solid waste disposal activities practiced by the community needs to be changed toward quantification and characterization of solid wastes they generate from their home helping to determine the size and number of functional units and equipment's required for managing the waste.

CHAPTER FIVE

CONCLUTION AND RECOMMENDATION

5.1 CONCLUSION

As field observation result indicated, Woreda three in Lideta sub-city has a problem of solid waste collection and disposal system. The communal storage containers to which householders carry their waste is not available. The disposal site is usually open reserved site, giving access to rats, flies, and animals, which is undesirable for hygienic and aesthetic reasons. From the survey result, there was strong evidence that some of the households (especially the lower income groups) were conscious about the recyclable materials such as glasses, plastic bottles and Tin cans.

This indicates that if authorized body provide suitable conditions for composting, recycling and secure markets for both recyclable and compost products, participation of households, private organizations in recycling and composting will increase.

Based on the empirical analysis of the data, the findings of this study are outlined and analysis of the solid waste generation rate based on households income level showed that, the quantity of solid waste generation responds to the income level of the households but does not responds to family sizes of the households. The study showed that on average the household solid waste generation rate of the study area is 0.95 kg/HH/ day for low Standard of living style, 1.17 kg/HH/ day for medium level and 1.44 kg/HH/ day for high level. In per capita generation rate 0.18 kg/person/day for low Standard of living style, 0.23 kg/person/day for medium level and 0.25 kg/person/day for high level. Generally, the overall average generation from the three socio-economic levels of the study area would be 0.21kg/person/day. The results have confirmed that, there is relationship between social standard of living and average ratio of daily waste generated by person.

Study of waste composition is an important step in selecting strategy for waste management. Results of this study have highlighted the characteristics of wastes per the three socio-economic levels of the households at the study area. As a result of fact the major households refuse includes, Organic wastes (64%) and recyclable wastes (18%), Combustible waste (12%), Hazardous waste (3%), others (3%) which are responsible for over whelming portion of total solid wastes originated from kebele 36 of Woreda 3 in lideta sub-city. The outcomes of this study could be used as a base for comparison with other outcomes from the same or different Woredas of the same or different Sub-cities of Addis Ababa City.

From the data on composition of waste from residential areas, it is seen that recovery of recyclables from every household is impossible through source separation of paper, plastic, glass and metal unless awareness is generated amongst the residents or incentives are offered to the citizens in the form of relief in taxes.

Design and operation of appropriate solid waste management systems are necessary for ensuring good sanitation and clean environment. The source specific solid waste quantification and characterization will be helpful in predicting the waste quantity from various waste generating sources in Woreda three and this can be used as a basis for managing the system in a better manner.

Due to lack of awareness about appropriate solid waste management, out of the different method of solid waste disposal system commonly practiced in the study area, majority of them used road side dumping site to dispose their wastes. So the community has to be provided with adequate education and develop awareness how to handle its solid wastes at home and about the consequences of disposing solid wastes everywhere illegally and not placing of solid wastes into the disposal sites properly. Generally, the study indicates that studying waste generation rate at household level is very vital to determine the quantity and composition of waste generation at the source. However, care should be taken during identification of income level of households for the matter of that, most of the households are not willing to declare their income, especially merchants.

5.2 RECOMMENDATION

To plan effectively and successfully in managing the solid wastes, proper quantification and characterization of it at household level is very essential. Additionally, it is highly recommended that similar study should be taken place with considerable factors, i.e. season, budget and number of participants. Woreda three in Lideta sub-city is expected to develop and employ an integrated solid waste management in order to minimize the rate of generation of solid wastes, to develop a better and effective mechanism of recycling and disposal, and to generate energy from the solid wastes, thereby to minimize the public health and environmental impact while maximizing profit or generating income, which can be possible through characterizing the solid wastes which is daily generated at household levels .

As some of the solid wastes are released because of the lack of knowledge and carelessness, the Woreda sanitation and beautification bureau can reduce its households solid waste generation by giving proper training to handle specific duty or activity and by assigning responsibility and taking some measure or the communities must be educated to reduce the amount of waste generated from their home by teaching them resource conservation, reuse and recycling techniques.

Closed communal containers with sufficient capacity should be located in reasonable distance (acceptable by the community) than using open reserved site to prevent both hygienic and aesthetic problems and should be emptied regularly.

In general, Woreda three in Lideta sub-city can significantly reduce the solid wastes rate of generation through, in addition to implementing integrated solid waste management program, minimizing wasteful materials and activities, providing proper and consistent training, promoting reusing, recycling and composting of generated solid wastes. Furthermore, exhaustive investigation of solid wastes in consistent manner is important and advisable.

Awareness should be given by Woreda administration for the community of Woreda three in Lideta sub-city to be volunteer in giving required information that they asked for the purpose of research as far as it may be for their benefit.

From this study results, most of the constituents of the generated wastes is either compostable or recyclable or energy can be reclaimed from it by Bio-gas formation. Hence, by mobilizing the community and NGOs in Woreda three of the sub-city, it is possible to generate huge amount of compost, which enriches the soil for urban agriculture and creates jobs opportunity for many youth job seekers.

To know the solid waste quantity and components that vary seasonally, similar study should be Conducted during rainy season.

REFERANCES

Aarne, P.W., William and D., Reinhart, (2002).Solid Waste Engineering.Gulford Publications, Spring Street, New Youk.

AACG-SBPDA, (2005).Current status of solid waste management of Administration of Addis Ababa.

Abu Rukah, Y., and Y., Al-kofahi, (2009).The assessment of the effect of landfill leachate on ground water quality. El-Akader landfill site, North Jordan

Agbola, T.,(1993).Environmental education in Nigerian schools. Environmental Education in the common wealth, the Common wealth of learning, Vancouver.

Alemayehu Addis, (2007). Hand book on General Principles to Solid Waste Management. Mega publishing enterprise, Addis Ababa.

Carlsson Reich, M., (2005).Economic assessment of municipal waste management systems. Case studies using a combination of life cycle assessment (LCA) and life cycle costing (LCC).Journal of Cleaner Production 13.

Cointreau, S. J., (1992). Environmental management of urban solid wastes in developing countries-a project guide, urban development department, World Bank, Washington. 7-18.

Daniel Hoornweg, (1999). What a waste solid waste management in Asia. The international Bank for Reconstruction and Development/ear the world Bank. Washington, D.C, U.S.A.

Dawit Walelign and Alebel Bayrau, (2003). Improvement of solid waste management in Addis Ababa, a participatory Approach (Draft), Addis Ababa, Ethiopia.

Van Dijk, M.,P., (2006). Managing cities in developing countries. Theory and practice of urban management. Cheltenham, Edward Elgar.

Dolk, M., (1997).Residents near waste.Landfill sites and risk of non-chromosal congenital malformations, collaboration study group, New York.

Dereje Tadesse,(2012). Study of Domestic solid waste management in jimma town, South west Ethiopia P.36.

EPA, (1996).Tool Kit for Solid Waste Management. Intermountain Region-National Park service

EPA (ENVIRONMENTAL PROTECTION AGENCY USA), (1999): Characterization of Municipal Solid Waste in the United States. Internet: www.epa.gov

EPHTI, (2004).Solid Waste Management.For Environment and Occupational Health Students. In collaboration with the Carter Center, the Ethiopian Minister of Health, and the Ethiopian Ministry of Education.TakeleTadesse, Gonder University.

Eshuan, J.K., (2002). Coordinating informal settlement solid waste into the municipal waste system; the case of Accra city. MA Thesis, Netherlands.

Feleke Amare, (2015), Practice and challenges of solid waste management in Durame town. Internet:www.swm.

Freduah George, (2004). Problems of Solid Waste Management in Nima, Accra.University of Ghana, Legon.

Gourlay, K. A., (1992). World of Waste, Dilemmas of industrial development, Zed Books Limited London.

Guy, H., (2000). Consideration in evaluating the cost effectiveness of environmental health interventions.Protection of the Human Environment, Geneva.

Hall, D., (1994). Waste Management Swage Sludge.Ethiopia Civil Service College, Addis Ababa.

Joseph, T., and P. Swartzbaugh, (1993). Recycling Equipment and Technology for Municipal Solid Wastes: Material Recovery Facilities. Park N.J., Noyes Data Corporation.

Justine, A., (1993). Community Based Solid Waste Management and Water Supply Projects, Problems and Solutions Compared. Urban waste expertise programme.Community participation to sustainable development.Phd Dissertation, ISS.

Karanja, A.(2005).SWM in Nairobi: Actors,institutional arrangements and Contributions to sustainable development studies, institute of social studies. The Huge Netherlands. Avi:http://www.shaker.nl.

Kebede Faris et al, (1993). Solid water problem, collection and Disposal program in Jimma town, n Ethiopia J. of Health Development volume 7(2).

Mohammed Aljaradin and Kenneth Mm., person, (2012). Environmental Impact of Municipal solid waste Landfills in Semi-Arid climate. Case study, Jordan. Department of water Resource Engineering,Lund University. Lund, Sweden.

Mandefro Seyoum, (2005), 2nd edition. Chemistry text book grade 10. Mega publishing enterprise, Addis Ababa.

Marshal, E., (1995).Analytic study to evaluate associations between dumpsites and birth effects. Atlanta.

Medina, M., (2002).Globalization, development and municipal solid water management in Third world Cities. Tijuana, Mexico.

Michael, W., (1995).An Integrated course for Geography, Stanley Thrones Ltd, England.

Moeller, D.W., (2005).Enviromental Health. MA. Harvard university press.3th edition.

Monroe T.M., (1997), Environmental Health Morton publishing company. U.S.A.

Mustafa, N., (1993). Plastics water management, disposal, recycling, and refuse. London. Marcel.

Organization for Economic Co-operation and Development, (2006).Improving Recycling Markets.OECD environment Programme. Paris.

PAN, (2008). Best practices on solid water Management of Nepalese cities. Supported by European union under the EC Asia pro. ECO-programme practical Action Nepal.

Perez G.B, Colon S.S, Garmendia M.A, Villarreal A.D, and Elena M.S.S, 2001. SW characterization study in the Guadalajara Metropolitan Zone, Mexico. Waste Management Research 19:413-424

Ray, A., (2008). Water Management in Developing Asia. Can trade and cooperation help?.The Journal of Environment and Development.

Sandra, C.L., (1995).Urban Management programme.Urban Management and the Environment. Private sector participation in Municipal solid waste Services in Developing countries.

Sango, I., and A. Sackey, (2007).Course Hand Book of Urban Environment Management. Ethiopian Civil Service College. Addis Ababa.

Samuel Shimelis, (2006). Commercial Solid Waste Generation and Composition Analysis: Arada Sub city, Addis Ababa.

SBPDA, (2003). Solid waste management status annual report of Addis Ababa the way for ward unpublished Addis Ababa.

Sha‟ Ato, R., and S.V., Intwange, (2009). Environmental Impact Assessment for a pilot project of Integrated solid waste Management in Makurdi, Nigeria. University of Agriculture, Makurdi.

Sha' Ato R., Aboho, S.Y., Oketunde, F.O., Eneji, I.S, Unazi, G, and Agwa S, (2007). Survey of solid waste generation and composition in a rapidly growing urban area in central Nigeria Waste Management 27: 352-358.

Sharma, M., McBean, E., (2007). A methodology for solid waste characterization based on diminishing marginal returns. Waste Management 27, 337–344.

Sinha, K.,(1993). Partnership in solid waste collection.Malaysian Experience. Regional Development Dialogue, Vol. 14,No.3.

Smith, (2010). What is Solid Waste Management? Retrieved from http://www.wise greek.com/ what-is-solid-waste-managment.htm web page Accessed, August 26/ 08/2013

Solomon Asrat (2007).Urban service Delivery: a case study of arada sub-city with particular emphases in household waste managemen.Unpublished MA thesis,Addis Ababa university, Regional and Local development studies,Addis Ababa.

TALG programme, (2008). Solid waste planning and Disposal.Service delivery training module 4. 4. The Asian Foundation.

Tchobanoglous, T., and B.J., Vigil, (1993).Integrated Solid Waste Management, Engineering Principle and Management Issues. The McGraw-Hill Companies, New York.

UNCHS, (1996). An urbanizing world global reports on human settlements. Oxford University Press, Oxford.

UNDP,(2004). Urban Agriculture: Food, Jobs and Sustainable Cities. New York: UNDP Urban Harvest Working Paper Series, Paper No. 1.

UNEP,(1996).International Source Book on Environmentally Sound Technologies for Municipal Solid Waste Management.UNEP Technical Publication 6, Nov. 1996.Retrieved from (http://www.unep.or.jp/ietc/estdir/pub/msw/).web page Accessed, August18, 2013.

UNEP, (1994). Partnerships for Sustainable Development: The Role of Business and Industry. Tufis University, London.

UNEP, (1999).News Letter and Technical Publication.Municipal Solid Waste Management.

UNEP,(2009). Developing Integrated Solid Waste Management Plan. Training Manual.Assement of Current Waste Management System and Gaps there in.Oskal Shiga, Japan.

UNICEF, (2008). Solid Waste Management Book: (technical report).

U.S Environmental Protection Agency, (2002).Municipal Solid Waste (MSW) Basic Facts.The environmental Magazine. Minnesota.

Wells, D., (1996). Environmental Policy: Abnormal Perspective to the Twenty First Century. New Jersey, USA.

Wilson, D.C., Velis, C., and C., Cheesema, (2006).Role of informal sector recycling in waste management in developing countries. Habitat International

World Health Organization, (1999).Safe Management of Wastes from Health Care Activities. A., Pruss, E., Giroult, P., Rush Brook.

Yamane, Taro. 1967. Statistics, an Introductory Analysis, 2nd Ed., New York: Harper and Row.

Yeuan, G., (2000). Disposal of Solid Wastes.Point Sources of Pollution.Local Effects and its Control. Tsinghua University, Beijing, China

Yitayal Beyene, (2005). Domestic solid waste quantity and composition Analysis in Arada Sub-City, Addis Ababa. MSc thesis paper, Addis Ababa University.

Zurbrug, C.,(2003).Solid Waste Management in Developing Countries.Retrieved from http://www.eawag.ch/organisation/abteilungen/sandec/publikationens-swm/downloads swm/basicsofSWM.pdf. Accessed on September 21, 2016.

Appendixes

Appendix A: PLATES

Sample figures which can speak by itself on indicating sorting of solid wastes generated from each households for the sac of characterization and showing the common practices of waste disposal system in the study area.

Plate 1 : Sample photo showing data collection on waste generated per sampled households per day (source: field survey)

Plate 2 : Photo showing Sorting and measuring wastes (source: field survey)

Plate 3: The underlying photo Showing one of the open dumping sites of the study area to indicate mainly lack of sanitary land fill sites in the study area, which is not Environmental Friendly Solid Waste disposal system (Source; Field survey).

Plate 4 : Photo showing Roadside solid waste disposal found in kebele 36 of woreda 3 in Lideta Sub-city. (Source; Field survey).

Appendix B; Chi square test

Table 9 Chi square test for the average quantity of SW generated per the three socio-economic levels (Low, Medium and High).

		Paired Differences					T	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Household Size Low - Average Quantity of Solid Waste/HH/day(kg)	4.38	1.880	.36183	3.638	5.1259	12.111	26	.000
Pair 2	Household Size Medium - Average Quantity of Solid Waste/HH/day(kg)	3.85	2.211	.42568	2.983	4.7331	9.063	26	.000
Pair 3	Household Size High - Average Quantity of Solid Waste/HH/day(kg) High	4.44	1.865	.35909	3.706	5.1829	12.378	26	.000

Table 11 chi square taste for solid waste composition.

		Low	Medium	High
Low	Pearson Correlation	1	.995**	.997**
	Sig. (2-tailed)		.000	.000
	N	18	18	18
Med	Pearson Correlation	.995**	1	.996**
	Sig. (2-tailed)	.000		.000
	N	18	18	18
High	Pearson Correlation	.997**	.996**	1
	Sig. (2-tailed)	.000	.000	
	N	18	18	18

Appendix C: Survey Questioners

The main purpose of these questionnaires is to collect first-hand information for the study that attempt to assess/investigate the quantity and characteristics of solid waste generated at household level for Woreda three in Lideta sub-city and trying to describe the way the generated waste would be discharged. The success of the study depends on your genuine responses to each question. Your response will be used only for the intended purpose. Therefore please read and respond to each item in the questionnaires and indicate your answer by ticking in the provided box for close ended questionnaires and indicate your answer by Writing on the provided space for open ended questions.
I appreciate your willingness to support my effort.

General direction

No need of writing your name. - Give only a single answer for close ended questions. If your response to the question is not included in the given alternatives, please, specify your answer on the space provided at the end of the alternatives.

Note:

- **I.** You are not required to reveal your name
- **II.** If you have additional comments please write in the space provided
- **III.** Put a **(√)** mark in appropriate given box for your answer.

Part I.

1.1 Respondent's background

A. Sex Male ☐ Female ☐

B. Educational status:

No education ☐ Basic education ☐ Elementary school (1-8) ☐ High school and Preparatory (9-12) ☐ Phd ☐ Master ☐ Degree ☐ Diploma ☐ Certificate ☐

1.2 Family Size_____

1.3 Average monthly income (in birr):

Less than 500 ☐ 501-1000 ☐ 1001-1500 ☐ 1500-2000 ☐ greater than 2000 ☐

Part II

1. What Materials do you commonly used to store Solid Waste at your house?

Local Basket ☐ Sacks ☐ Plastic bag ☐ Others ☐

Write if any_____

2. How do you evaluate the existing solid waste management practice in Your Woreda?

_____

_____-

3. Is temporarily Solid Waste disposing Site available in your neighborhood?

Yes No

4. If your answer for question 5 is yes, do you use it? And how it is managed?

_____

_____

5. If your answer for question 5 is No, what other means do you frequently use to dispose the solid waste of your households 1. Damp on road side 3.Damp on open field 2.Burn in my compound 4. Damp in to open ditches

Mention if any other_____

6. Who usually take the solid Waste from your home to the temporarily disposed site ?

My children ☐ Micro and small scale enterprise ☐ Informed Waste collectors ☐

Hose servant ☐

Mention if any_____

7. For how many days the waste generated stay at home before disposed to the site selected for temporary disposal?

1 day ☐ 2-4 day ☐ 5-7 days ☐ 8-10 days ☐ >10 days ☐

8. Do you reuse and recycle the waste generated in your house?

Yes ☐ No ☐

9. If your answer to question 10 is `**Yes**', For what purpose do you frequently Use (You can use more than one).

☐ Sale for 'Kuralew' ☐ Exchange for liwach

☐ Composting ☐ Using as fuel

☐ Feed for animals Mention if any_____

10. If your answer for question 10 is **No**, what is/are the reason/s?

_____

_____

11. Is there a problem due to late disposal of Solid waste generated from your house?

Yes ☐ No ☐

12. If your answer for question 11 is **yes**, what is/ are the problem/s? (You can choose more than one). Bad smell ☐ Insect breading ☐ Decrease aesthetics ☐

13. Do you pay fees for solid waste disposal service you get from the municipality?

Yes ☐ No ☐

14. Have you come across any form of lesson about solid waste management?

Yes ☐ No ☐

15. If your answer to question 18 is **Yes**, through what method do you get the lesson? (You choose more than one)

1. Kebele meeting 2. Radio and TV 3. Health center 4. Posters and Photographs

16. Do you know that there are rules and regulations about solid waste management in the sub-city?

Yes ☐ No ☐

17. If your answer to 19 is **Yes**, how is the follow up of the responsible body to practice the rules and the regulations?

Strong ☐ Weak ☐ No follows up ☐

18. In your opinion do you believe that the solid Waste disposal service that the municipality of the sub-city providing is satisfactory? Yes ☐ No ☐

19. If your answer for question 19 is **No**, what are the major problems?

_____

20. What should be done towards the adoption of safe and effective SWM mechanisms in your surrounding?_____

_____

_____

$$per\ capita\ waste\ generation\ = \frac{Total\ weight\ of\ SW generated\ at\ households}{Total\ number\ of\ persons in\ the\ household\ x\ total\ number\ of\ generation\ days}$$