

**SOLID WASTE MANAGEMENT IN GHANA: THE CASE OF TAMALE  
METROPOLITAN AREA**

**By**

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## **ABSTRACT**

The study aimed ensuring a clean environment in the Tamale Metropolis. It analysed the underlying factors affecting effective solid waste management in the metropolis and suggested possible measures to tackle the problem. The research gathered data from two main sources namely: secondary and primary sources. The three main techniques employed in gathering the primary data were: preliminary field investigation, questionnaire survey and face-to-face interview. The following key findings were established to be the factors affecting effective solid waste management in the Metropolis. These are:

- Inadequate skip supply for storing waste.
- Lack of routine collection of waste.
- Poor methods of waste management.
- Inadequate resources for waste management institutions to effectively collect the waste generated.

In the light of these problems enumerated above, the research recommended the adequate supply of skips, regular collection of waste, use of Integrated Solid Waste Management (ISWM) Model, proper management of the landfill and adequate rsourcing of the waste management institutions.

## **DEDICATION**

This piece of work is dedicated to my little daughter Faith Mwin-nongme Puopiel. The work is also dedicated to my dear wife Dogber Beatrice for her unrelenting support and prayer towards a successful completion of this work.

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## LIST OF ABBREVIATIONS/ACRONYMS

<b>Abbreviation/Acronym</b>	<b>Full Meaning</b>
AMA.....	Accra Metropolitan Assembly
DACF.....	District Assembly Common Fund
DESSAPs.....	District level Environmental Sanitation Strategies and Action Plans
EHSDs.....	Environmental Health and Sanitation Departments
EPA.....	Environmental Protection Agency
ESICOME.....	Expanded Sanitary Inspection and Compliance Enforcement
ESP.....	Environmental Sanitation Policy
GHC.....	Ghana Cedis
GIM.....	Ghana Innovation Market Place
GSS.....	Ghana Statistical Service
IGF.....	Internally Generated Fund
ISWM.....	Integrated Solid Waste Management
KMA.....	Kumasi Metropolitan Assembly
Ltd.....	Limited
MLGRD.....	Ministry of Local Government and Rural Development
MMDAs.....	Metropolitan, Municipal and District Assemblies
MSW.....	Municipal Solid Waste
NESP.....	National Environmental Sanitation Policy
NESPoCC.....	National Environmental Sanitation Policy Co-ordination Council
SWM.....	Solid Waste Management
TAMA.....	Tamale Metropolitan Area
UNEP.....	United Nations Environmental Programme
USEPA.....	United States Environmental Protection Agency
WMD.....	Waste Management Department

## CHAPTER ONE

### GENERAL INTRODUCTION

#### 1.1 Background to the Study

Solid waste is any material which comes from domestic, commercial, and industrial sources arising from human activities which has no value to people who possess it and is discarded as useless. In the early days, waste disposal did not pose difficulty as habitations were sparse and land was plentiful. Waste disposal became problematic with the rise of towns and cities where large numbers of people started to congregate in relatively small areas in pursuit of livelihoods (Shafiul and Mansoor, 2003). While the population densities in urbanised areas and per capita waste generation increased, the available land for waste disposal decreased proportionately. Solid waste management thus emerged as an essential, specialised sector for keeping cities healthy and liveable.

Solid waste management refers to source separation, storage, collection, transportation and final disposal of waste in an environmentally sustainable manner. In the light of this, solid waste management is an important environmental health service, and an integral part of basic urban services. This is because, the health implications of poor waste management can be very damaging to the people exposed to these unsanitary conditions. Diseases such as cholera, typhoid, dysentery and malaria are all related to the practice of poor waste management. This can result in the loss of human resources needed in the development of the country.

The collection, transfer and disposal of waste have been generally assumed by metropolitan governments in both developed and developing world. This constitutes a basic and expected government function. The format varies in most urban areas where solid waste is collected either by a government agency or private contractor. Despite the fact that developing countries do spend about 20 to 40 per cent of metropolitan revenues on waste management, they are unable to keep pace with the scope of the problem (Zerbock, 2003). In fact, when the governments of African countries were required by the World Health Organization (WHO) to prioritize their environmental health concerns, the results revealed that solid waste was identified as the second most important problem after water quality (Senkoro, 2003 cited by Zerbock, 2003).

In this case, Ghana is not an exception and for that matter Tamale Metropolitan Area (TAMA). This topic came to light when I viewed a documentary on Metro television vision coupled with frequent news publications, radio and television discussions on solid waste situation in the Accra Metropolitan Area (AMA). Upon viewing the clip and listening to the discussions, a quick survey was done to assess the situation in TAMA. The observation confirmed that the situation though not as huge as the one in AMA; was emerging since Tamale is a growing city. Therefore, the next section states the problem of solid waste management in TAMA.

## **1.2 Problem Statement**

Over the years, solid waste disposal has become a major problem in the Tamale Metropolitan Area (TAMA). Therefore, indiscriminate dumping, irregular collection of waste generated and inadequate resources are the key problems facing solid waste management in the Metropolis. In the Metropolis, it is estimated that 810 tonnes of waste is generated a day and out of this, 216 tonnes are hauled daily. This leaves a backlog of 594 tonnes uncollected a day.

This has resulted in littering, heaping of waste and overflowing of skips with waste in the Metropolis most especially in the low class residential and peri-urban areas. The recent proliferation of polythene bags for packaging has seriously aggravated the situation in the study area. This makes the above mentioned residential areas filthy and unattractive for living. Therefore, if the situation is left unchecked it can result in the out break of communicable diseases such as cholera, typhoid and this will affect people exposed to this unsanitary conditions. On the basis of this, the study intends to examine the problem enumerated above in TAMA in the Northern Region. Therefore, the research seeks to establish the causes of this problem by answering the following questions:

1. What types of solid waste are generated in the Metropolis?
2. How do people dispose off their domestic waste?
3. How frequent is the waste collected and disposed of?
4. What resources are available in collecting the waste generated?
5. What is the way forward?

### **1.3 Aim and Objectives of Study**

The main aim of the study is to examine the factors affecting effective solid waste management in the metropolis and suggest possible measures to tackle the problem. Specifically, the research aims at achieving the following objectives.

1. To assess the types and components of solid waste generated in the Tamale Metropolis.
2. To examine means of waste disposal by households (place of disposal).
3. To analyse the mode and frequency of solid waste collection.
4. To analyse how the waste collected is finally disposed of.
5. To assess the capacity of the waste management institutions in managing solid waste in the area.
6. To make recommendations for effective management of solid waste in the Metropolis.

### **1.4 Scope of Study**

Geographically, the study area covered TAMA in the Northern Region of Ghana. TAMA was chosen because it is a growing city just like other Metropolitan areas such as Kumasi and Accra and as such is facing a bigger problem of managing its solid waste effectively. Contextually, the study focused on domestic solid waste management. This is because about 80 per cent of solid waste generated in metropolis comes from domestic sources. Figures 1.1 and 1.2 below illustrate maps of Northern Region and TAMA respectively.



Figure 1.1: Map of Northern Region showing TAMA



Figure 1.2: Map of TAMA showing areas of study

### **1.5 Justification of Study**

Solid waste management has become a major development challenge in TAMA in recent times. This deserves not only the attention of the Metropolitan Assembly and the waste management institutions but also concerns of corporate organizations and individuals to find a lasting solution to the problem. This is because, vital human resource could be lost through poor waste management and this will affect productivity in the Metropolis. The study therefore intends to explore appropriate strategies and recommendations in clearing solid waste in all segments in the Metropolis in a sustainable manner.

Despite the immensity of the problem, very little research on solid waste management has been carried out in the Metropolis. The study will serve as a reference point to the Metropolitan Assembly and waste management institutions as far as solid waste management is concerned. In this case, it will give them an in-depth understanding of what the problems of solid waste management are and the strategies to tackle the problems. Additionally, the study will contribute to existing body of knowledge on solid waste management and also stimulates further research on the subject in other Metropolitan Areas and Municipalities.

### **1.6 Chapter Organisation**

The research work is presented in six (6) chapters. Chapter one provides a general introduction to the research. It analyses the extent of the problem in Tamale Metropolis and addresses the significance of the study in TAMA. Chapter two examines existing literature on solid waste management. That is concepts, processes and methods of managing solid waste. Chapter three describes the methodology employed in gathering data from the field. These included preliminary field investigation, questionnaire survey and face-to-face interviews. Chapter four provides a brief description of the location of TAMA, the history, population and housing characteristics as well as cultural values and their relationship with solid waste generation and management. Chapter five analyses the findings gathered from field and chapter six summarises the key findings of the study, recommendations and conclusion.

### **1.7 Limitations of Study**

The following hindered the smooth completion of the study. These are enumerated below.

- The prevailing unstable condition in the Yendi Municipal Assembly affected the scope of the study. The intended areas of study were Tamale Metropolis and Yendi Municipal. However, the unstable peace situation necessitated the exclusion of the Yendi Municipal for the study.
- The inability to obtain the total female population figures between of the ages 20 years and above for the study was a limiting factor. Additionally, the female population for each of the selected areas could not also be obtained. This explains why the sample size was divided equally among the areas of study.
- Some potential respondents wanted to be compensated for the time spent in responding to the questionnaire. This makes the administration of questionnaire quite difficult.

### **1.8 Research Direction**

The chapter provided an overview of the topic on waste management. This included background to the study, problem statement, objectives, scope and justification. The next chapter reviews literature on solid waste management. It examines key concepts and methods of waste management.

## CHAPTER TWO

### SOLID WASTE MANAGEMENT

#### 2.1 Introduction

Events of the 20<sup>th</sup> and early into the 21<sup>st</sup> century indicate that waste in whatever form or classification- solid, liquid or toxic have become a major consequence of modernization and economic development (Tsiboe and Marbell, 2004). In the quest for ‘Western-styled’ development, humanity did not budget for the problems related to the management of waste. This chapter therefore explores literature on solid waste management. It examines key concepts, methods and problems of waste management. The chapter concludes with the summary of key lessons learnt from the review and a conceptual framework that guides the study. The next section examines some of the concepts of solid waste management for better understanding of solid waste management.

#### 2.2 Waste

Waste is more easily recognised than defined. Something can become waste when it is no longer useful to the owner or it is used and fails to fulfill its purpose (Gourlay, 1992 cited by Freduah, 2004). There are basically two types of waste namely liquid and solid waste. But for the purpose of the study, the focus is on solid waste. This is discussed in the next section of the review.

##### 2.2.1 Solid Waste

The term solid waste has been defined differently by various authors. Solid waste is any material that arises from human and animal activities that are normally discarded as useless or unwanted (Tchobanoglous *et al* 1993). According to Zerbock (2003), solid waste includes non-hazardous industrial, commercial and domestic waste including:

- household organic trash
- street sweepings
- institutional garbage and
- construction wastes.

The Ghana Innovation Market Place (2009) popularly known as ‘GIM’ defines solid waste as neither wastewater discharges nor atmospheric emissions, arising from domestic, commercial, industrial, and institutional activities in an urban area.

Operationally, it can therefore be said that, solid waste is any material which comes from domestic, commercial, and industrial sources arising from human activities which has no value to people who possess it and is discarded as useless. Having analysed what solid waste is; the next section examines the sources and types of solid waste.

### 2.2.2 Sources and Types of Solid Waste

Tchobanoglous *et al* (1993), classified types of solid waste in relation to the sources and generation facilities, activities, or locations associated with each type which is presented in table 2.1 below.

**Table 2.1 Typical Waste Generation Facilities, Activities, and Locations associated with various Source of Solid Waste**

Source	Typical location	Types of Solid Waste
Residential	Single-family and multifamily dwellings, low-medium, and high-rise apartments.	Food wastes, rubbish, ashes, special wastes
Commercial/ Municipal	Stores, restaurants, markets, office buildings, hotels, motels, print shops, auto repair shops, medical facilities and institutions.	Food wastes, rubbish, ashes, demolition and construction wastes, special wastes, occasionally hazardous wastes
Industrial	Construction, fabrication, light and heavy manufacturing, refineries, chemical plants, lumbering, mining, demolition.	Food wastes, rubbish, ashes, demolition and construction wastes, special wastes, occasionally hazardous wastes.
Open areas	Streets, alleys, parks, vacant plots, playgrounds, beaches, highway and recreational areas.	Special wastes, rubbish
Treatment plant sites	Water, wastes water, and industrial treatment processes.	Treatment plant wastes, principally composed of residual sludge
Agricultural	Field and row crops, orchards, vineyards, dairies, feedlots and farms.	Spoiled food wastes, agricultural wastes, rubbish, hazardous wastes

Source: Tchobanoglous et al 1993 p.52-53.

Tchobanoglous *et al* (1993) has further explained the types of solid waste which include food waste, rubbish, ashes and residues and special waste. These are explained below.

*Food waste:* Food wastes are all the animal, plant or vegetable residues resulting from the handling, preparation, cooking, and eating of foods (also called garbage). The most important characteristics of these waste is that they are highly putrescible and will

decompose rapidly, especially in warm weather. Often, decomposition will lead to the development of offensive odors. In many locations, the putrescible nature of these wastes will significantly influence the design and operations of solid waste collection.

*Rubbish:* Rubbish consists of combustible and non-combustible solid wastes of households, institutions and commercial activities. This excludes food wastes or other highly putrescible materials. Typically, combustible rubbish consists of materials such as paper, cardboard, plastics, textiles, rubber, leather, wood, furniture, and garden trimmings. Non-combustible rubbish consists of glass, tin cans, aluminium cans, ferrous and other non-ferrous metals, and dirt.

*Ashes and Residues:* These are materials remaining from the burning of wood, coal, coke and other combustible wastes in homes, stores, institutions, and industrial and municipal facilities for purposes of heating, cooking and disposing of combustible wastes. These are referred to as ashes and residues.

*Special waste:* Special waste includes street sweepings, roadside litter, litter from municipal containers, catch-basin debris, dead animals and abandoned vehicles.

The Centre for Environment and Development (2003) has also classified types of solid waste based on origin (food waste, rubbish, ashes and residues, demolition and construction, agriculture waste), based on characteristics (biodegradable and non-biodegradable), based on the risk potential (hazardous waste). The Centre also enumerated sources of solid waste as residential, waste from shops, commercial establishments, hotels/restaurants/eating stalls, slaughter houses and others. This has confirmed the sources and types of solid waste outlined by Tchobanoglous *et al* (1993). Based on the types of solid waste enumerated by Tchobanoglous *et al* (1993) and the Centre for Environment and Development (2003), it can be said that types of solid waste include the following: food waste, rubbish, ashes and residues, demolition and construction, and agriculture waste. The sources of solid waste also include domestic, commercial and industrial.

### **2.2.3 Components of Solid Waste**

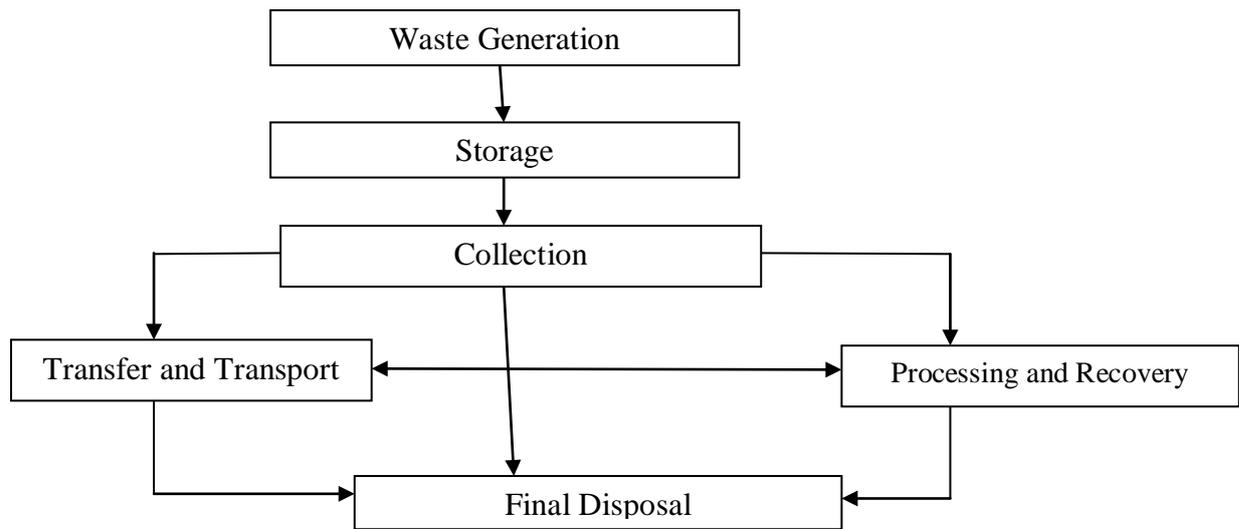
Solid waste consists of many different materials. Some can burn, some cannot. Some can be recycled, some cannot. Therefore, a detailed understanding of the composition of solid waste will indicate the management methods that will be used. Solid waste is composed of combustibles and non-combustible materials. The combustible materials include paper, plastics, yard debris, food waste, wood, textiles, disposable diapers, and other organics. Non-combustibles also include glass, metal, bones, leather and aluminium (Denison and Ruston 1990; Kreith 1994 and Zerbock 2003). Having understood the concept of solid waste, sources, types and components of solid waste, this leads the discussion on solid waste management in the next section.

### **2.3 Solid Waste Management**

The term solid waste management has been viewed differently by various authors. Kumah (2007: 2) defines solid waste management as “the administration of activities that provide for the collection, source separation, storage, transportation, transfer, processing, treatment, and disposal of waste”. However, Tchobanoglous et al (1993: 7), provide a more comprehensive definition of solid waste management. According to them, solid waste management is:

“.....that discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics and other environmental considerations and that is also responsive to public attitudes”.

Therefore, if solid waste management is to be accomplished in an efficient and orderly manner, the fundamental aspects and relationships involved must be indentified and understood clearly (Tchobanoglous *et al*, 1993). On the basis of this solid waste management incorporates the following: source separation, storage, collection, transportation and disposal of solid waste in an environmentally sustainable manner. These are some of the six key elements illustrated in Figure 2.1 below.



**Figure 2.1: Key Elements of Solid Waste Management**

### ***2.3.1 Solid Waste Management Processes***

As shown in figure 2.1 above, the key elements in solid waste management include: waste generation, storage, collection, transfer and transport, processing and recovery and final disposal. This means that when waste is generated it is first stored in either dustbins or skips. It is then collected and finally disposed of in landfill. Also, when waste is collected it can be transferred from small collection equipment like the tricycle to a bigger truck for final disposal. On the other hand, waste collected can be processed and recovered for materials to be reused. These elements are further elaborated below

#### ***2.3.1.1 Waste Generation***

Waste generation encompasses those activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal (Momoh and Oladebeye, 2010). According to UNEP (2009), in 2006 the total amount of municipal solid waste (MSW) generated globally reached 2.02 billion tones, representing a 7 per cent annual increase since 2003. It is further estimated that between 2007 and 2011, global generation of municipal waste will rise by 37.3 per cent, equivalent to roughly 8 per cent increase per year (UNEP, 2009). The programme also says that, as per WHO estimations, the total health-care waste per person per year in most low income countries, is anywhere from 0.5 kg to 3 kg. That notwithstanding, the causes of this increased should have enumerated by the organisation and therefore, has not exhausted the issue on discussion. It is accepted that solid

waste generation is increasing at a faster rate globally as indicated by UNEP and this is confirmed by Mensah and Larbi (2005) concerning solid waste generation in Ghana.

#### *2.3.1.2 Storage*

Tchobanoglous *et al* (1977) explain storage to mean where solid waste is stored before it is collected. It could be stored in a skip or dustbins and not thrown away indiscriminately. According to them, storage is of primary importance because of the aesthetic consideration.

#### *2.3.1.3 Collection:*

The element of collection includes not only the gathering of solid waste, but also the hauling of waste after collection to the location where the collection vehicle is emptied ( Kreith, 1994). According to Kreith (1994), the most common type of residential collection services in the United States include “curb”, “setout-setback” and “backyard carry”. According to the USPS (2000), in the city of Thimphu in Bhutan the collection of solid waste from households, commercial set-ups was done in concrete receptacles placed at strategic points and conveyed by trucks/tractors. Accordingly, there were concrete bins and containers provided at various locations from where the waste was lifted for disposal. Individual bins/containers were also placed alongside the shops in certain areas, which were emptied directly into the trucks/tippers. This prevents people from dumping waste indiscriminately. On the other hand, the building of these concrete bins and containers may be expensive to do in Ghana and for that matter TAMA.

#### *2.3.1.4 Transfer and Transport:*

According to Kreith (1994), transfer and transport involves two steps: (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 distances to the final disposal site.

#### *2.3.1.5 Processing and Recovery:*

The element of processing and recovery includes all the technology, equipment, and facilities used both to improve the efficiency of other functional elements and to recover usable materials, conversion products or energy from solid wastes (Tchobanoglous *et al*, 1977). In the recovery, separation operations have been devised to recover valuable resources from the mixed solid wastes delivered to transfer stations or solid waste processing plants (Tchobanoglous *et al*, 1977).

### *2.3.1.6 Disposal*

It is the ultimate fate of all solid wastes whether they are residential wastes collected and transported directly to landfill site. Having explained the various elements in the diagram by some authorities, the next section analyses in further details the final disposal methods of solid waste. Several methods of solid waste management have evolved over the years. These methods according to the Centre for Environment and Development (2003) vary greatly with types of wastes and local conditions. For the purpose of this analysis, this section is divided into early practices of managing solid waste and contemporary methods of waste management systems.

## **2.4 Early Practices of Solid Waste Management**

According to Tchobanoglous *et al* (1993: 17-18), the most commonly recognized methods for the final disposal of solid wastes were:

- dumping on land, canyons and mining pits
- dumping in water
- ploughing into the soil
- feeding to hogs
- reduction and incineration

Some of these unwholesome practices of solid waste identified during the early disposal practices still exist in cities, towns and villages today. Indiscriminate dumping on opened land and dumping in gutters particularly are clearly evident in towns and cities, while dumping in water especially people living in coastal towns is common place.

Burning of dumps is also common in peri-urban and rural communities in Ghana and in many other less developed countries. A study carried out in Ado-Akiti in Nigeria by Momoh and Oladebeye (2010) showed that, the methods of solid waste disposal include dumping of waste in gutters, drains, by roadside, unauthorized dumping sites and stream channels during raining season and burning of wastes on unapproved dumping sites during the dry season. This has gone to confirm that the practices of solid waste disposal in the 1950s still exist today and study area is not an exception. On the other hand, Momoh and Oladebeye's (2010), assessment of waste situation in Ado-Akiti in Nigeria is questionable as they did not further explain what brought about the indiscriminate dumping. It could be that people dumped the waste any how because they were no skips or dustbins for the people to store

their waste for collection. Having assessed how solid waste was disposed in the early days, the next section discusses the contemporary methods of managing solid waste.

## **2.5 Contemporary Methods of Managing Solid Waste**

In the contemporary era, the methods of managing solid waste include source reduction, sanitary landfills, composting, recycling, and incineration (Denison and Ruston, 1990). These methods are examined below.

### ***2.5.1 Source Reduction***

Denison and Ruston (1990) viewed source reduction as any action that reduces the volume or toxicity of solid waste prior to its processing and disposal in incinerators or landfills. This view is similar to the one given by Kreith (1994). According to him, source reduction focuses on reducing the volume and /or toxicity of waste generated. Source reduction includes the switch to reusable products and packaging, the most familiar example being returnable bottles. According to USPS (2000) in the city of Thimphu in Bhutan to reduce waste problems in future, reduction in waste generation would be the most important factor. Examples of possible reduction at the consumption level include reuse of containers (including bags), better buying habits, and cutting down on the use of disposable products and packaging (USPS, 2000).

It is agreed that, source separation and resource recovery is an important method in waste management. This is because there is nothing like waste on this earth. Wastes that are discharged may be of significant value in another setting, but they are of little or no value to the possessor who wants to dispose of it. According to Tsiboe and Marbel (2004), Austria, the Netherlands, and Denmark developed a waste management processes to efficiently resolve the waste disposal problem by essentially coaxing their citizens to separate their domestic solid waste into glass, paper, plastic categories; thereby enabling easy collection and consequently reuse. As suggested by the three authors, one way of effectively managing solid waste is to minimise solid waste generation through source reduction.

### ***2.5.2 Sanitary Landfill***

Sanitary land filling includes confining the waste, compacting it and covering with soil. It not only prevents burning of garbage but also helps in reclamation of land for valuable use (Centre for Environment and Development, 2003). The placement of solid waste in landfills is the oldest and definitely the most prevalent form of ultimate waste disposal (Zerbock, 2003:16). He further argued that “landfills” are nothing more than open, sometimes controlled dumps. According to him the difference between landfills and dumps is the level of engineering, planning, and administration involved. Open dumps are characterized by the lack of engineering measures, no leachate management, no consideration of landfill gas management, and few, if any, operational measures such as registration of users, control of the number of “tipping fronts” or compaction of waste (Zerbock, 2003).

Further more, landfills are one form of waste management that nobody wants but everybody needs (Kreith, 1994: 2.8) According to him, there are simply no combinations of waste management techniques that do not require landfilling to make them work. Of the basic management options of solid waste, landfills are the only management technique that is both necessary and sufficient. According to Kreith (1994) some wastes are simply not recyclable, many recyclable wastes eventually reach a point where their intrinsic value is completely dissipated and they no longer can be recovered, and recycling itself produces residuals. He further highlighted that the technology and operation of modern land fill can assure the protection of human health and the environment.

In contrast to what the various authors have said about sanitary landfill as an option for waste management, they have failed to recognize that land fill in itself has some disadvantages as it is costly to construct and maintain, can pollute ground water through leaching, location is a problem in terms of availability of land particularly in the cities. Other critical factors such as gas recovery, composting, waste to energy recovery, storm water control, distance to any settlement and water body were not clearly spelt out by the authors. Therefore, there could be an alternative which is recycling. This method is discussed in the next sub-section.

### ***2.5.3 Recycling***

According to Momoh and Oladebeye (2010: 1) recycling has been viewed as a veritable tool in minimizing the amount of household solid wastes that enter the dump sites. It also provides the needed raw materials for industries. According to them, it has been established that, it is the best, efficient and effective method of solid waste management system. However, this may not be cost effective in developing countries like Ghana. The United States Environmental Protection Agency (USEPA) (1999) has recommended recovery for recycling as one of the most effective waste management techniques. According to USEPA, recycling turns materials that would otherwise become waste into valuable resources and, it yields environmental, financial, and social returns in natural resource conservation, energy conservation, pollution prevention, and economic expansion and competitiveness. More importantly, a sizeable portion of what is thrown away contains valuable resources—metals, glass, paper, wood, and plastic—that can be reprocessed and used again as raw materials (USEPA, 1999).

Kreith (1994) has also added that, recycling is the most positively perceived and doable of all the waste management options. According to him recycling will return raw materials to market by separating reusable products from the rest of the municipal waste stream. The benefits of recycling are many, he added. It saves precious finite resources, lessens the need for mining of virgin materials which lowers the environmental impact for mining and processing. For example, according to the Institute of Waste Management cited by Tsiboe and Marbel (2004), UK recycles only 11 per cent of its household waste, Italy and Spain only 3 per cent, Netherlands 43 per cent, Denmark 29 per cent, and Austria 50 per cent respectively. Having proposed recycling by different authors as the best option to manage solid waste in modern times; they have forgotten about the cost component which is key to successful implementation of any recycling project. Even developed countries are not able to successfully do it. But alternatively, it may be the best option for effectively managing solid waste in Ghana.

### ***2.5.4 Composting***

Composting process uses microorganisms to degrade the organic content of the waste. Aerobic composting proceeds at a higher rate and converts the heterogeneous organic waste materials into homogeneous and stable humus (Centre for Environment and Development, 2003: 9).

UNEP (2009) has also defined composting as a biological decomposition of biodegradable solid waste under controlled predominantly aerobic conditions to a state that is sufficiently stable for nuisance-free storage and handling and is satisfactorily matured for safe use in agriculture. According to the UNEP (2009), composting is the option that, with few exceptions, best fits within the limited resources available in developing countries. A characteristic that renders composting especially suitable is its adaptability to a broad range of situations. According to Zerbock (2003), a low-technology approach to waste reduction is composting. He further says that in developing countries, the average city's municipal waste stream is over 50 per cent organic material.

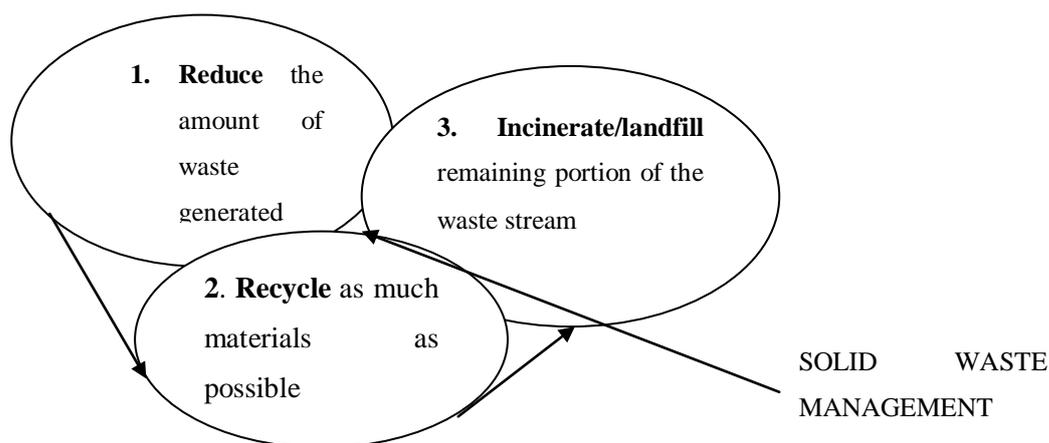
### ***2.5.5 Incineration***

According to the Centre for Environment and Development (2003: 9), incineration is a controlled combustion process for burning combustible waste to gases and reducing it to a residue of non-combustible ingredients. According to the Centre, during incineration, moisture in the solid waste gets vapourised and the combustible portion gets oxidised and vapourised. CO<sub>2</sub>, water vapour, ash and non-combustible residue are the end products of incineration. Incinerators have the capacity to reduce the volume of waste drastically, up to nine fold than any other method (Kreith, 1994). According to him incineration can also recover useful energy either in the form of steam or electricity. He however recognised that the main constraints of incineration are high cost of operation, relatively high degree of sophistication needed to operate them safely and economically as well as the tendency to pollute the environment through emissions of carbon dioxide. Having assessed the major methods that have been proposed by the various authors, literature has further revealed that there is an alternative method of managing solid waste effectively which is synonymous to waste reduction and recycling as mentioned earlier on. This forms the next section of the review.

### ***2.5.6 Integrated Solid Waste Management***

Although considerable efforts are being made by many Governments and other entities in tackling waste-related problems, there are still major gaps to be filled in this area (UNEP, 2009). According to UNEP (2009), the World Bank estimates that in developing countries, it is common for municipalities in developing countries to spend 20 to 50 percent of their available budget on solid waste management, even though 30 to 60 percent of all the urban

solid wastes remain uncollected and less than 50 percent of the population is served. The programme (UNEP) suggested that if most of the waste could be diverted for material and resource recovery, then a substantial reduction in final volumes of waste could be achieved and the recovered material and resources could be utilized to generate revenue to fund waste management. This forms the premise for the Integrated Solid Waste Management (ISWM) system based on 3Rs (reduce, reuse and recycle) principle. ISWM system has been pilot tested in a few locations (Wuxi, PR China; Pune, India; Maseru, Lesotho) and has been well received by local authorities. It has been shown that with appropriate segregation and recycling system significant quantity of waste can be diverted from landfills and converted into resource (UNEP, 2009). Similarly, the United States Environmental Protection Agency (1999) has said that if a state or local government wants to plan for and implement ISWM, they have to consider a hierarchy of methods which are reduce, recycle, and incinerate/landfill. Figure 2.2 below is a model of the ISWM.



**Figure 2.2: Model of ISWM**

Having discussed extensively by different authors on the methods that can be used to manage solid, the next section assesses the problems facing effective solid waste management in developing countries.

## **2.6 Problems of Managing Solid Waste**

According to Ogawa (2005), a typical solid waste management system in a developing country displays an array of problems, including low collection coverage and irregular collection services, crude open dumping and burning without air and water pollution control.

He categorised these challenges into technical, financial, institutional and social constraints. He further discussed these constraints in relation to the sustainability of solid waste in developing countries.

### ***2.6.1 Technical Constraints***

According to him, in most developing countries, there are inadequate human resources at both the national and local levels with technical expertise necessary for solid waste management planning and operation. Many officers in charge of solid waste management, particularly at the local level, have little or no technical background or training in engineering or management.

### ***2.6.2 Financial Constraints***

Ogawa (2005) intimated that, solid waste management is given a very low priority in developing countries, except perhaps in capital and large cities. As a result, very limited funds are provided to the solid waste management sector by the governments, and the levels of services required for protection of public health and the environment are not attained. The problem is acute at the local government level where the local taxation system is inadequately developed and, therefore, the financial basis for public services, including solid waste management, is weak. This weak financial basis of local governments can be supplemented by the collection of user service charges. However, users' ability to pay for the services is very limited in poorer developing countries, and their willingness to pay for the services which are irregular and ineffective.

### ***2.6.3 Institutional Constraints***

He indicates that, several agencies at the national level are usually involved at least partially in solid waste management. He however, indicated that, there are often no clear roles or functions of the various national agencies defined in relation to solid waste management and also no single agency or committee designated to coordinate their projects and activities.

“.....The lack of coordination among the relevant agencies often results in different agencies becoming the national counterpart to different external support agencies for different solid waste management collaborative projects without being aware of what other national agencies are doing. This leads to duplication of efforts, wasting of resources, and unsustainability of overall solid waste management programmes. The lack of effective legislation for solid waste management, which is a norm in most developing countries, is partially responsible for the roles/functions of the relevant

national agencies not being clearly defined and the lack of coordination among them” (Ogawa,2005: p.2).

According to him, Legislation (Public Health Act, Local Government Act, Environmental Protection Act) related to solid waste management in developing countries is usually fragmented.

Zurbrugg (2009) further added that, solid waste collection schemes of cities in the developing world generally serve only a limited part of the urban population. The people remaining without waste collection services are usually the low-income population living in peri-urban areas. According to him, one of the main reasons is the lack of financial resources to cope with the increasing amount of generated waste produced by the rapid growing cities. Often inadequate fees charged and insufficient funds from a central municipal budget cannot finance adequate levels of service. He indicated that, apart from financial constraints that affect the availability or sustainability of a waste collection service; operational inefficiencies of solid waste services such as deficient management capacity of the institutions and inappropriate technologies affect effective waste management. Zurbrugg (2009) therefore underscores the key challenges of waste management which include financial and institutional constraints.

## **2.7 Solid Waste Management in Ghana**

Over the years, solid waste disposal in Ghana has become a major challenge to MMDAs. As a result of urbanisation and increasing densities, Metropolitan Assemblies find it difficult to deal with the large quantities of solid waste generated. This is due to the fact that, people resort to indiscriminate dumping as the only means to managing their domestic solid waste thus resulting in littering and heaping of waste. This section of the review analyses solid waste management processes in Ghana with AMA and KMA as a case. These include collection and disposal as well as waste management regulation and policy in Ghana. The next sub-section discusses solid generation in AMA and KMA.

### **2.7.1 Solid Waste Generation**

According to Mensah and Larbi (2005) based on an estimated population of 22 million and an average daily waste generation per capita of 0.45 kg, Ghana generates annually about 3.0 million tonnes of solid waste. Boateng and Nkrumah (2006) have further added that, solid

waste generated daily in Accra was between 1500-1800 tonnes. According to Anomanyo (2004) about 1800 tonnes of municipal solid wastes were generated per day in the Accra Metropolis and the average waste generated per capita per day was estimated at 0.5 tonnes. He attributed this to the rate of population growth in the Metropolis which stood at 3.5 per cent. Waste from domestic sources include, food waste, garden waste, sweepings, ash, packaging materials, textiles and electric and electronic waste with organic waste being the major component. This constituted about 65 per cent. According to him, the high proportion of food and plant waste was due to the fact that Ghana's economy largely depended on agricultural products for export and domestic consumption. But the waste rate of AMA was about 2000 tonnes a day with per capita waste generation of 0.45kg (AMA, 2009). Also, according to KMA (2009), the current domestic waste generation in Kumasi rate was approximately between 1000-1500 tonnes a day. This was based on the projected population of 1,610,867. According to Ketibuah et al (2010), in Kumasi the bulk of household waste is found to be organic waste which includes food waste and pustrecible waste with an average of 55 per cent. Having discussed the quantities and composition of waste generated in the two Metropolis, this leads the discussion on solid waste collection in the next sub-section.

### ***2.7.2 Solid Waste Collection***

According to Tsiboe and Marbel (2004), there are basically three methods of household waste collection in Accra:

- Waste Management Department (WMD) curbside collection by trucks directly outside each house. According to them, this collection method was provided weekly in the high-income residential areas like Roman Ridge, Airport and Cantonment by compactor trucks.
- WMD collected from communal containers to which people must bring their own waste. These were restricted to low-income areas like Niima and amounted to some 200 communal containers. Households that could not afford the house to house collection service took their waste to any of these 200 communal containers and from which the WMD collected the waste and disposed of it at the landfill site (Stephens et al 1994: 25) cited in Tsiboe and Marbell (2004) and
- Door-to-door collection services in middle-income areas like Labadi.

According to Anomanyo (2004), for the purpose of effective waste collection, the city was demarcated into waste collection districts where a company was contracted by AMA to collect waste in one district or two. Fifteen (15) waste collection companies were contracted. These include: Liberty Waste Service Company, Vicma Waste Construction, Ako Waste Management Limited, Gee Waste Limited and Daben Cleansing Construction Services Limited. The main types of vehicles used by AMA were compaction and skip trucks. The wastes were taken by road directly to the disposal sites. There were no waste transfer stations.

According to him, solid waste collection in the city was carried out both on franchise and contract basis. On the franchise basis, a house-to-house collection was done in high income areas and the contractors charged the households some fees with weekly collection frequency. These areas were well-planned residential areas with access roads described as first and second class areas and include areas as Airport residential area and Cantonments. Each household had plastic containers with covers. These contractors then paid a tipping fee to the AMA for the use of its dump site. The user fees charged form about 20 per cent of general service to the beneficiaries whose wastes were collected. On contract bases, waste contractors were paid by AMA to perform both block and communal container collection. Block collection occurred in middle-income residential areas including Dansoman, Adabraka, Kaneshie and other parts of Accra. Approximately 75 per cent of the waste generated was collected in these areas. Central communal skip collection occurred in low income high population density and deprived residential areas such as James Town, Nima and other parts of Accra where houses were not well planned with poor or even no access roads (third class areas). Market places were also covered under this arrangement. Residents deposited their waste in such communal containers and the frequency of collection was at least once daily. Waste generators here did not pay user charges. He added that despite the strategies put in place for the collection of waste in Accra, maximum waste collection was not achieved. Between 65 and 75 per cent of waste was collected per day.

According to KMA (2006), there are two modes of waste collection in the Kumasi Metropolis. These are house-to-house and communal collection. According to Metropolitan Assembly, Aryetey Brother Company Limited (ABC), Waste Group Ghana Limited (WGG), Sak-M Company Limited (SAK-Mo Meskworld Limited (ML) and Kumasi Waste Management Limited (KWML) were contracted for solid waste collection. About 33 per cent of the population enjoys this service but payment for the service was irregular.

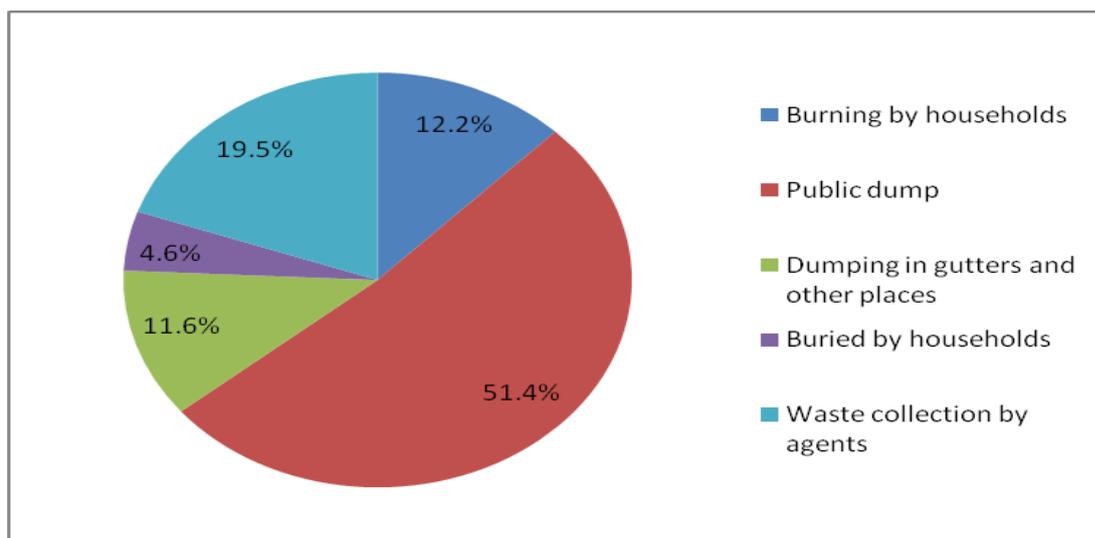
It is on franchise basis for a monthly fee of GH¢1 to GH¢3 per house. Additionally, the communal collection was awarded to Kumasi Waste Management Limited (KWML), Waste Group Ghana Limited (WGG), Meskword (ML) and Aryetey Brother Company Limited (ABC). The total quantities collected were weighed at the disposal site and payment was based on a rate of GH¢ 9 per tonne.

From the above assessment, it can be deduced that there are basically, two main modes of waste collection in AMA and KMA. These are door-to-door or house-to-house collection and communal collection which are carried out in the high class and low class residential areas respectively. Unlike the door-to-door collection which attracts some fee from households, the communal collection is carried out at no cost to the households in AMA. In the case of KMA waste collection is charged per house. However, the door-to-door collection may not favour the poor or low income areas and therefore there is the likelihood of poor waste collection services in these areas. Additionally, attention on collecting solid waste in these areas will be less. So there is the tendency for residents to dump waste anyhow because of poor collection service.

However, to use income as measure to stratify residential areas in a city like Accra may be misleading. This is because those living in the supposedly low income residential areas may be well to do than those residing in the high income areas as indicated by Stephen et al (1994) and accepted by Tsiboe and Marbell (2004). This means that Tsiboe and Marbell did not critically examine the text before accepting it. Instead, the class of buildings, willingness and ability of the people to pay for the collection service should have been considered.

### ***2.7.3 Solid Waste Disposal***

According to Anomanyo (2004), waste disposal from households in AMA took different forms. These are represented in figure 2.3 below.



**Figure 2.3: Waste Disposal of Households in AMA, 2004.**

It can thus be ascertained that out of the about 1800 tonnes of waste generated, only 19.5 per cent was collected. Anomanyo (2004), further added that between 1991 and late 2001, the AMA's Municipal solid waste in the Accra metropolis was deposited at Mallam, a suburb of Accra. This dumping at the Mallam site however was stopped in late 2001 as the dump capacity had been exceeded and objections from nearby residents. Waste dumping was henceforth shifted to Djanman which unfortunately could not last as it was filled to capacity in just three months. These abandoned Mallam and Djanman sites were mountains of dumps and since they were neither landfills nor were there controls to their spread and emissions, they are of great concern as a result of their threat to human health, leachate and landfill gas formation. According to him the dump site was an old stone quarry at Oblogo in the McCarthy Hills of Accra. Before it began to be used in early 2002 there was an installation of clay lining. The site had no engineered containment of leachate. AMA was only able to compact the waste to guarantee some level of proper dumping and hence "this site was considered a controlled dump rather than a properly engineered landfill" (Anomanyo, 2004). He further added that since the formal systems of solid waste disposal could not cope with the ever-increasing volume of solid waste being generated in Accra, the public itself employs various means of waste disposal. Waste was thus disposed off indiscriminately especially in watercourses and drainage channels and also through burning.

According to KMA (2006), a well-engineered sanitary site was used at Dompouse where waste was placed compacted and covered at the site. A weighbridge was also available and

attached to a control room where the waste was weighed and inspected before being accepted into the landfill. A maintenance bay and offices were also at the site. Heavy-duty equipment were available for spreading of waste, compaction and covering. Grading and gravelling of access roads are other vital activities at the landfill site.

Comparing the two Metropolis in terms of waste disposal in landfill, KMA has well designed sanitary landfill which meets all the requirements. These include weighbridge, access roads, maintenance bay, leachate measures, heavy duty equipment for spreading waste, compacting and covering.

#### ***2.7.4 Waste Management Regulation and Policy***

According to the Ministry of Local Government and Rural Development (MLGRD) (2004), general waste management in Ghana is the responsibility of the MLGRD, which supervises the decentralized Metropolitan, Municipal and District Assemblies (MMDAs). However, the ministry indicates that, regulatory authority is vested in the Environmental Protection Agency (EPA) under the auspices of the Ministry of Environment and Science. The Metropolitan, Municipal and District Assemblies are responsible for the collection and final disposal of solid waste through their Waste Management Departments (WMDs) and their Environmental Health and Sanitation Departments (EHSD). The policy framework guiding the management of hazardous, solid and radioactive waste includes the Local Government Act (1994), Act 462, the Environmental Protection Agency Act (1994), Act 490, the Pesticides Control and Management Act (1996), Act 528, the Environmental Assessment Regulations 1999, (LI 1652), the Environmental Sanitation Policy of Ghana (1999), the Guidelines for the Development and Management of Landfills in Ghana, and the Guidelines for Bio-medical Waste (2000). All these Acts and Regulations emanate from the National Environmental Action Plan (MLGRD, 2004).

Furthermore, the ministry has published the National Environmental Sanitation Policy (NESP) since May 1999. Accordingly, the policy looks at the basic principles of environmental sanitation, problems and constraints. The role and responsibilities assigned to communities, ministries, departments and agencies and the private sector impinge on environmental management and protection, legislation and law enforcement and the criteria for specifying services and programmes, funding, equipment and supplies. Out of the National Sanitation Policy, the MLGRD has also developed a technical guideline document

titled ‘The Expanded Sanitary Inspection and Compliance Enforcement (ESICOME) Programme guidelines. The programme guidelines which are implemented by the MMDA’s, routinely looked at four broad areas namely; effective environmental health inspections (Sanitary Inspections), dissemination of sanitary information (Hygiene Education), pests/vector control and law enforcement. All MMDAs have developed waste management and environmental health plans to help solve the numerous sanitation problems. Generally, the National Environmental Sanitation Policy Co-ordination Council (NESPoCC ) is responsible for coordinating the policy and ensuring effective communication and cooperation between the many different agencies involved in environmental management in their respective Districts (MLGRD, 2004).

The ministry further indicates that in an effort to address the problem of waste management, Government has over the years put in place adequate national policies, regulatory and institutional frameworks. Due to this the Environmental Sanitation Policy (ESP) was formulated in 1999. This policy has currently been amended and strategic action plans developed for implementation according to the report. Various relevant legislations for the control of waste have also been enacted. These include the following.

- Local Government Act, 1990 (Act 462)
- Environmental Assessment Regulations, 1999 (LI 1652).
- Criminal Code, 1960 (Act 29).
- Water Resources Commission Act, 1996 (Act 522).
- Pesticides Control and Management Act, 1996 (Act 528).
- National Building Regulations, 1996 (LI 1630).

The Ministry also collaborated with the Ministry of Environment, Science and Technology (MEST), EPA and the Ministry of Health have prepared the following guidelines and standards for waste management:

- National Environmental Quality Guidelines (1998)
- Ghana Landfill Guidelines (2002)
- Manual for the preparation of district waste management plans in Ghana (2002)
- Guidelines for the management of healthcare and veterinary waste in Ghana (2002)

- Handbook for the preparation of District level Environmental Sanitation Strategies and Action Plans (DESSAPs).

It is observed from the above that, despite the numerous sanitation regulations and policies that have been put in place by the MLGRD to deal with the solid waste menace in the country, there has not been any improvement in the area of solid waste management. Rather it has moved from bad to worst and therefore has failed to achieve its goal of clearing filth in the country. Secondly, drawing from the views given by the Sanitation Country Profile Ghana and the National Report for Waste Management in Ghana, it can be said with certainty that MMDAs are the primary authorities to manage solid waste at the local level.

#### ***2.7.5 Problems of Waste Management***

In Ghana, Boadi and Kuitunen (2004) pointed out some of the problems affecting solid waste management. These include: weak institutional capacity and lack of resources; both human and capital. They also indicated that, home collection of waste is limited to high and, some middle income areas while the poor are left to contend with the problem on their own. This leads to indiscriminate disposal of waste in surface drains, canals and streams, creating unsanitary and unsightly environments in many parts of the city. Furthermore, MLGRD (2004) summarises the challenges of solid waste management in Ghana as follows: poor planning for waste management programmes; inadequate equipment and operational funds to support waste management activities; inadequate sites and facilities for waste management operations; inadequate skills and capacity of waste management staff; and negative attitudes of the general public towards the environment in general.

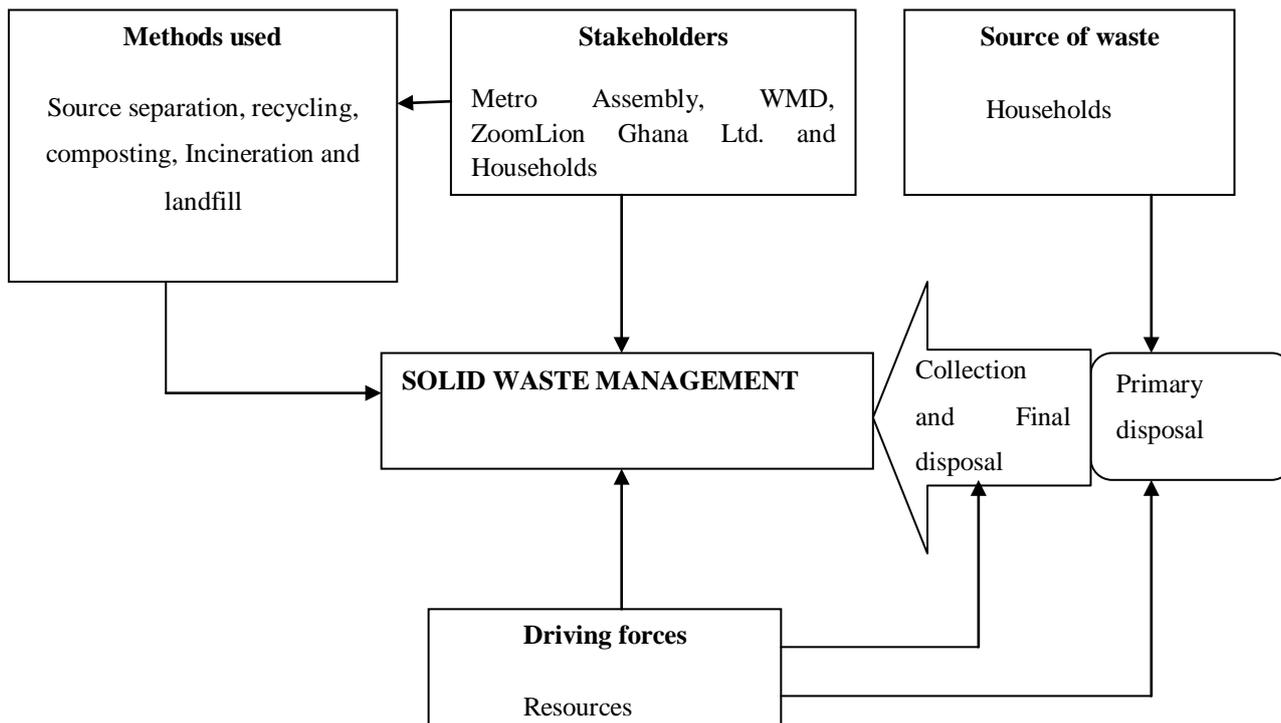
It can therefore be said that the main challenges facing solid waste management in developing countries and for that matter Ghana include: inadequate funds to support waste management, inadequate equipment to support waste storage, collection and disposal, low collection coverage and irregular collection services, crude open dumping and burning without air and water pollution control.

## **2.8 Key Issues**

From the review of the literature above, solid waste collection and disposal are the critical issues in solid waste management. The various methods in disposing solid waste are: sanitary landfills, composting, recycling, incineration and ISWM (Reduce, reuse and recycle/incinerate/landfill) for managing solid waste. But in Ghana landfills are mainly used for final waste disposal. Also, there are two main modes of solid waste collection system in Ghana namely door-to-door/house-to-house and communal.

Even today people still resort to unscrupulous methods of disposing solid waste such as dumping into gutters, drains, roadside among others. Therefore, solid waste management should be the primary responsibility of all but not only the management authorities like the government and district assemblies. Furthermore, the provision of solid waste collection facilities, frequency of waste collection, and equipment for managing solid waste and the cost involved which are the corner stone in managing solid waste were silent in the literature. However, the management is challenged by factors such as inadequate funds to support waste management, inadequate equipment to support waste storage, collection and disposal, low collection coverage and irregular collection services.

This forms the basis of the conceptual framework of the study that focuses on three key issues, namely: primary level of waste disposal, methods used in managing solid waste and lastly, the availability of resources both material and human in managing the solid waste in TAMA. Figure 2.4 below illustrates the conceptual frame work of the study.



**Figure 2.4: Conceptual Framework**

From figure 2.4 above, household solid waste management is the focus of the framework. Therefore, in the solid waste management stream, three main issues have been considered. These are: driving forces of managing solid waste (resources), methods used (source separation, reuse, recycling, composting and landfill) and the role stakeholders play (MMDAs, waste management institutions and waste generators-households and individuals) in managing solid waste. It is important to recognise that, the major portion of solid waste comes from domestic sources. However its proper disposal depends heavily on availability of skips and dustbins and attitudes of the people. The waste that is disposed of from the households has to be collected and transported for final disposal. The collection and transportation depends heavily on resources. Having been guided by lessons learnt from the literature; an appropriate research methodology has been developed to collect data to fill the gaps identified in relation to three key issues outlined in the framework. This forms the basis of the next chapter of the study.

## **CHAPTER THREE**

### **METHODOLOGY OF THE STUDY**

#### **3.1 Introduction**

Having reviewed the literature in the previous chapter, certain key issues were identified in relation to the objectives of the study which are relevant to the study of solid waste management. These were: availability of waste management facilities, household waste disposal, waste collection and disposal as well as capacity of waste management authorities in managing solid waste in TAMA. Based on this, an appropriate methodology was developed to collect data on the key issues enumerated above. In the light of this, the study gathered data from secondary and primary sources using varied techniques. The next section discusses the sources into detail.

#### **3.2 Secondary Data**

Secondary data were obtained from books, articles, newspapers and internet sources to review literature. These were analysed in chapter two. Secondary data were also obtained from the District Medium Term Development Plan (DMTDP) of the Metropolitan Assembly. The data obtained include: objective of waste management by the Assembly, strategies, activities, time frame, implementing agencies, collaborators and indicative cost.

#### **3.3 Primary Data Collection**

Primary data were collected through preliminary field investigation, questionnaires survey and face- to-face interviews. These are further discussed in the sub-sections below.

##### ***3.3.1 Preliminary Field Investigation***

The field observation involved scouting through the study area to assess the following.

- Communal waste collection skips.
- Dustbins in the selected areas of study in the metropolis.
- Dump sites.
- Landfill site
- Informal contacts with Tamale Metropolitan Assembly, WMD and ZoomLion Ghana Ltd.

During this process, pictures were taken of heaps of solid waste in dump sites, solid waste skips overflowing with solid waste, scattered solid waste in between houses.

This was included in the analysis of data gathered from the field. This process weighed the problems and guided the formulation of questionnaire survey and interview schedule.

### 3.3.2 Questionnaire Survey

As the adage goes “No survey is better than its questionnaires”. Therefore, household data were collected through questionnaire survey. Data collected were on the following variables:

- Types of solid waste,
- Place of disposal,
- Availability of skips and bins for storing waste,
- Mode of collection and
- Payment for collection and distances covered to dispose of waste in skips as shown in appendix III.

Target population for the questionnaire survey were women between the ages 20 years and above. This is because they were mostly in charge of sweeping and gathering of all sorts of domestic solid waste in homes and disposing of them. Men were excluded because they were not culturally bound to perform such duties at home.

#### 3.3.2.1 Sample Frame and Sample Size Determination

A total number of eighty thousand, five hundred and ninety-nine (80,599) female population between the age group of 15 and 64 was obtained from Ghana Statistical Service (GSS) for TAMA. This represented the sample frame of the questionnaire survey. Furthermore, the mathematical method was used to determine the sample size for the survey. Below is the procedure.

Formula:  $n = \frac{N}{1+N(\alpha)^2}$ , Where  $n$ =sample size,  $N$ =sample frame (**80599**) and  $\alpha$  represented the margin of error which is **0.08** with confidence level of **92%**. By substituting 80599 and 0.08 into the formula:  $= \frac{80599}{1+80599(0.08)^2}$ , **n=156**.

Therefore, the sample size for the survey was one hundred and fifty six (156). This was to ensure that the sampled mean was closer to the population mean and minimise errors.

It is however important to note that the sample size depended on financial resources and the stipulated period of the study. In the light of this, the distribution of the sample size in the study area was considered critical to the study.

### 3.3.2.2 Sampling Techniques

The following sampling techniques were employed to select the respondents for the study. These were: cluster, purposive, stratified, systematic and accidental sampling. Firstly, the study area was zoned into three clusters namely: Central Sub-Metro, North Sub-Metro and South Sub-Metro. Secondly, purposive sampling was used to select twelve (12) areas from the three sub-metros for the survey as shown in figure 1.2 in chapter one. Table 3.1 below gives the selected areas under each of the sub-metros.

**Table 3.1: Sub-Metros and Selected Areas of Study (Cluster Sampling)**

Sub-Metro	Selected Areas	Total
Central	Moshi Zongo, Aboabo, Choggu	3
North	Education Ridge, Kalpohin Etates, SSNIT Flates, Sakasaka	5
South	Vitting Estates, Nyohini, Lamashegu, Ghanasco	4
<b>Total</b>		<b>12</b>

Source: Author's Construct, March, 2010.

The selected areas were further stratified into low class, middle class and high class residential areas in the metropolis. Table 3.2 below shows the stratification of selected areas. Further refer to appendix II for criterion used in determining classes of residential areas.

**Table 3.2: Stratification of Selected Areas of Study**

No.	Low Class	Middle Class	High Class
1.	Aboabo	Education Ridge	Kalpohin Estates
2.	Choggu	Ghanasco	SSNIT Flats
3.	Lamashegu	Russian Bungalows	Vitting Etates
4.	Moshi Zongo		
5.	Nyohini		
6.	Sakasaka		
<b>Total</b>	<b>6</b>	<b>3</b>	<b>3</b>

Source: Author's Construct, March, 2010.

Due to lack of census data for the female population of each listed area, the sample size of 156 was divided equally among the 12 selected areas. This gave a sample size of thirteen (13) for each selected area. This means that 13 women were interviewed in each selected area in the metropolis. Furthermore, systematic sampling technique was used to select houses in each selected area. Table 3.3 below illustrates the systematic sampling procedure.

**Table 3.3: Systematic Sampling Procedure**

Selected Area	No. of Houses (Sample frame)	Total women to be surveyed (Sample Size)	Sample fraction(Kth house)
Aboabo	165	13	Every 13 <sup>th</sup> house
Choggu	243	13	Every 19 <sup>th</sup> house
Lamashegu	235	13	Every 18 <sup>th</sup> house
Moshi Zongo	160	13	Every 12 <sup>th</sup> house
Nyohini	198	13	Every 15 <sup>th</sup> house
Sakasaka	166	13	Every 13 <sup>th</sup> house
Education Ridge	120	13	Every 9 <sup>th</sup> house
Ghanasco	50	13	Every 4 <sup>th</sup> house
Russian Bungalows	48	13	Every 4 <sup>th</sup> house
Kalpohin Estates	98	13	Every 8 <sup>th</sup> house
SSNIT Flats	61	13	Every 5 <sup>th</sup> house
Vitting Estates	43	13	Every 3 <sup>rd</sup> house

Source: Author's Construct, March, 2010.

Because most of the houses in selected areas were not well planned with serial numbers, a serpentine movement was used to select every Kth house starting from the direction of the first point of contact with any house in the selected area. With this approach a respondent was interviewed in each Kth house until the required sample of 13 women was obtained in each area.

Finally, accidental sampling method was used to select the respondents for interview. That is, the first woman to be contacted in each selected house was interviewed. If the first woman contacted was not ready, the next available woman was interviewed. Since some of respondents did not understand English language people who understood both the English and the local dialect were trained and employed to administer the questionnaires. The questionnaires were pre-tested in the study area before the full survey was carried out.

The pre-testing gave the opportunity for certain pertinent issues which could not be captured initially to be included in the final questionnaire. The questionnaire survey was carried out before the interview because certain new issues came up during the survey which could not be captured in the questionnaire survey.

### ***3.3.3 Face-to-face Interview***

Face-to-face interviews were used to collect data from the following key stakeholders as far as solid waste management is concerned in the study area.

- Assemblymen in the selected areas
- Tamale Metropolitan Assembly (Metropolitan Budget Officer)
- Waste Management Department (Landfill Manager) and
- Zoomlion Company Limited (Assistant Regional Operations Supervisor).

#### ***3.3.3.1 Purposive Sampling***

Purposive sampling technique was used to select the above. As the name implies, in trying to adhere to the objectives of the study, respondents who can answer the research questions best are selected. In this case, these key stakeholders had the necessary information, adequate knowledge and experience on solid waste management in the study area. Below is the type of data collected from each key stakeholder.

1. Assemblymen:
  - Solid waste collection and disposal.
  - Availability of dustbins and skips
  - place of disposal of waste by households and
  - Mode and regularity of collection as shown in appendix IV
2. Tamale Metropolitan Assembly: Revenue and solid waste management. Revenue generated in a month, amount spent on waste management as well as the DACF and the amount spent on solid waste management as shown in appendix VI.
3. Waste Management Department and Zoomlion Ghana Ltd.:
  - Types and components of waste generated.
  - Quantity generated.
  - Mode of collection.
  - Provision of dustbins and skips.

- Availability of waste management equipment.
- Frequency of collection.
- Disposal site.
- Management options as shown in appendix Appendix V. Table 3.3 below provides a summary of primary data collection process.

**Table 3.4: Primary Data Collection Process**

<b>Target Population</b>	<b>Data Collection Method/Sampling Technique</b>	<b>Type of Data Required</b>	<b>Number of Respondents</b>
Women	<b>Questionnaire Survey</b> Combination of -Cluster sampling -Purposive sampling -Stratified sampling -Systematic sampling -Accidental sampling	-Place of disposal of waste -Availability of skips and dustbins -Mode and frequency of waste collection -Payment for collection	156
Assemblymen of selected areas (12 selected areas)	<b>Face-to-face interview</b> -Purposive Sampling	- Population of selected areas -Place of disposal -Number of skips and Dustbins available -Mode and frequency of waste collection -Methods of managing waste -Problems of managing waste	12
Staff of WMD (Landfill Manager) and ZoomLion Ghana Ltd. (Assistant Operations Supervisor)	<b>Face-to-face interview</b> -Purposive	-Types of waste generated -Quantity generated -Mode and frequency of waste collection -Provision of skips and dustbins Management options: source reduction, recycling, incineration, composting and landfill. -Final disposal of waste -Availability of resources for waste management. -Challenges of managing waste.	2
Budget Officer-Metropolitan Assembly	<b>Face-to-face interview</b> -Purposive	-IGF generated in a month. -Amount spent on waste collection in a month. -Amount of DACF spent on waste management. -Problems of managing waste.	1

Source: Author's Construct, May, 201

### **3.4 Data Processing and Analysis**

Administered questionnaires were examined to check completeness, accuracy and consistency of responses in order to detect and eliminate errors. The Statistical Package for Social Sciences (SPSS) was used to process the quantitative data. The data were processed into statistical tables and charts for interpretation and discussion. Processed data were analysed both quantitatively and qualitatively. Data analyses were further disaggregated into the various classes of residential areas in the Metropolis.

### **3.5 Summary**

Data were collected from two main sources namely secondary and primary. Field investigation, questionnaire survey and face-to-face interview were employed to gather primary data. The sampling techniques used were cluster sampling, stratified sampling, systematic sampling and purposive sampling. Data were analysed both quantitatively and qualitative using tables, bar graphs and pictures. The next chapter describes the profile of TAMA in order to gain better understanding of the data obtained from the field survey.

## CHAPTER FOUR

### PROFILE OF THE STUDY AREA

#### 4.1 Introduction

This chapter provides the profile of the Tamale Metropolis in order to glean more information about solid waste management. The variables analysed include: location and size, population characteristics, household characteristics, ethnicity and cultural values and revenue.

#### 4.2 Location and Size

As shown in figures 1.1 and 1.2, the Tamale Metropolitan Area is located at the centre of the Northern Region. It shares common boundaries with Savelugu/Nanton District to the north, Tolon / Kumbungu District to the west, Central Gonja District to the south-west, East Gonja District to the south and Yendi Municipal to the east. The Tamale Metropolis occupies approximately 750 square kilometres which is 13 per cent of the total area of the Northern Region. Tamale became a district in 1988 by Legislative Instrument 1453. It was called West Dagomba District Assembly. It was then promoted to West Dagomba Municipal Assembly in 1994 and finally elevated to the status of a Metropolitan Assembly in 2004 by legislative instruments (LI) 1801 of the Local Government Act 1993, (Act 462).

#### 4.3 Demographic Characteristics

According to the Ghana Statistical Service (2000), the Tamale Metropolis has a population of 293,881. This figure shows an increase of 75 per cent over the 1984 population of 167,778 and represents an intercensal growth rate of 3.5 per cent as shown in table 4.1 below. This is far higher than the regional and national rates of 2.8 per cent and 2.7 per cent respectively. Similarly, the population growth rate in TAMA is higher than that of the Accra Metropolitan Area (AMA) which is 3.2 per cent. This is because Tamale is a fast growing city and as result a lot of people move to the city to do businesses. Meanwhile, the population in AMA in 2000 was 1,658,937, about six times higher than TAMA. On the other hand, the growth rate in Kumasi Metropolitan Area (KMA) is 5.4 per cent; which is far greater than TAMA and AMA. The growth rate of KMA is high because it is a central point for business in the country linking the north and south. Table 4.1 below summarises the populations of TAMA, KMA and AMA in 1984, 2000 and their growth rates.

**Table 4.2: Populations and Growth Rates of TAMA, KMA and AMA of 1984 and 2000**

<b>Year Area</b>	<b>1984</b>	<b>2000</b>	<b>Growth Rate</b>
TAMA	167,778	293,881	3.5
KMA	496,628	1,170,270	5.4
AMA	987,290	1,658,937	3.2
<b>Nation</b>	<b>12,296,081</b>	<b>18,912,079</b>	<b>2.7</b>

Source: Author's Construct, May, 2010.

Another reason for the big difference in the growth rate in TAMA is the boundary change of the Metropolis since 1984. Apart from the change in boundary of the metropolis, Tamale was the capital of the three regions in the North. Due to this certain major administrative services are still rendered in the Metropolis and because of this people move there for these services. With an urban population of 67.1 per cent; the Metropolis is the only district in the region which is predominantly urban. The population density of 318.6 persons per square kilometres for the Metropolis is about 12 times higher than the regional average density of 25.9 persons per square kilometres. Therefore, the growth rate and the density of population in the area have implications for waste generation and management. This explains why waste generation has increased from 150 tonnes a day in 2006 to 810 tonnes in 2010 (TAMA, 2010).

#### ***4.3.1 Ethnicity and Cultural Values***

The Dagombas who are the indigenous population constitute about 80 per cent of the total population in the Metropolis. Apart from Metropolitan centre where there is ethnic diversity almost all people in the surrounding villages are Dagombas. Before the advent of both Christianity and Islam religions, the Dagombas were mostly traditionalists. Their culture was deeply enshrined in their customs and beliefs. The result of this is still manifested in the numerous traditional festivals still practised. These practices are no longer pronounced in Metropolitan centre as a result of the ethnic diversity and the influence of both Islam and Christianity.

On the religious front, the people in the Metropolis are mostly muslims since this was the first religion exposed to them by Arabs from the north. It is therefore not surprising that almost 90 per cent of ethnic Dagombas are muslims. On the other hand, Christianity arrived

later from the south and hence mostly practised by non-Dagomba ethnic groups. Until recently, festivals were largely enshrined in the customs of the Dagombas. However, this is changing as a result of the practice of Islam. Festivals are not much celebrated especially in the Metropolis as compared to the villages. The most important festivals are discussed below.

#### *4.3.1.1 The Fire Festival:*

This is to commemorate the occasion when the beloved son of a powerful chief got missing and the chief ordered his subjects to search for the boy. Torches were consequently lit in the night and the child was found. This marks the beginning of the fire festival as practised today. On this day, a lot of grasses are lit in the night by people from all walks of life; children, women and men alike on almost all the streets and even in the metropolitan centre. By the break of day a lot of rubbish is produced and usually on all the main roads in the Metropolis. In short, a lot of waste is produced during this festival.

#### *4.3.1.2 The Damba Festival:*

This is to commemorate the birthday of the holy Prophet of Islam, Muhammed. Damba is celebrated after the fire festival. With this festival, a lot of solid waste is produced, especially plastic waste through the sale of food items.

#### **4.3.2 Household Characteristics**

A total of about 45,269 households live in the Tamale Metropolis. Out of this total, about 69.8 per cent live in rooms in compound houses. It is common among the Dagomba people to have large families. Until recently, this practice was to get more people to help on family farms. Anecdotal evidence suggests that, it is considered a great pride among the Dagombas to have more than one wife. The number of children one has is one of the indices for measuring one's wealth. About 65 per cent own their dwellings. The average household size is 6.5. The types of dwellings are shown in table 4.2 below.

**Table 4.2: Types of Dwellings**

<b>Dwellings</b>	<b>Number</b>	<b>Percentage</b>
Separate House	6142	13.6
Semi-detached House	2827	6.2
Flat/Apartment	946	2.1
Rooms (Compound)	31601	69.8
Hut/Buildings (Same compound)	3305	7.3
Hotel/Hostel	133	0.3
Tents	31	0.1
Kiosk/Container	68	0.2
Living quarters attached to shop/office	64	0.1
Others	152	0.3
<b>Total</b>	<b>45269</b>	<b>100</b>

Source: Tamale Metropolitan Assembly, 2009.

From table 4.2 above, the main type of dwellings in the Tamale Metropolis is compound (69.8 per cent) and the least being tents and living quarters attached to shop/office (0.1 percent each). These compound dwellings are found mostly in the low class residential areas such as Sakasaka, Moshi Zongo, Aboabo, Nyohini and Lamashegu. Also, flats/apartments and living quarters are found in the middle class and high class residential areas which include SSNIT Flats, Kalpohin Estates, Vitting Estates, Education Ridge, Ghanasco and Russian Bungalows. The type of dwellings informs waste managers as to whether a particular dwelling should be given dustbin or skips for waste storage. For instance, a compound house would deserve a skip because the number of people who live there is greater than those who live in a flat/apartment. The latter may be given a 120 or 240 litre dustbin for storing their waste.

#### **4.4 Revenue**

Waste management has huge financial implications. The Assembly depends heavily on District Assembly Common Fund (DACF) to finance waste management. On the other hand, the locally generated revenue has also improved over the years. The Assembly has been recording a high growth rate of an average of 91.17 per cent achievement of the yearly budget. However, the actual performance over the period has increased from 36 per cent to 350 per cent.

Hitherto, the Assembly uses its own revenue collectors, but in the period she employed development partners who assisted in revenue collection especially in the area of property rate. Table 4.4 below shows locally generated revenue, targeted and actual from 1999-2002 in Ghana cedis (GH¢).

**Table 4.4: Locally Generated Revenue from 1999-2002**

<b>Year</b>	<b>Budgeted (GH¢)</b>	<b>Actual (GH¢)</b>	<b>Performance (%)</b>
1999	26,4404.02	23,002.584794	87.12
2000	102,809.6	31,390.4,755.00	30.53
2001	65,648.7	45,780.089311	69.73
2002	71,300.8	126,427.031503	177.31
<b>Grand total</b>	<b>266,163.12</b>	<b>226,600.181108</b>	<b>91.17</b>

Source: Tamale Metropolitan Assembly, 2009.

Therefore, if the Internally Generated Fund (IGF) of the Assembly is increasing, it is a potential to sustainable source of funding for waste management. This is because the Assembly is the major financier of managing solid waste in the area. A total amount of about GH¢22,221 was used to finance waste management, water and sanitation projects in 2001.

#### **4.5 Summary**

The growth rate of 3.4 per cent and density of the population of 318.6 have influence on the quantity of waste that is generated particularly per capita waste generation. The various festivals which include the Fire and Damba celebrated in the Metropolis also add up to the quantity of waste generated. Compound houses which are the main type of dwellings demand skip supply as the ideal equipment for effective waste management in the Metropolis. Additionally, the sharp increase in the revenue generation will go to sustain solid waste management in the area. This is because solid waste management has financial implications. In the light of this, the next chapter analyses particularly findings from the field survey on types and components of solid waste generated, disposal sites of households solid waste, collection and final disposal as well as the cost involved in managing solid waste in the Metropolis.

## **CHAPTER FIVE**

### **DATA ANALYSES AND DISCUSSION**

#### **5.1 Introduction**

This chapter is divided into two main components. The first section provides an overview of waste management plan of the Metropolitan Assembly between 2006 and 2009. Section two analyses the primary data collected from Tamale Metropolitan Area (TAMA). These are further discussed below.

#### **5.2 Waste Management Plan of TAMA**

According to the Medium-Term Development Plan (2006-2009); under the Growth and Poverty Reduction Strategy, the main objective of the Metropolitan Assembly on sanitation was to ensure efficient waste management. The following strategies were outlined to tackle the waste problem in the Metropolis. These include: improve stock of sanitary equipment, promote private participation in waste management and improve monitoring and supervision of waste collection and disposal. The rest are: promote education of hygienic conditions and promote community participation in waste management. Series of activities were proposed. These include: assess equipment needs of the WMD, procure equipment, sensitize public on private participation in waste management, build capacity of staff of WMD and acquire more sanitary facilities (100 dustbins). An amount of GH¢ 53, 781 was budgeted for waste management within the period; 2006-2009. The next section examines the extent to which the objective of ensuring efficient waste management has been achieved in the Metropolis.

#### **5.3 Waste Management in TAMA**

This section analyses the data collected from the study areas in the Metropolis through preliminary field investigation, questionnaire survey and face-to-face interviews. In all, 156 respondents were surveyed and interviews were carried out with 15 key respondents including institutional heads and Assemblymen of the study areas. (Refer to appendix I for background information of respondents of the Questionnaire survey). Data were collected on the following issues:

- Types and components of solid waste generated in the area.
- Disposal sites of household solid waste.

- Solid waste collection and final disposal.
- Cost involved in managing solid waste.
- Capacity of the waste management institutions in managing solid waste in the area

These are discussed in the sub- sections below.

### ***5.3.1 Types and Components of Solid Waste Generated***

Knowledge on types and the components of solid waste generated will inform management to use the appropriate method to effectively deal with the various components in solid waste. Methods such as source separation, recycling, composting can be used depending on the component of waste in the waste stream.

The Waste Management Department (WMD) and ZoomLion Ghana Ltd. estimated that 0.45kg daily per capita of waste was generated in the Metropolis. This amounts to 810 tonnes a day. According to the Zoom Lion and WMD, the commonest types of waste generated in the area were food waste, rubbish, and ashes. These components are shown in table 5.1 below.

**Table 5.1: Major Components of Waste Generated**

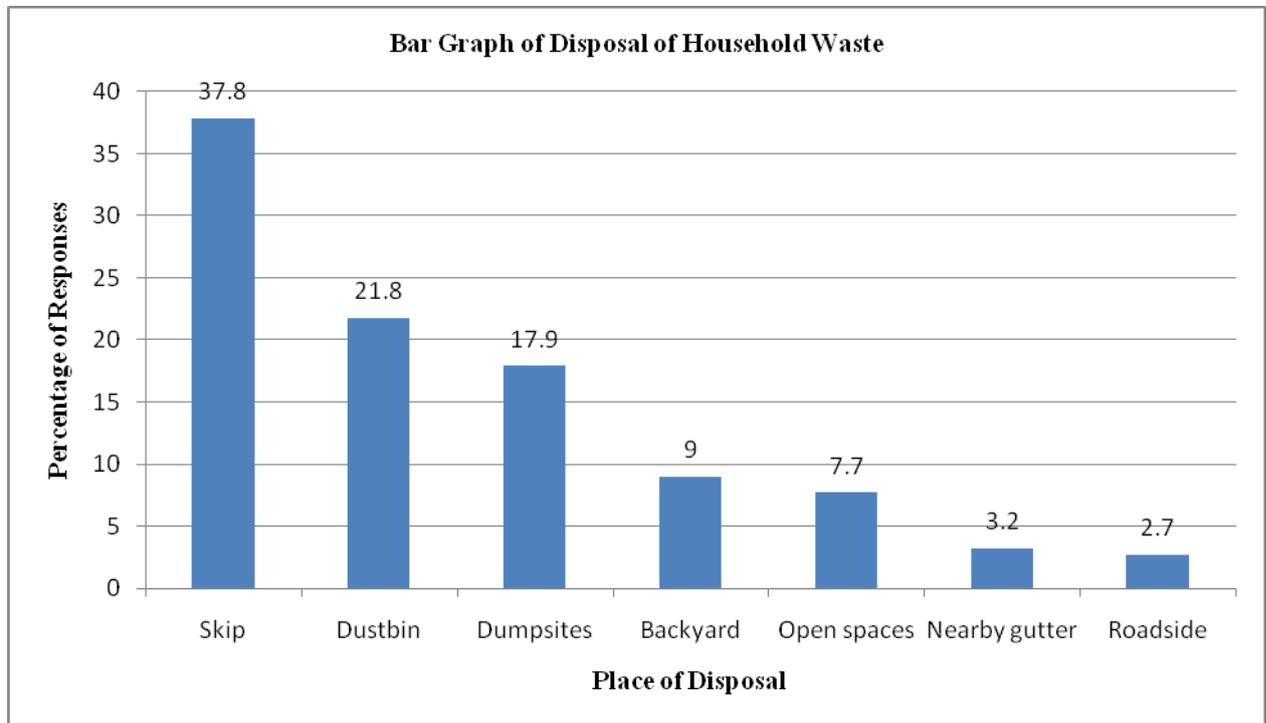
<b>Component</b>	<b>Percentage Generated (%)</b>
Plastic	57.5
Food waste	20
Metals	10
Paper	5
Wood	2.5
Glass	5
<b>Total</b>	<b>100</b>

Source: WMD and ZoomLion Ghana Ltd., April, 2010.

Table 5.1 above shows that, plastic waste constituted about 57.5 per cent of all the components of waste generated in the Metropolis and the least component of waste generated was wood. This means that a lot of polythene bags were used for packaging especially food items in the Metropolis. Wood was the least component of waste. This further explains why a lot of polythene bags were seen littered in most of the study areas such as Aboabo, Choggu and Moshi Zongo. Therefore, the next section elaborates on how the respondents disposed of their household waste.

### 5.3.2 Methods of Disposal of Household Solid Waste

The disposal of household solid waste is one of the functional elements in the management of waste. Figure 5.1 below illustrates the methods of disposal sites of solid waste by respondents in TAMA.



**Figure 5.1: Disposal Sites of Household Solid Waste.**

From figure 5.1 above, the commonest place of waste disposal was the skip (37.8 per cent). This method was used in the low class residential areas in the metropolis. These areas include: Sakasaka, Choggu, Moshi Zongo, Lamashegu and Aboabo. This is followed by storing waste in dustbins (21.8 per cent) mostly in the high class residential areas and some middle class residential areas in the Metropolis. These areas were: Vitting Estates, Russian Bungalows, SSNIT flats and Kalpohin Estates. The rest of respondents (40.5 per cent) resorted to dumping waste in either the roadside, dump, open spaces, nearby gutter or backyard. These methods of waste disposal also happened in the low class residential areas as mentioned above. This resulted in littering and heaping of waste thereby making the environment filthy. Therefore, the possibility of outbreak of cholera and other environmental related diseases is high if such practice continues.

### 5.3.3 Availability of Skips and Dustbins for Waste Storage

An interview with the Assemblymen in the twelve (12) selected areas revealed that lack of skips and dustbins was major problem in the Metropolis. ZoomLion Ghana Ltd. which was the main company in charge of waste collection has been unable to supply skips and dustbins to areas they served. Table 5.2 below shows the selected areas, estimated population, number of dustbins and skips available as well as the number required for storing waste.

**Table 5.2: Distribution of Dustbins and Skips in Selected Areas of Study**

Residential Area/Section	Estimated Population	Number of Dustbins available	Number Required	Number of Skips available	Number required
<b>Low Class Residential Areas</b>					
Aboabo	25,555	-	500	8	14
Choggu	36,682	-	100	3	12
Lamashegu	41,001	-	500	3	30
Moshi Zongo	35,131	-	1000	3	6
Nyohini	30,219	2	400	3	16
Sakasaka	47,317	9	300	3	6
<b>Total</b>	<b>215,905</b>	<b>11</b>	<b>2800</b>	<b>23</b>	<b>84</b>
<b>Middle Class Residential Areas</b>					
Education Ridge	3500	50	1400	-	6
Ghanasco	5000	-	200	-	15
Russian Bungalows	10000	5	300	-	10
<b>Total</b>	<b>18500</b>	<b>55</b>	<b>1900</b>	<b>-</b>	<b>31</b>
<b>High Class Residential Areas</b>					
Kalpohin Estates	2000	130	300	1	4
SSNIT Flats	1500	300	-		4
Vitting Estates	6000	15	40		20
<b>Total</b>	<b>9500</b>	<b>445</b>	<b>340</b>	<b>1</b>	<b>28</b>

Source: Assemblymen of selected areas, April, 2010.

From table 5.2 above, the skip ratio to the population in the low class residential areas was 1:9378 as opposed to the acceptable standard of 1:700 (as indicated by ZoomLion). This means that the average population a skip served was 13 times greater than the standard maximum population a skip was supposed to have served. This explained why 40.5 per cent of the respondents in figure 5.1 resort to dumping waste at roadside, dump sites, open spaces, nearby gutter, backyard or burning as means to deal with their domestic waste in the Metropolis. This scenario is not different from waste disposal in the low income areas in AMA. In terms of availability of skips in the low class residential areas, Aboabo had the highest number of skips in the Metropolis because there was a market sited in the heart of the settlement. In this case, a lot of waste was produced in the area. To avoid indiscriminate dumping, a lot of skips had to be provided. However, this was still not adequate as 14 more skips were required. In effect skips were seen overflowing with waste.

In the middle class residential areas, no skip container existed and door to door services were not rendered. This also explains why the respondents in figure 5.1 resorted to dumping waste at unapproved sites. It is also important to add that very few households used dustbins in these areas (Middle class). The rest resorted to dumping their waste in front of their houses and burning them. However, the average household income earned by respondents monthly was GH¢ 460. This means that people could afford for the door-to-door collection service as it cost GH¢ 7.00 a month per household.

In the high class residential areas, dustbins were strictly used by households. Therefore, the dustbin ratio to the household was 1: 3 as compared to acceptable standard of 1:1. This means that very few households did not use dustbins for storing their waste. Therefore, in these areas where dustbins were used the environment looked very clean and serene. Waste was not dumped indiscriminately compared to the situation in the low class residential areas. This also implied that those people in these areas had the capacity to pay and were committed to ensure effective and sustainable waste management. The average income earned monthly by respondents was GH¢ 400. Figure 5.2 below further illustrates areas where dustbins and skips were used in the Metropolis.

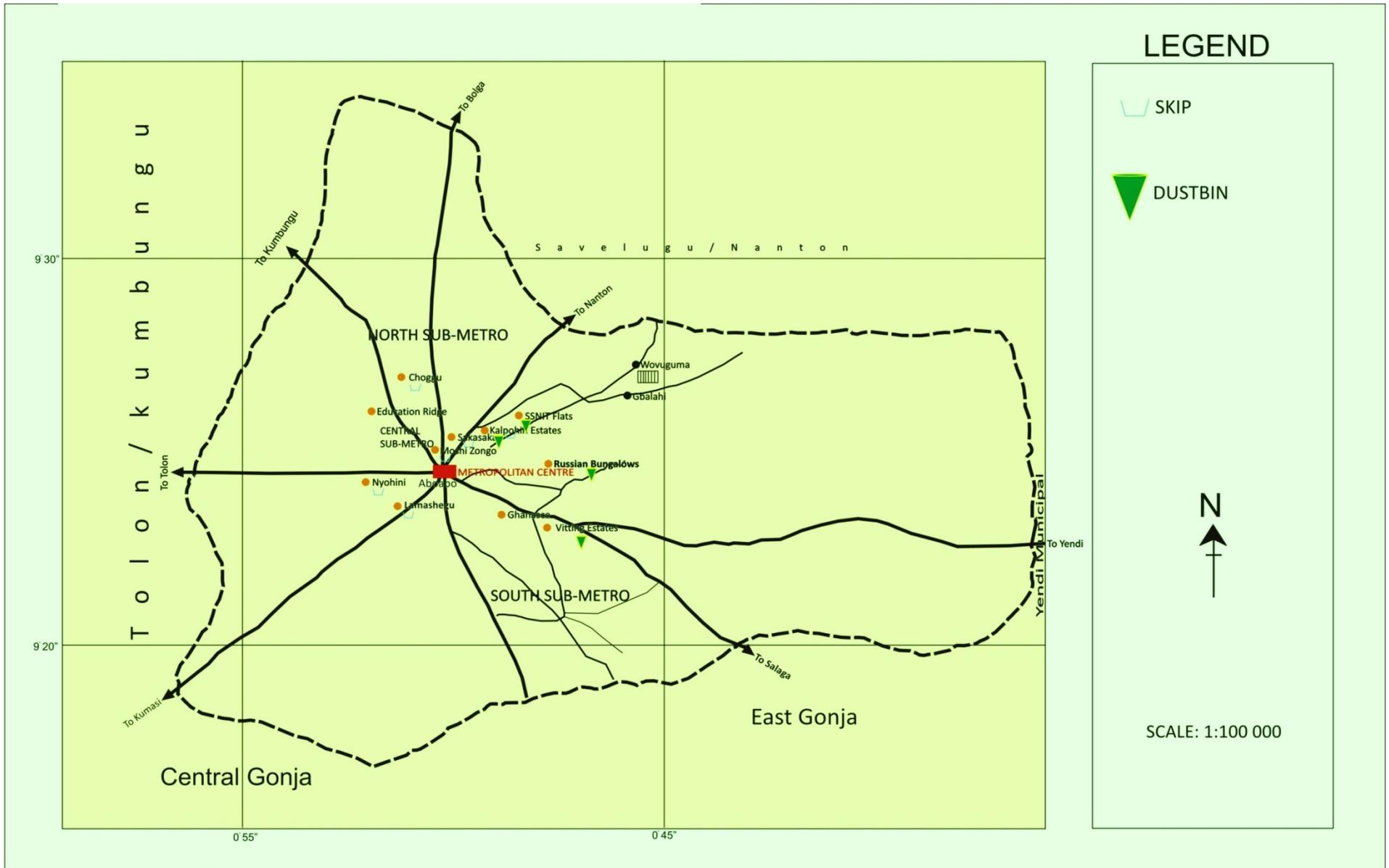


Figure 5.2: Map of TAMA showing areas where skips and dustbins are used

Figure 5.3 below further shows the indiscriminate nature of waste disposal in Sakasaka which is a low class residential area.



**Figure 5.3: Indiscriminate Dumping of Waste in Gutters- Sakasaka**

From figure 5.3 above, plastic waste constitutes major portion of the waste dumped in the gutter and this can easily be blown by wind back to where it came from. This will further aggravate littering in the area. The dumping of waste in the gutter can easily cause flooding when it continues. This is because when the stream is choked with waste; it will block water from flowing thereby causing the over flowing of the stream banks. This can easily affect nearby houses in the area. Additionally, this may also cause malaria through stagnated water and possibly pollute a nearby water body that takes its source from this stream.

The above analyses show that waste disposal in low class residential areas was similar to those identified-in Ado-Akiti in Nigeria by Momoh and Oladebeye (2010) where waste was similarly dumped in gutters, drains, roadside and unauthorised dump sites.

However, the indiscriminate dumping of waste was shaped by lack of skips in the low class residential areas. Moreso, the indiscriminate dumping could be attributed to the negative attitudes of the people towards waste disposal. This is because the waste dumped in the gutter could have been safely dumped in an organised dumpsites for collection by ZoomLion. This discussion leads to the analyses of time spent by residents in the low class residential areas to dispose of waste in skips.

#### ***5.3.4 Time Spent to Dispose of Waste in Skip***

The survey showed that 53 respondents (representing 34 per cent) have access to skips in the low class residential areas. Out of this, 11 of them spent between 5 and 10 minutes to dispose of waste at skip site, and the rest of the 42 (66 per cent) spent above 10 minutes. Table 5.3 below shows time spent by respondents to dispose off waste at skip site in the low class residential areas.

**Table 5.3: Time Spent to Dispose off Waste at Skip Site**

<b>Time Spent</b>	<b>Frequency</b>	<b>Percent</b>
5-10 minutes	11	20.8
11-15 minutes	31	58.5
16-20 minutes	7	13.2
21-25 minutes	2	3.8
More than 25 mins.	2	3.8
<b>Total</b>	<b>53</b>	<b>100.0</b>

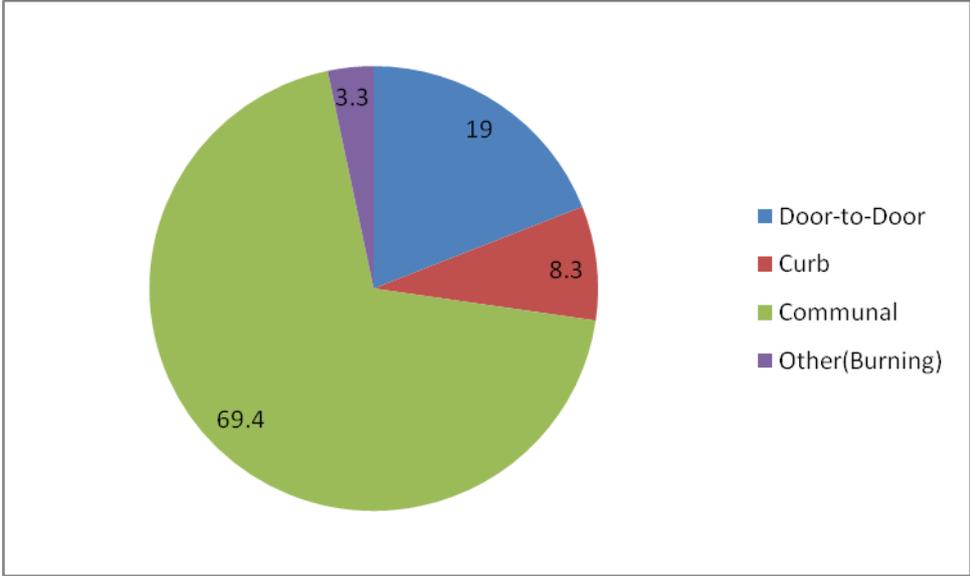
Source: Field Survey, April, 2010.

From table 5.3 above, 79.2 per cent of respondents spent above 10 minutes to dispose of their household waste in the skip. Out of the 79.2 percent, 63.3 per cent of them responded that, it inconveniences them to spend such time to dispose of waste in the skip. As a result, 57.9 per cent of them burnt their household waste, 31.6 per cent dumped their waste in the nearest gutter and 10.5 per cent dumped their waste in nearest available space. Therefore, the time spent to dispose of waste in the skip goes to add up the dumping of waste at unapproved sites though the attitudes cannot be completely ruled out in this case. The field investigation also confirmed that, there were about 17 skips available in the selected areas of study that were visited particularly in the low class residential areas. This further explains why people resort to burning of waste, dumping of waste in open spaces and in gutters.

In the light of the discussion above, solid waste collection is inevitable in solid waste management. Therefore, the next section discusses solid waste collection in TAMA.

**5.3.5 Solid Waste Collection**

Solid waste management includes the hauling and final disposal at landfills. Figure 5.4 displays the mode of collection of solid waste in the Metropolis.



**Figure 5.4: Mode of Solid waste Collection**

As shown in figure 5.4, there are three main modes of waste collection in TAMA. These are: door-to-door and curb (primary waste collection), communal dumpsites (secondary waste collection). The waste collected was finally disposed of in a landfill located at Gbalahi, a suburb of Tamale Metropolis. These are further elaborated in the sub-sections below.

**5.3.5.1 Primary Waste Collection**

From the survey, 19.0 per cent of the respondents indicated that, waste was collected directly from their yards (door-to-door) while 8.3 per cent indicated waste was collected outside their yards (curb). These are displayed in figure 5.4. The door-to-door and curb modes of waste collection were carried out mainly in the high class residential areas such as Kalpohin Estates, SSNIT Flats and Vitting Estates. These modes of waste collection were verified with key stakeholders (the Assemblymen, WMD and ZoomLion Ghana Ltd.). Figure 5.5 below shows primary waste collection (Curb) at SSNIT Flats.

Therefore, the door-to-door collection in Tamale was similar to waste collection in AMA and KMA which is carried out mainly in highly class residential areas.



**Figure 5.5: Curb collection at SSNIT Flats in Tamale**

The beneficiaries of the door-to-door collection paid a monthly charge of GH¢ 7 per 120 litre dustbin. According to the Assemblymen this charge was exorbitant and this accounted for the lack of patronage in the Metropolis. Secondly, there was lack of patronage because ZoomLion did not regularly collect waste in these areas. In effect some people resorted to burning as a means of dealing with their waste.

#### *5.3.5.2 Secondary Waste Collection*

Figure 5.4 shows that, the main mode of waste collection in TAMA was communal. This was carried out mainly in the low class residential areas as in the case of AMA and KMA. The survey further showed that, 63.2 per cent of the respondents were not asked to pay for the collection of waste in their residential areas particularly those living in the low class residential areas by ZoomLion Ghana Ltd. though 76.5 per cent of respondents were

prepared and could pay for the collection of waste in their area or at homes. This is because the average income earned monthly by respondents was about GH¢ 260. If the residents were charged for collection it could improve upon waste collection in these areas. Figure 5.6 below indicates secondary mode of waste collection at Sakasaka in TAMA.

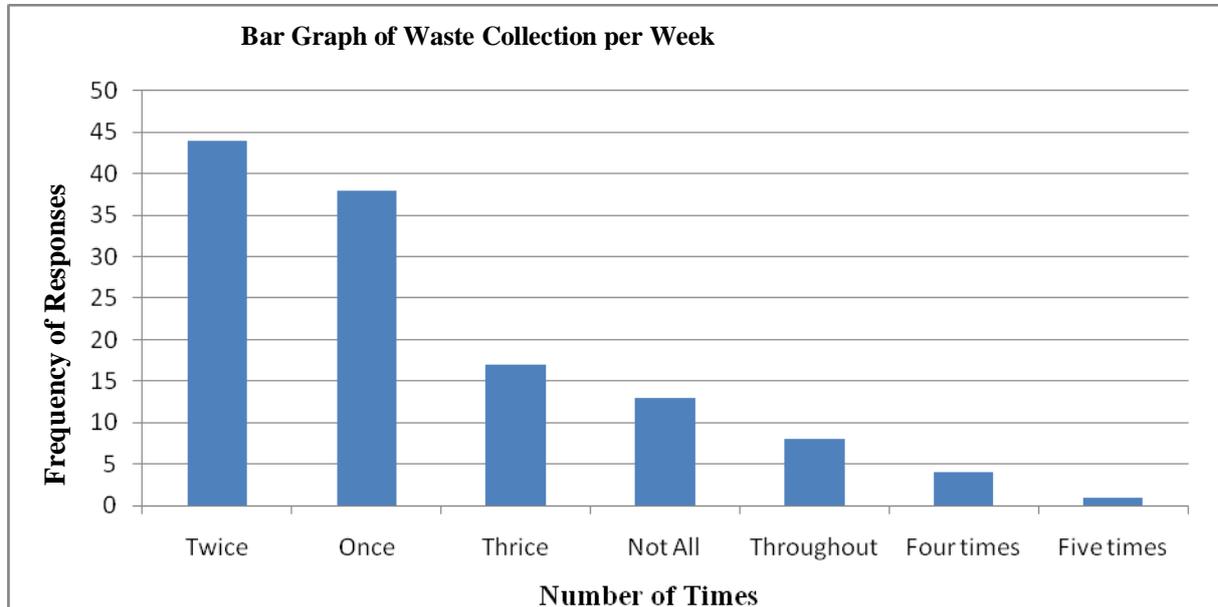


**Figure 5.6: Secondary Mode of Waste Collection at Sakasaka**

Figure 5.6 above shows that, waste from various households were dumped in the skips for onward collection by ZoomLion Ghana Ltd. How regular the skips were lifted is to be answered in the next discussion.

### 5.3.6 Regularity of Waste Collection

Regular collection is an important exercise in solid waste management. Figure 5.7 below illustrates generally, the number of times waste was collected per week in TAMA.



**Figure 5.7: Waste Collection per Week in TAMA**

From figure 5.7 above, 35.2 per cent of respondents indicated that waste was collected twice a week and in some instances once a week as indicated by 30.4 per cent of the respondents. In some areas like Russian bungalows and Education Ridge collection did not take place at all. Five times a week which should have been the required number of times waste was collected was rather the least particularly in the low class residential areas. This brought about heaping of waste in dumpsites and skips overflowing with waste particularly in the low class residential areas. Table 5.4 below further summarises the mode and number of times waste was collected in a week in the selected areas of study in the metropolis given by the ZoomLion Ghana Ltd and confirmed by the Assemblymen.

**Table 5.4: Mode and Number of Times of Waste Collection per Week**

<b>Residential Area/Section</b>	<b>Mode of Collection</b>	<b>Number of Times in a Week</b>
<b>Low Class Residential Areas</b>		
Aboabo	Communal	6
Choggu	Communal	3
Lamashegu	Communal	4
Moshi Zongo	Communal	4
Nyohini	Communal	3
Sakasaka	Communal	3
<b>Middle Class Residential Areas</b>		
Education Ridge	Communal	1
Ghanasco	Communal	1
Russian Bungalows	Communal/Door-to-door	1
<b>High Class Residential Areas</b>		
KalpoHin Estates	Door-to-door	2
SSNIT Flats	Door-to-door	2
Vitting Estates	Door-to-door	2

Source: ZoomLion, TAMA, April, 2010

Table 5.4 above, suggests that, the average number of times that waste was collected in low class residential areas was thrice a week as opposed to the minimum of four times a week. It is also important to add that waste was collected six (6) times a week in Aboabo because there was a market located in the heart of the settlement. Therefore, a lot of waste was generated in this area. This explains why an extra 14 skips were demanded as indicated in table 5.2.

In the middle class residential areas, waste was collected once a week. This is because these areas were supposed to demand door-to-door collection in the Metropolis which they did not do. As a result ZoomLion did not find it prudent to communally collect waste from these areas like the low class residential areas. This is because ZoomLion felt the people in the middle class were capable of paying for the door-to-door collection. But respondents also gave a contrary view. According to them, door-to-door services were expensive.

Additionally, though indicated by ZoomLion waste was collected at least once in the middle class residential areas, the survey revealed a different view. In some areas like Education Ridge and Russian bungalows, collection did not take place at all as indicated in figure 5.7. This resulted in respondents dumping their waste at unapproved sites and in some cases burning the waste. The interview with ZoomLion showed that 216 tonnes were hauled every day out of the 810 tonnes generated daily. This means that a backlog of 594 tonnes was left uncollected in the entire Metropolis. During the field investigation it was observed that a lot of skips were overflowing with waste uncollected for days in the low class residential areas. This has the tendency of breeding diseases such as typhoid, cholera, chicken pox which are sanitation related diseases. Figure 5.8 below illustrates the situation in Choggu.



**Figure 5.8: Solid waste container overflowing with waste at Choggu**

### ***5.3.7 Final Disposal of Waste***

The final disposal site of solid waste in the Metropolis was landfill site at Gbalahi, about 13 kilometres away from the city centre. A visit to the site showed that, it was in a bad shape. Ideally, a sanitary landfill should have the following functional elements:

- Weighbridge
- Internal access

- Treatment plant
- Leachate collection system
- Gas recovery and
- Location should be far away from human settlement and existing water body.

This was not the case with the landfill in Tamale. Though there was presence of the facilities mentioned above they were not functional. Additionally, the landfill has no internal access and the site was closed to a community called Wovuguma. This community was about one kilometer (1km) away from the site. (See figure 1.2 in chapter one for location of landfill site). Almost all the cells at the site were filled to capacity. Waste dumped in the cells was not leveled and compacted as required of a sanitary landfill. This left a mountain of waste at the site. Worst of it all burning of waste occurred at the site. Therefore, the description of the landfill site in Tamale Metropolis was similar to the one described by Anamanyo (2004) in Accra Metropolis. Figure 5.9 below illustrates burning of waste at the site.



**Figure 5.9: Burning at Landfill site, Gbalahi, TAMA**

According to the WMD and ZoomLion, waste separation which is one of the initial steps to reduce the volume and/or toxicity of waste was not carried out before final disposal. This is because plastic waste takes approximately two-hundred (200) years to decompose. In addition, other components of waste such as metals may not decompose at all. In this case if waste is not segregated before dumping in landfill, the intention of decomposition of waste in the landfill for reclamation of land for use will fail since about 57.5 per cent of the waste in the Metropolis is plastic. Similarly through waste disaggregating, reusable products and packaging such as returnable bottles will be diverted from the landfill. That notwithstanding, waste management involving collection, transportation and disposal at the landfill site has huge financial implications. In the light of this the next section analyses the cost of managing solid waste in TAMA.

### **5.3.8 Cost of Managing Waste**

An amount of GH¢ 15,000 was spent on solid waste by the WMD. This amounted to GH¢ 60,000 in a month. Out of this 60 per cent went into fuel for collection, 25 per cent for maintenance of vehicles and equipment and 15 per cent for other administrative duties. However, this amount was given to the WMD by the Metropolitan Assembly monthly. Also, ZoomLion spent approximately GH¢ 2,700 a week on waste collection and maintenance (GH¢ 108,000 a month). An interview with the Metropolitan Assembly showed that an amount of GH¢ 1,711,984.2 was spent on waste management out of the total revenue of GH¢ 4,003,158.64 received in 2009. That is, both IGF and DACF. This represents 42.8 per cent of the Metropolitan revenue spent on solid waste management. Table 5.5 below summarises the revenue and expenditure on waste management for 2009.

**Table 5.5: Revenue and Expenditure on Waste Management-2009**

<b>Source of Revenue</b>	<b>Amount Received (GH¢)</b>	<b>Amount Spent (GH¢)</b>
IGF	266,140.8	1,444,087.2
DACF	3,737,017.84	267,897
<b>Total</b>	<b>4,003,158.64</b>	<b>1711,984.2</b>

Source: Tamale Metropolitan Assembly, March, 2010.

From table 5.5 above, IGF by the Assembly per month was GH¢ 22,178.40. However, an amount of GH¢ 120,340.61 was spent on waste management per month by the Metropolitan

Assembly which was far greater than the revenue earned. Because the IGF alone could not be used to finance waste management, an amount of GH¢ 1,177,946.52 was taken from the Common Fund to finance the deficit. This implies that 31.5 per cent of the DACF went to support waste management in 2009. In effect waste management is taking a chunk of the Metropolitan Assembly revenue which could have been used for other infrastructural development. Having analysed the cost involved in managing solid waste by the Metropolitan Assembly; the next section assesses the capacity of the waste management institutions in the Metropolis.

### **5.3.9 Capacity of Waste Management Institutions**

An understanding of the capacities of WMD and the ZoomLion Ghana Ltd. will enable conclusions to be drawn regarding their effectiveness. This section assesses the capacities of the WMD and ZoomLion Ghana Ltd. in terms of equipment and technical staffing.

An interview with the WMD and ZoomLion Ghana Ltd. revealed the equipment base of the two waste management institutions in the Metropolis. Table 5.6 below displays the equipment used for storing and collecting waste by the two institutions.

**Table 5.6: Equipment Base of Waste Management Institutions (WMD and ZoomLion)**

<b>Equipment</b>	<b>WMD (number available)</b>	<b>Number required</b>	<b>ZoomLion (number available)</b>	<b>Number required</b>	<b>Total available</b>	<b>Total required</b>
Dustbins	550	1000	1047	3000	1,597	4000
Skips	118	200	68	30	186	230
Oboafo tricycle	-	-	100	200	100	200
Motorist	-	-	8	50	8	50
Graders	1	2	-	2	1	4
Skip Loaders	3	4	3	3	6	7
Compaction trucks	1	2	1	2	2	4
Roll on/Roll off trucks	3	4	2	4	5	8

Source: WMD and ZoomLion, TAMA, April, 2010.

Analyses of the equipment base from table 5.6 are grouped into their respective uses namely storage, collection and transportation. In terms of waste storage two-hundred and thirty (230) skips were required by ZoomLion Ghana Ltd. and WMD to be supplied in both the middle and low class residential areas. However, one hundred and eighty-six (186) were

available and supplied for storing waste in the Metropolis. In effect, if this extra skips were not supplied this could result in people dumping waste at unapproved sites. Also, about four-thousand (4000) dustbins were needed for storing waste in the high class residential areas for effective service in the Metropolis particularly those living in the high class residential areas. This is because dustbins are the main equipment for storing waste in order to prevent dumping of waste at unapproved sites.

In terms of waste collection and transportation in the Metropolis Oboafu tricycle, motorist skip loaders, roll on/roll off and compaction trucks were mainly used. The Oboafu tricycle and motorist were used for primary collection and transferring of waste collected into a compaction truck for final disposal at the landfill. However, these were not enough to ensure regular collection and transportation of waste to the landfill. For instance about two-hundred (200) Oboafu tricycles were needed by the waste management institutions for the door-to-door collection. Also, the compaction trucks which were used for the door-to-door collection were only two (2) for the entire Metropolis. In effect if the few existing core waste equipment for collection and transportation like skip loaders, compaction trucks and roll on/roll off trucks are broken down for just a day or two it will result in heaping of waste. This can lead to outbreak of communicable diseases such as cholera, typhoid and chicken pox.

On staffing situation of the two institutions the Metropolis have high calibre of personnel at the top management position. Table 5.7 below shows the technical staff of WMD and ZoomLion Ghana Ltd.

**Table 5.7: Technical Staff of Waste Management Institutions in TAMA**

<b>Institution</b>	<b>Personnel</b>	<b>Number</b>	<b>Qualification</b>
WMD	-Directors	2	MSc. Civil Engineering
	-Engineer	1	BSc. Civil Engineering
	-Technical Supervisors	8	Dip. Environmental Health
	-Supervisors	3	Certificate
ZoomLion Ghana Ltd	-Regional Operations Supervisor	1	B.A. Social Science
	-Assist. Regional Operations Supervisor	1	M.A. Env'tal Management
	-Technical Supervisor	1	Advance Certificate in Engineering

Source: WMD and ZoomLion Ghana Ltd., April 2010.

From table 5.7 above, the WMD had more technical staff than the ZoomLion Ghana Ltd. Once the ZoomLion are into solid waste management technical staff like engineers were required especially at the landfill site to ensure effective waste disposal. Even if the operation supervisors were engineers that would have still been inadequate for a Metropolis not even to talk of the whole Northern Region. Additionally, the technical supervisors were woefully inadequate as compared to the WMD which had eight (8). This is because one (1) person cannot supervise waste collection in the whole Metropolis with over thirty (30) communities.

In summary, the types of waste generated in the Metropolis include the following: food waste, rubbish and ashes with plastic as the major component of waste. The commonest place of household waste disposal was the skip of which secondary mode of waste collection being the main mode of waste collection. Waste collected in the Metropolis was finally disposed of in landfill; 13 kilometres away from the city centre. The next chapter therefore, summarises the key findings, recommendations and conclusion of the study.

## CHAPTER SIX

### SUMMARY OF KEY FINDINGS, RECOMMENDATIONS AND CONCLUSION

#### 6.1 Introduction

In the Tamale Metropolis indiscriminate dumping, irregular collections of waste and inadequate resources are the key problems in solid waste management. Therefore, the main objective of the study was to establish the underlying factors affecting effective waste management in TAMA and suggest possible measures to tackle the problem. Below are the key findings of the study.

#### 6.2 Key Findings

Through the analyses, the following are the key findings of the study. These are discussed below.

##### *6.2.1 Waste Disposal*

Inadequate skip supply was a major factor affecting waste disposal in TAMA especially among the low class residential areas. The survey established that about 66 per cent of respondents have no access to skips for disposing their waste particularly those living in the low class residential area. This implies that respondents resorted to dumping waste in nearby gutters, by roadside, opened spaces and other unapproved ways of managing their domestic waste.

Additionally, the skip ratio to population was very high. That was 1: 9378 compared to the maximum number of seven hundred people to a skip (1:700). These include high populated areas like Moshi Zongo, Aboabo, Lamashegu and Sakasaka. This goes to reaffirm the inadequacy of skip supply in the Metropolis. Also, the time spent by residents to dispose of waste at the few existing skip sites was a latent factor influencing dumping of solid waste at unapproved sites.

##### *6.2.2 Waste Collection*

Indeed there was irregular or lack of routine collection of waste by ZoomLion Ghana Ltd. especially in the low class residential areas in the Metropolis. Waste collection was mostly carried out twice a week and in some areas like middle class residential areas no collection took place. Even in the high class residential areas collection was done once a week.

This resulted in people dumping their waste in opened spaces and in most cases burning was the alternative to final disposal at the landfill. Unlike the door-to-door collection which attracted a monthly charge of GH¢ 7.00 in the high class residential areas, the communal collection was carried out at no cost to the residents in all the low class residential areas. This is because respondents in these areas were not requested to pay for waste collection though their monthly average monthly income (GH¢ 260) earned could support the payment.

### ***6.2.3 Final Disposal***

The landfill did not meet the requirement of a sanitary landfill as in the case of KMA and therefore could be described as an open dump. Though the landfill had a weighbridge, gas recovery system, leachate collection system they were not functioning. The landfill too had no internal access and sited near a settlement. Additionally, waste was not usually separated into their various components before final disposal. This led to burying of some valuable resources in the landfill which could have been otherwise re-used. More so, burning of waste occurred in the landfill.

### ***6.2.4 Resources for Waste Management***

The waste management institutions were unable to deliver efficient services as they were under resourced. Skips for storing waste generated were woefully inadequate. In the whole Metropolis one hundred and eighty six (186) skips were supplied particularly in the low class residential areas. However, about 230 extra skips were required by WMD and ZoomLion Ghana Ltd. to be supplied to the low class residential areas. Also, about four thousand (4000) dustbins extra were required to be supplied in the middle and high class residential areas in the Metropolis as against about one thousand, five-hundred and ninety-seven (1,597) dustbins distributed.

Equipment for waste transportation were also inadequate. These include: oboafu tricycle, compaction trucks, roll on/roll off trucks and skip loaders. For instance two hundred (200) oboafu tricycles were needed by the waste management institutions for the door-to-door collection. However, about one hundred (100) tricycles were available. Further more, the compaction trucks which were used for the door-to-door collection were only two (2) for the entire Metropolis. Therefore, four (4) were required to ensure regular collection.

### **6.3 Recommendations**

Based on the findings of the study, the following measures are recommended for efficient and effective management of solid waste in TAMA. These are discussed below.

#### ***6.3.1 Provision of adequate Skips and Dustbins***

Adequate dustbins and skips should be provided by ZoomLion Ghana Ltd. in collaboration with the WMD and Metropolitan Assembly for residents in the Metropolis for waste storage. Approximately six hundred (600) skips should be supplied. This should be provided particularly for the low class residential and middle class residential areas to avoid dumping of waste in open spaces, gutters, boilers and roadside. At least, four- hundred (400) people to a skip and at most six- hundred (600) people to skip. These should be placed at least within 30 metres radius and at most 50 metres radius in the low class residential areas. With this, residents in the low class residential areas will spend less time to dispose off their domestic waste at the skip site. Also, the backlog of five thousand and forty (5040) dustbins should be supplied by ZoomLion Ghana Ltd. particularly for the high class residential areas.

#### ***6.3.2 Regular Collection of Waste***

There should be regularity of waste collection by ZoomLion Ghana Ltd. particularly in highly populated areas like Moshi Zongo, Sakasaka, and Choggu to avoid heaping of waste and over flowing of skips with solid waste. At least, waste should be collected four times a week in these areas and thrice in the Middle and high class residential areas. There should be regular monitoring of waste collection by the Metropolitan Assembly. This will keep the place constantly clean and prevent any possible outbreak of communicable diseases such as cholera and typhoid.

#### ***6.3.3 Use of Integrated Solid Waste Management Model***

The Integrated Solid Waste Management (ISWM) should be adopted to ensure effective solid waste management in the area. Residents should be encouraged by WMD and ZoomLion Ghana Ltd. to separate the waste generated into their various components before final disposal. Waste can be disaggregated into plastic, metals, wood, cans, bottles and food waste. In this case rubber cans, bottles, metals can be reused; plastics like polythene bags and empty water sachets can also be recycled. The rest like food waste can be composted for manure, incinerate those that are combustible and landfilled those that cannot be subjected to any of the above mentioned methods.

#### ***6.3.4 Proper Management of Landfill***

The landfill site should be properly managed to avoid heaping of waste and burning. The following should be revived for the landfill to work effectively. These include the weighbridge, gas recovery system and leachate collection system. With the weighbridge the quantity of waste that goes into the landfill can be easily determined. With proper leachate system put in place the possibility of waste polluting groundwater in the area will be prevented. Also, waste dumped in the landfill should be spread, compacted and cover with soil. This will prevent heaping of waste in the landfill. Furthermore, the landfill management should ensure that waste that is carried to the landfill does not contain fire. Any container that contains fire should be isolated and fire quenched before dumping is done. Waste collection sources should be checked to ensure that waste does not contain any drop of fire. This will go along way to prevent the burning of waste in the landfill. The Environmental Protection Agency (EPA) which is the regulatory authority on sanitation should ensure routine monitoring of management of the landfill site. The landfill site should also be relocated because of its negative environmental impact on the lives of people in a nearby community (Wovuguma). The relocation will prevent the community from being constantly engulfed by smoke from the landfill. This will also prevent possibility of the waste in landfill especially hazardous waste from polluting water sources of the community through percolation.

#### ***6.3.5 Adequate Resourcing of Waste Management Institutions***

The waste management institutions should be adequately resourced by the Metropolitan Assembly to ensure efficient and effective waste management in the area. The Metropolitan Assembly should liaise with other corporate bodies like the United Nations Development Program (UNDP) as well as the sister city in the United States (US) to pull financial resources to support the institutions in charge of managing waste especially the ZoomLion Ghana Ltd. With the support, adequate dustbin, skips and core waste management equipment such as compaction trucks, roll on/roll off trucks, skip loaders would be purchased to ensure effective waste collection and disposal. People particularly in the low class residential areas should be made to pay for disposing their waste. This is because they are the very people who generate the waste. That is the 'pay as you throw principle' should be introduced. All these should be done through education by letting residents know the importance of environmental cleanliness and how they can contribute to it. This will go to support the financial base of the waste management institutions.

## 6.4 Conclusion

In the study, the following objectives were set to be achieved. The first objective was to assess the types and components of solid waste generated in the Tamale Metropolis. Therefore, the survey established that the types of solid waste were food waste, rubbish and ashes with plastic being the major component. The second objective was to examine means of waste disposal by households (place of disposal). The survey revealed that the commonest place of waste disposal in the Metropolis was the skip. However, this was woefully inadequate. Thirdly, the research seeks to analyse the mode and frequency of solid waste collection in TAMA and the commonest mode of waste collection is communal. On the other hand, the collection was irregular. The study also meant to analyse how the waste collected was finally disposed off. It can therefore be said that waste collected was finally disposed in the landfill. However, the landfill was in a poor state. Further more, the study intended assessing the capacity of waste management institutions particularly in terms of physical resources to effectively manage waste in the Metropolis. Therefore the main equipment used for waste storage and collection were: dustbins, skips, obofo tricycle, skip loaders, compaction trucks and roll on/ roll off trucks. But these equipment were not enough to ensure effective waste collection and disposal.

Therefore, all the objectives set were achieved and with regard to the main objective of the study it can be concluded that the following are indeed the key factors affecting effective waste management in the Tamale Metropolis. These include inadequate skip supply for storing waste; high population to skip ratio; lack of routine collection of waste, poor methods of waste management and inadequate resources for waste management institutions to effectively collect the waste generated. To effectively tackle the problems enumerated, the following measures are recommended.

- Provision of adequate skips and dustbins
- Regular collection of Waste
- Use of Integrated Solid Waste Management Model
- Proper Management of Landfill
- Adequate resourcing of Waste Management Institutions

If the above recommendations given are well taken and implemented, it will bring about effective solid waste management; ensure a clean environment and curb any possible outbreak in TAMA.

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## APPENDICES

### Appendix I

#### Background Information of Respondents

##### Age:

Age	Frequency	Percent
20-24	25	16.0
25-29	32	20.5
30-34	29	18.6
35-39	20	12.8
40-44	21	13.5
45-49	15	9.6
50-54	10	6.4
54 plus	4	2.6
<b>Total</b>	<b>156</b>	<b>100.0</b>

##### Level of Education:

Level of education	Frequency	Percent
None	36	23.1
Primary	10	6.4
Middle/JSS/JHS	18	11.5
Secondary/technical	34	21.8
Vocational	10	6.4
Training college	21	13.5
Tertiary	27	17.3
<b>Total</b>	<b>156</b>	<b>100.0</b>

**Occupation:**

<b>Occupation</b>	<b>Frequency</b>	<b>Percent</b>
Farming	11	7.1
Petty trading	44	28.2
Business	28	17.9
Public servant	51	32.7
Other	22	14.1
Total	156	100.0

## Appendix II

### (b). Criterion for Classification of Residential Areas in Tamale Metropolitan Area

Class of Residential Area	Criteria Used
<i>Low Class</i>	<ul style="list-style-type: none"> <li>-Mostly, compound houses.</li> <li>-Mud and thatch houses. Some are in deplorable conditions.</li> <li>-Buildings are of poor quality material such as untreated timber and zinc roofing sheets for walling.</li> <li>- The housing environment is characterised by haphazard development, inadequate housing infrastructure, poor drainage, erosion and high population concentrations.</li> <li>-Occupants of houses are mostly indigenous people and migrants workers.</li> </ul>
<i>Middle Class</i>	<ul style="list-style-type: none"> <li>-They are mostly quarters.</li> <li>-Housing pattern is nucleated or linear.</li> <li>-Less population concentration.</li> <li>-Buildings are of good quality materials.</li> <li>-Occupants are predominantly nurses, teachers and civil servants.</li> </ul>
<i>High Class</i>	<ul style="list-style-type: none"> <li>-These areas are all planned and have well developed infrastructure with spacious and landscaped ground in sharp contrast with the low class areas. -Buildings are usually built with sandcrete blocks, they have walls and roofed with aluminium, or asbestos roofing sheets. They constitute flats and bungalows.Roads are tarred</li> <li>-Occupants are Directors and Heads of Departments</li> </ul>

**Appendix III**

**DEPARTMENT OF PLANNING**

***FACULTY OF PLANNING AND LAND ECONOMY***

**COLLEGE OF ARCHITECTURE AND PLANNING**

**Kwame Nkrumah University of Science and Technology, Kumasi.**

**M.Sc. Development Policy and Planning (DEPP)**

***Solid Waste Management in Ghana: The Case of Tamale Metropolitan Area***

**Household Questionnaire**

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*The research is mainly for academic purpose. Therefore, answers given will be treated as confidential.*

*Thank you.*

Location of House: .....

House Number (if available): .....

Date of Interview:.....

Questionnaire Number: .....

**SECTION A**

Please tick *ONLY THE BOX* of the response given/state briefly for an unprovided answer.

**Place of Disposal of Household Waste**

Q1. Where do you dump your waste?

- Roadside
- Skip
- Dump sites
- Open spaces
- Nearby gutter
- Backyard
- other, specify: .....

Q2. If waste is dumped in skip, do you pay as you throw?

- Yes
- No

Q3. If yes, on average how much are you charged?

- 20pesewas
- 30pesewas
- 50pesewas
- 60pesewas
- Other, specify:.....

Q4. Have you ever dumped your refuse at unapproved sites (anywhere else) because you did not have money to pay?

- Yes
- No

Q5. If waste is dumped in skip, approximately, how many minutes does it take you to get to the site?

- 5-10mins.
- 11-15mins.
- 16-20mins
- 21-25mins.
- More than 25mins.

Q6. If travel more than 10mins to dispose off the waste, does it inconvenience you?

Yes     No            **(If No, go to Q8)**

Q7. If yes, what do you do with the waste? I/ dump them in

- Nearest available space
- Nearest gutter
- Burn them
- Barry them
- Other, specify.....

**SECTION B**

**Waste Collection by Waste management Institutions**

Q9. Which of the following types of waste do you generate in your home? (You can tick more than one answer).

- Food wastes
- Rubbish
- Ashes
- Other, specify: .....

Q10. Which waste management institution collects waste in your area for disposal?

- Waste Management department (Metro. Assembly)
- ZoomLion
- None
- Don't know **(If none or don't know, skip to Q18)**
- Other, specify: .....

Q11. How many times is the waste collected in a week?

- Not at all
- Once
- Twice
- Thrice
- four times
- Five times
- Throughout

Q12. What is the mode of collection of waste in your area?

- Door-to-door
- Curb
- Communal
- Other, (specify):.....

Q13. If any of the modes, how many times a week?

- Not at all
- Once
- Twice
- Thrice
- Four times
- Four times
- Throughout

Q14. Are you charged for the collection?

- Yes
- No

Q15. How much? Indicate the amount in GH¢.....

Q16. Are you position to pay?

- Yes
- No

Q17. If no, why?

- I am not working
- I don't see the need
- My income is very small
- Other reason (Specify): .....

Q18. In your own view, give four ways you can effectively manage the disposal of solid waste in your area (**You can tick more than one answer**).

- Contributing to buy waste containers
- Paying for the disposal and collection of waste
- Stop dumping waste any how
- Other (specify):.....

Q19. Are you able to do any of these?

Yes       No

Q20. If yes, mention those that you are able to carry out.

Contributing to buy waste containers

Paying for the disposal and collection of waste

Stop dumping waste any how

Other specify:.....

**SECTION C**

***Background Information***

Q21. How old are you?  
month?

- 20-24
- 25-29
- 30-34
- 35-39
- 40-44
- 45-49
- 50-54
- 54+

Q24. Approximately, how much do you earn in a

.....

Q22. What is your highest level of education?

- |  |   |
|--|---|
| <input type="checkbox"/> None                | <input type="checkbox"/> Training College |
| <input type="checkbox"/> Primary             | <input type="checkbox"/> Tertiary         |
| <input type="checkbox"/> Middle/J.S.S/J.H.S  |   |
| <input type="checkbox"/> Secondary/Technical |   |
| <input type="checkbox"/> Vocational          |   |

Q23. What is your major Occupation?

- Farming
- Petty Trading
- Business
- Public servant
- Other, specify.....

**Appendix IV**

**DEPARTMENT OF PLANNING**

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***Solid Waste Management in Ghana: The Case of Tamale Metropolitan Area***

**Interview schedule for Assemblymen**

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*Thank you.*

Name of Electoral Area.....

Location: .....

Date of Interview: .....

**SECTION B**

Please record answers in the *spaces* provided

**Solid waste collection and disposal**

Q1. What is the estimated population in the area (in figures): .....

Q2. Availability of dustbins and skips

<b>Bins/Skips</b>	<b>Number Available</b>	<b>Number Required</b>
Dustbins		
Skips		
Others:		

Q3. Are the skips and bins adequate?

Yes       No

Q4. If the skips provided are not adequate, what happens to waste generated from households?

.....  
.....

Q6. Which waste management institution does the collection of waste in the area? (If more than one mention all)

.....  
.....

Q7. How many times does the collection take place in a week?

.....  
.....

Q8. What is the mode of collection? (If more than one, indicate all)

.....  
.....

Q9. Do the people pay for the cost of collection?

Yes       No

Q10. If yes, indicate the amount per house/household in GH¢ .....

Q11. What is the mode of payment?

.....

Q12. Are the people able to pay?

Yes       No

Q14. If No, what are the reasons?

1.....

2.....

3.....

4.....

Q15. What happens to the waste if they are not able to pay?

.....

.....

Q16. In your own view, what are some of the factors affecting effective waste management in the area? (List at most four)

1.....

2.....

3.....

4.....

Q17. Do you have any other relevant information regarding solid waste management in the area? (State them briefly).

- 1.....
- 2.....
- 3.....
- 4.....

**Appendix V**

**DEPARTMENT OF PLANNING**

***FACULTY OF PLANNING AND LAND ECONOMY***

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**Kwame Nkrumah University of Science and Technology, Kumasi.**

**M.Sc. Development Policy and Planning (DEPP)**

***Solid Waste Management in Ghana: The Case of Tamale Metropolitan Area***

**Interview schedule for WMD and ZoomLion Ghana Ltd.**

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*Thank you*

Position of Respondent: .....

Date of Response: .....

**SECTION A**

**Please record answers in the *spaces* provided**

**Waste collection and disposal**

Q1.What is the quantity of waste generated in a day in tonnes? (In figures):  
.....

Q2.What is the quantity of waste generated per capita in a day in tonnes? (In figures):.....

Q3. What are the common types of waste generated in the area? (List them)

1.....

2.....

3.....

4.....

5.....

Q4. Do you separate the waste before disposal? (Either into plastic, wood, metals, glass, food waste among others)

Yes       No

Q5. If yes, indicate the reasons.

1.....

2.....

3.....

4.....

Q6. What are the major components of waste generated in the area? (Indicate their percentages in the table provided below).

<b>Major Component</b>	<b>Percentage Generated</b>
Plastic	
Glass	
Wood	
Metals	
Food Waste	
Other:	

Q7. What is the mode of collection and the number of times waste is collected per week in the following listed sections in the metropolis?

<b>Name of section</b>	<b>Mode of collection</b>	<b>Number of times per week ( in words)</b>
Aboabo		
Choggu		
Lamashegu		
Moshi Zongo		
Nyohini		
Sakasaka		
Education Ridge		
Ghanasco		
Russian Bungalows		
Kalpohin Estates		
SSNIT Flats		
Vitting Estates		

Q8. What is the cost of collection per week? Indicate the amount in GH¢.....

Q9. Where do you dispose off the waste collected from the various sections? (Final disposal site).....

Q10. What is the distance covered to final disposal site in kilometres? .....

Q11. Is the distance a problem?

Yes     No

Q12. If yes, indicate the problems

1.....

2.....

3.....

4.....

Q13. How do these problems affect the frequency of waste disposal at the site?

1.....

2.....

3.....

4.....

Q14. What methods do you use in managing the solid waste generated in the area? (If more than one indicate them)

- Composting
- Recycling
- Incineration
- ISWM (Reduce, Reuse and Recycle/landfill/incinerate)
- None
- Other, (specify):.....

Q15. Why do you choose to use any of the method(s) for managing solid waste above? (Indicate the reasons in the spaces provided below).

- 1.....
- 2.....
- 3.....
- 4.....

## SECTION C

### Availability of Resources for Managing waste

Q16. Waste collection and disposal equipment (Indicate the number available and the number needed)

<b>Equipment</b>	<b>Number Available</b>	<b>Number Required</b>
1.Dustbins		
2.Skips		
3.Obofo tricycle		
4.Motorist tricycle		
5.Graders		
6. Skip Loaders		
7.Compaction trucks		
8.Roll on/Roll off trucks		
9.Bulldozers		
10. Road sweepers		
11.Bulldozers		
12.Road sweepers		
14. Others:		

Q17. Availability of qualified personnel for managing waste (Technical Staff)

<b>Personnel(Technical Staff)</b>	<b>Number</b>	<b>Qualification</b>

Q18. In your view what are some of the problems facing the department in terms of managing waste? (List at most four)

- 1.....
- 2.....
- 3.....
- 4.....

Q19. How can the problems be solved? (State them briefly)

- 1.....
- 2.....
- 3.....
- 4.....

**Appendix VI**

**DEPARTMENT OF PLANNING**

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**COLLEGE OF ARCHITECTURE AND PLANNING**

**Kwame Nkrumah University of Science and Technology, Kumasi.**

**M.Sc. Development Policy and Planning (DEPP)**

***Solid Waste Management in Ghana: The Case of Northern Region***

**Interview schedule for the Office of Metropolitan Assembly**

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*Thank you.*

Position of Respondent: .....

Date of Response: .....

**SECTION B**

**Please record answers in the spaces provided**

**Revenue and solid waste management**

Q1.How much revenue do you generate in a month? Indicate the amount in GH¢.....

Q2. How much do you spend on waste collection? Indicate the amount in GH¢.....

Q3.How much do you spend on acquiring waste management equipment? Indicate the amount in GH¢.....

Q4.Amount spent on maintaining waste management equipment. Indicate the amount in GH¢.....

Q5.How much common fund did you receive last year? Indicate the amount in GH¢.....

Q6. How much of that is spent on waste collection? Indicate the amount in GH¢.....

Q7. How much of that is spent on acquiring waste management equipment? Indicate the amount in GH¢.....

Q8. How much was on maintaining waste management equipment? Indicate the amount in GH¢.....

Q9.What are some of the challenges of managing solid waste in the Metropolis? (List at most four)

1.....

2.....

3.....

4.....

Q10. How can these challenges be overcome? (State them briefly)

1.....

2.....

3.....

4.....