ASSESSMENT OF HOUSEHOLD SOLID WASTE MANAGEMENT IN GOMBE, NIGERIA

BY

BUBA, HAJARA BIRMA
B. URP (A.B.U ZARIA) 1998
M.Sc/ENV-DESIGN/44143/2012-2013

A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTER OF SCIENCE IN URBAN MANAGEMENT

DEPARTMENT OF URBAN AND REGIONAL PLANNING
FACULTY OF ENVIRONMENTAL DESIGN
AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA

NOVEMBER, 2016

DECLARATION

I hereby declare that the work in this dissertation entitled “ASSESSMENT OF HOUSEHOLD SOLID WASTE MANAGEMENT IN GOMBE, NIGERIA” was carried out and written by me in the Department of Urban and Regional Planning under the supervision of Professor M.B Yunusa and Malam A.S Usman. The information derived from the literature has been duly acknowledged in the text and a list of reference provided. No part of this dissertation has been presented for another degree at any institution.

………………………………………......... ……………………..

BUBA, HAJARA BIRMA DATE

M.SC/ENV-DESIGN/44143/2012-2013

CERTIFICATION

This dissertation entitled "ASSESSMENT OF HOUSEHOLD SOLID WASTE MANAGEMENT IN GOMBE, NIGERIA" by BUBA, HAJARA BIRMA meets the regulations governing the award of the degree of Master of Science in Urban Management, Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

……………………………………….	…………………
Professor M.B Yunusa	Date
Chairman, Supervisory Committee	
………………………………………	…………………..
Mal. A.S Usman	Date
Member, Supervisory Committee	
……………………………………….	…………………..
Professor M.B Yunusa	Date
Head of Department	
………………………………………..	…………………..
Professor Kabir Bala	Date
Dean, School of Postgraduate Studies	

DEDICATION

This dissertation is dedicated to my late beloved father ALHAJI BUBA BIRMA KALSHINGI for his love and support.

ACKNOWLEDGEMENT

I thank Almighty Allah (SWT) for granting me the opportunity, time and courage to complete this dissertation successfully. I wish to express my sincere appreciation to my supervisors Professor M.B Yunusa and Mal. A.S Usman, who critically went through the scripts and were always ready to give valuable advice. My sincere gratitude also goes to Professor Adamu Ahmed, Dr. M. Sani, Dr. Ashiru Bello, Mal. U.F Yaya, Mr. Ojibo, Mal. Idris Iliyasu and the entire staff of URP Department.

I am grateful to the staff of Gombe State Environmental Protection Agency (GOSEPA), Gombe Local Government Council and Inex Cleaners Limited for their assistance that made it easier for the collection of data. Also I am grateful to Alhaji Ubayo Dept. of Primary Health Care Gombe Local Government, Alh. Gidado Bureau of Statistics, Gombe State Ministry of Finance and Surveyor Yakubu Maikano.

My family members also deserve my sincere gratitude especially my parents Late Alhaji Buba Birma, Hajiya Maryam Buba Birma and Hajiya Rabi Buba Birma, for their untiring love and support. To my brothers Adamu, Abdullahi, Aminu, Ibrahim, Suleiman, Bello, Ali, Sani and Sadiq, my sisters Dr. Rahmatu, Hafsat, Zainab, Fatima and Aishatu for their support and encouragement. May Allah reward you all (Amin). My profound gratitude goes to my uncles Baba Tolba, Bappah Zakari, Alhaji Daudu, Kaka Mele and Dr. Babayo (Dan Iyan Gombe), my aunts Hajiya Zara, Hajiya Ladi, Hajiya Ruqaiya, Hajiya Maryam, Aunty Esther and Aunty Halima.

Finally, my appreciation also goes to my colleagues in the Department of Urban and Regional Planning, Gombe State Ministry of Lands and Survey, Gombe State Urban Planning and Development Board and my friends for their support both directly and indirectly towards the successful completion of this course.

ABSTRACT

This study examines the household solid waste management practices and the role of agencies responsible for its management in Gombe. The research gathered data from two main sources: primary and secondary sources. The secondary data were obtained from the library and internet sources while the primary data were obtained from the household heads, field surveys and oral interviews of employees of relevant waste management agencies such as: Gombe State Environmental Protection Agency (GOSEPA), Gombe Local Government, Formal Private Contractor (Inex Cleaners Limited), Informal Private Operators, operating in high and medium income neighborhoods, CBOs and waste collectors. In all, two hundred (200) copies of structured questionnaires were distributed randomly among selected household heads on the basis of density that is Low, Medium and High. The study revealed that the socio-economic characteristics of the households in the study area have influence on waste generation, collection and disposal interms of their educational levels, monthly income, households' family size etc. At the high and medium income neighborhoods such as G.R.A and Federal Lowcost the rate of waste generation is higher compared to the low income neighborhoods such as Ajiya and Kagarawal. This is as a result of the high income levels of the residents of the high and medium income neighborhoods in purchasing more items than the residents of the low income neighborhoods. The study also revealed that majority of the residents in Gombe dumps their wastes in open spaces, drainages and vacant plots. About 32% of the residents do not have their wastes collected at all most especially in the low income neighborhoods such as Kagarawal. The results also indicate that waste separation does not take place at both households' level and official dumpsites. Most of the wastes generated are food, paper, textile materials, plastic materials, polythene bags, bottle and tin cans. The results indicated that the agencies in charge of solid waste management in Gombe were not efficient. This could be closely linked with the lack of equipments, trained manpower, and poor funding of these agencies and also the negative attitude of the households towards solid waste management. Based on these findings, the study recommended strategy options for efficient and effective management of solid waste in Gombe. These include community participation, payment for waste management, public-private partnership, adequate resourcing of waste management agencies, monitoring and supervisor, use of integrated solid waste management model, use of appropriate technology etc.

TABLE OF CONTENTS

CHAPTER 2: LITERATURE REVIEW

CHAPTER 3: RESEARCH METHODOLOGY

CHAPTER 4: RESULTS AND DISCUSSIONS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Solid waste management has become a global problem especially in developing countries of the world. One of the major factors that directly contribute to solid waste generation is urbanization and population growth. World population reached seven billion in 2011 and continues to rise with projection nearing 9.3 billion by 2050 (UNFPA 2010). Urban areas are the most populous areas in the world, especially in developing countries, where people migrate from rural areas to urban areas in search of better life and employment (UNFPA 2011). This increase in population which is accompanied by unexpected and unplanned rapid urbanization on the one hand and economic growth in developing countries on the other, have accelerated the generation rate of municipal solid waste (Al-Khatib 2010, Awomeso 2010, Medina 2010, Zerbock 2003, UNEP 2005a). The amount of household solid waste produced daily is significantly increasing in the cities of developing world. While the capacity and effectiveness of municipalities in providing municipal solid waste services remains undesirably low, (UN-HABITAT 2003, Medina, 2010). This result in the inability of the municipal corporations of the developing countries to handle the increasing quantities of wastes generated. These uncollected wastes litter the streets, roads and public places, this inefficient management and disposal of solid waste is an obvious cause of degradation of the environment in most cities of the developing world (Rathi, 2005).

In Nigeria, for instance it is not unusual to see heaps of garbage in the major cities littering the streets, dumped in drains, vacant plots, and water bodies, and this has in many cases resulted in spread of communicable diseases. The situation appears to continue unabated due largely to the factors of urbanization, population growth, improved life style and insufficient funds to properly manage solid waste. Furthermore, some of the factors influencing solid waste generation in Nigeria include inadequate technology, facility for separation at source, strength of solid waste management policy and enforcement, environmental education and awareness and income status of individuals (Abel, 2009). The local government councils are mandated to exercise exclusive constitutional function of solid waste management. The 1976 local government edict was later entrenched in the1979 and 1999 constitutions of the Federal Republic of Nigeria (FGN, 1999 and 1979). Essentially, solid waste management in Nigeria is under the responsibility of the Local Environmental Protection Agency as stipulated by the [16] 1988 decree which established the Federal Environmental Protection Agency (FEPA). Decree 58 of 1988 was amended by FEPA (Amendment) Decree No.59 of 1992. This legislation vests in FEPA the overall responsibility for the protection and development of the environment, biodiversity conservation and sustainable development of Nigerian's natural resources in general and environmental technology, including initiation of policy related to environmental research and technology, among other functions (Decree No. 59 1992).

In spite of the establishment of Federal Environmental Protection Agency (FEPA) and the formulation of the national environmental policy, the environment has not been adequately protected as interest and efforts are mainly channeled on aesthetics, which is rarely achieved (Agunwamba, 1998). Wastes collection is irregular and restricted to the major cities, thereby endangering public health by encouraging the spread of odours and diseases, uncontrolled recycling of contaminated goods and pollution of water sources (Adejoke, 1989). Rapid growing population, rapid economic growth, and rise in community living standards have accelerated the generation rate of municipal solid wastes, thereby causing its management to be a major worldwide challenge (Al-Khatib *et al, 2010*).

Gombe whose population has multiplied sixteen times since 1952, reaching approximately 300,000 today has been as a typical example representing many other fast growing towns. Such high population growth rates of 6% results in a doubling of the population every twelve years (Balzerek 2001, 2003). This together with insufficient tools and equipments for collection coupled with irregular collection of these wastes, improper disposal method, inadequate transportation and storage facilities, and lack of separation and treatment mechanism in place compound problems of waste management. To cope with these challenges the State Government is resorting to the use of the private contractors for waste collection, transportation and disposal. Also, there is the presence of informal private operators in high and medium income neighborhoods. Yet, more and more heaps of this waste accumulates in various corners of the town. Therefore, it is against this background that this study focused on household solid waste generation and the examination of the capacities of agencies responsible for its management in Gombe.

1.2 STATEMENT OF RESEARCH PROBLEM

The management of household solid waste has been a major challenge facing agencies responsible for solid waste management in Gombe, as the volume of solid waste being generated continues to increase at a faster rate than the ability of the agencies to improve on the financial and technical resources needed to parallel this growth. In Gombe urban area, streets, residential backyards, waterways, uncompleted buildings, public spaces and undeveloped plots are littered with solid wastes as illegal refuse dumps for households. This is due to lack of adequate spatial distribution of designated household refuse collection points because it does not coincide with the rapid population growth and variation in neighborhood characteristics, leading to inefficient solid waste management by the Gombe State Environmental Protection Agency (GOSEPA) as well as the State Ministry of Environment in conjunction with the Gombe Local Government and the Private Contractors.

Currently, solid waste management in Gombe has severe problems such as low collection rate and non collection in some areas, inadequate transportation and storage facilities, improper disposal method, and lack of separation and treatment mechanism in place. Furthermore, there is spatial area differentiation according to waste generation, collection and disposal in Gombe based on the socio-economic characteristics of households in the neighborhoods. At the high and medium income neighbourhoods, such as the Old and New G.R.A and Federal lowcost, the rate of generation of waste is high compared to the low income neighbourhoods such as Ajiya, Bolari, Dawaki and Shamaki etc. which form the center of the traditional setting and peri urban areas of Gombe. This is as a result of the high income level of the residents in purchasing more items than the residents of the low income neighborhoods. The collection of waste depends on the income of the owner of the waste to be able to pay the amount charged by the private contractors. At the low income neighbourhoods receive no or minimal waste collection. Disposal of waste is done openly on available spaces or set on fire in a little corner of the low income neighbourhoods backyards. This current management practices have further compounded the existing situation in the area.

Although many studies on solid waste management have been undertaken by other researchers; Ojo (2008) Urban solid waste are generated by households with an average of $0.14m^3$ per week, in Anambra state, also Batagarawa (2011) and Nwude *et al.,* (2011) conclude that solid waste management strategies and agencies responsible for its management are ineffective and inefficient in Kaduna metropolis, as cited in Stanley *et al.,* (2011) while Stanley in the assessed household solid waste disposal practices in Sabon Gari conclude that households generate substantial quantity of waste which are not properly disposed of. For most of these studies, the management of household solid waste in Gombe is given little attention. This study examines the processes of household solid waste management and the role of all agencies involved in household solid waste management in Gombe with a view to making useful policy options for the improvement of the situation.

The study therefore, sets out to answer the following specific questions:

(i) What are the current household solid waste management practices and challenges in Gombe?

(ii) What are the agencies involved in the household solid waste management practices and what roles do these agencies play in solid waste management in Gombe?

(iii) What strategies and options are available to deal with challenges of household solid waste management practices in Gombe?

1.3 AIM AND OBJECTIVES OF THE STUDY

1.3.1 AIM

The aim of this study is to assess the household solid waste management practices in Gombe with a view to making recommendations on how to improve the solid waste management system.

1.3.2 SPECIFIC OBJECTIVES

This study is set to achieve the following objectives:

(i) To review the strategies and processes of household solid waste management practices in Gombe.

(ii) To examine the spatial variation, challenges and prospects of household solid waste management practices in Gombe.

(iii) To evaluate the roles of agencies responsible for solid waste management in Gombe.

(iv) To make recommendations for the improvement of household solid waste management practices in Gombe.

1.4 JUSTIFICATION FOR THE STUDY

The accumulation of wastes at various corners of the Gombe urban area coupled with varying levels of collection or non-collection in areas of the town, inadequate transportation and storage facilities has made refuse common features of the Gombe urban area. Despite the efforts put in by the Gombe State Environmental Protection Agency (GOSEPA) as well as the State Ministry of Environment in conjunction with the Gombe Local Government in managing solid waste in Gombe, it still faces waste management problem.

In order for the State Government to overcome the technical and financial deficiencies associated with the current system, the State Government resorts to the use of private contractors for collection, transportation and disposal and the presence of informal private operators in high and medium income neighborhoods. Yet, the problem still persists. Despite this problem, very little research on solid waste management has been carried out in Gombe. Therefore, waste management and handling capacity in Gombe must be enhanced. And this can be enhanced through the analysis of household solid waste management practices and the formulation of appropriate strategies and policies for the management of urban household wastes.

1.5 SCOPE AND DELIMITATION

In this study, the assessment of household solid waste management practices in Gombe is the major issue to be considered with the view of identifying the agencies responsible for its management. The work focused mainly on the spatial variation of neighborhoods characteristics on the basis of density that is Low, Medium and High within the four selected wards of Gombe urban area.

1.6 STUDY AREA

Gombe is located in north east geopolitical zone of Nigeria. It is the largest city and capital of Gombe State. Gombe is situated right within the expansive savannah region of Gombe State which was created in 1996 out of the former Bauchi State. It shares interstate boundaries with Yobe to the North, Bauchi to the West, Taraba to the South, while Borno and Adamawa States are to its East. Gombe State covers an area of 17,100sq kilometers which lies between latitude 10^0 15'N and 11^0 10'E and between longitude 10.250^0N and 11.167^0E. Figure 1.1 shows Gombe Urban Area - the study area.

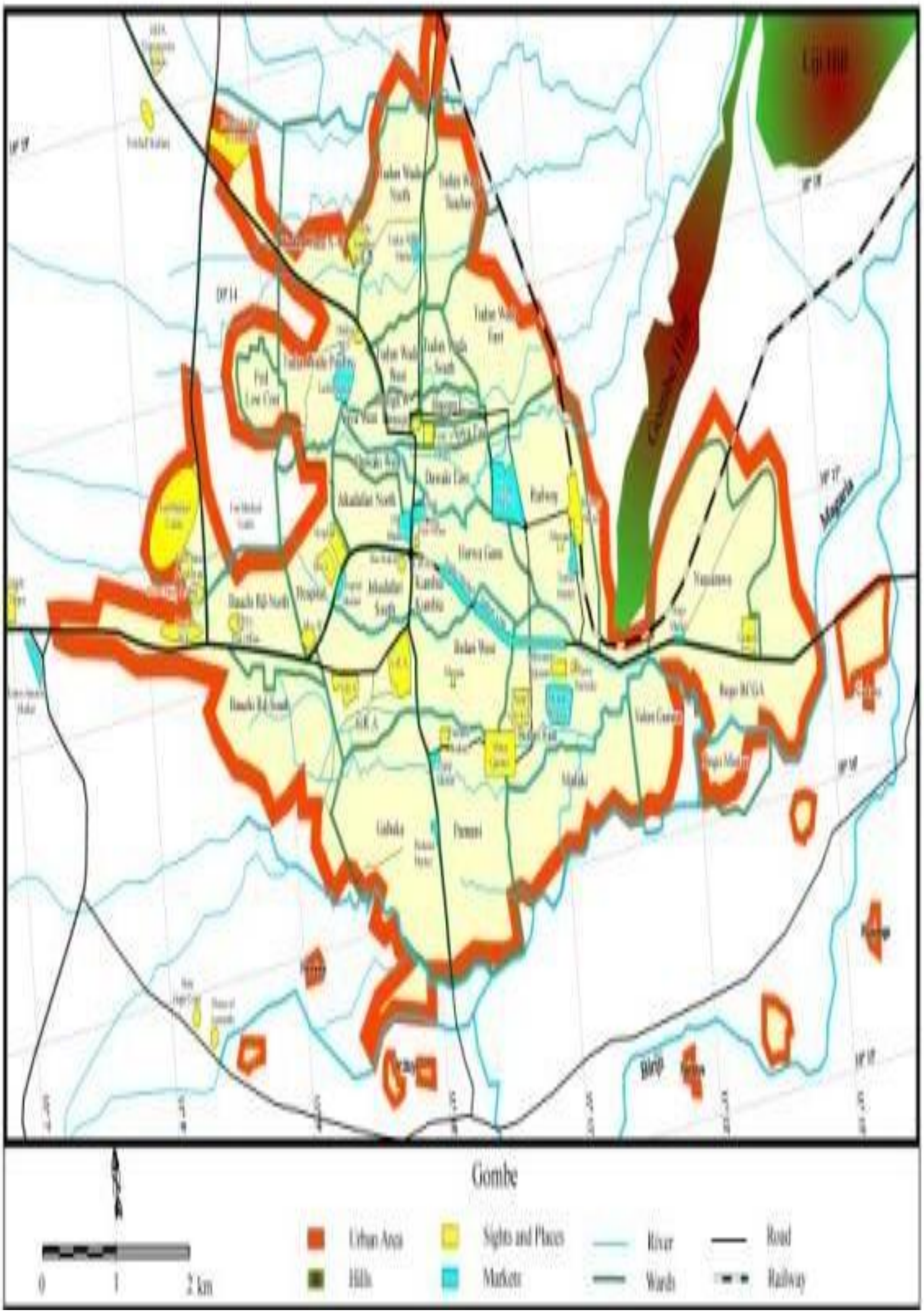


Figure1.1: Gombe Urban Area Source: Satellite Imagery, 2015.

Gombe Urban Area has an area of 52km^2 and a population of 266,844 persons according to 2006 population census (NPC, 2006). The population is projected to be 399,531 persons in 2015 using 3.2% growth rate (National Population Commission Gombe State Office). The Gombe urban area shares common borders with Kwami in the North, Akko in the South and Yamaltu Deba Local Government Area in the East. It has eleven (11) wards and nine Districts and a number of hamlets under each district. Major tribes of the area are Fulani, Bolawa, Kanuri, Tera and Hausa.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews the strategies and processes of solid waste management and the role of all agencies involved in solid waste management. This covers waste handling practices such as generation, storage, sorting, collection, transportation and disposal of waste. This chapter further reviews literature on solid waste management which revolves around developed and developing countries with particular reference to Nigeria.

2.2 CONCEPTUAL DEFINITIONS

Urban household solid waste, according to Senkwe and Nwale (2001) are those wastes from human, animal, domestic and economic activities in the household. These wastes could be organic substances that are biodegradable e.g. food items, peels, grass, vegetables, etc and inorganic substances that are non-degradable e.g. plastics, bottles, metals etc. Solid wastes have been identified as one of the most important environmental problems of urbanization.

Therefore, solid wastes could be defined as non-liquid and nongaseous by-products of human activities, regarded as being useless. It could take the forms of refuse, garbage and sludge (Leton and Omotosho, 2004). 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.

Solid waste management may be defined as " a process associated with the control, generation, storage, collection, transfer and transportation, processing and disposal of solid wastes in a manner that is in accord with the best principles of public health, economic, conservation, aesthetics and other environmental considerations; and that also is responsive to public attitudes" (MNES, 2001). Waste management is regarded as a public service where efficient collection and safe disposal of wastes are essential to public health and environmental protection (Cointreau-Levine, 1994). It has evolved from the simple transportation of waste to landfills to complex systems, including waste prevention and waste recycling as well as several waste treatment and landfill technologies (Salhofer *et al*., 2007). Improper waste management may have health, environmental and economic problems. Ecological phenomena such as water, soil, and air pollution have been attributed to improper management of solid wastes. 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).

2.3 SOLID WASTE MANAGEMENT PROCESSES

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 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 volume and range of solid wastes generated daily in Nigeria has been increasing within the last few years and this is mainly due to the high population growth, urbanization, industrialization and general economic growth. These wastes as observed by Ojo (2008) are generated mostly in urban centres.

2.3.2 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.

2.3.3 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 “curbs”, “setout-setback” and “backyard carry”. According to the USPS (2000), in the city of Thimphu in Bhutan the collection of solid waste from households 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 Nigeria and for that matter Gombe.

2.3.4 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.

2.3.5 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).

2.3.6 Disposal: It is the ultimate fate of all solid wastes whether they are residential wastes collected and transported directly to landfill site.

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. This is divided into early practices of managing solid waste and contemporary methods of waste management systems.

2.3.7 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 Nigeria and in many other less developed countries. A study carried out in Ado-Akiti 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 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 there were no skips or dustbins for the people to store their waste for collection.

2.3.8 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;

2.3.8.1 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.

2.3.8.2 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). The author further argued that "landfills" are nothing more than open, sometimes controlled dumps. According to the author, 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). Furthermore, landfills are one form of waste management that nobody wants but everybody needs (Kreith, 1994). According to the author, there are simply no combinations of waste management techniques that do not require land filling 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. The author 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.

2.3.8.3 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 Nigeria. 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 the author, 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, 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 11per 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 Nigeria, particularly in Gombe town.

2.3.8.4 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. The author further says that in developing countries, the average city's municipal waste stream is over 50 per cent organic material.

2.3.8.5 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 vaporized and the combustible portion gets oxidized and vaporized. CO_2, 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 the author, incineration can also recover useful energy either in the form of steam or electricity. The author, 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.

2.3.8.6 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 2.1: Below is a model of the ISWM. 1. Reduce the amount of 3. Incinerate/landfill waste remaining portion of the generated waste stream 2. Recycle as much materials as possible.

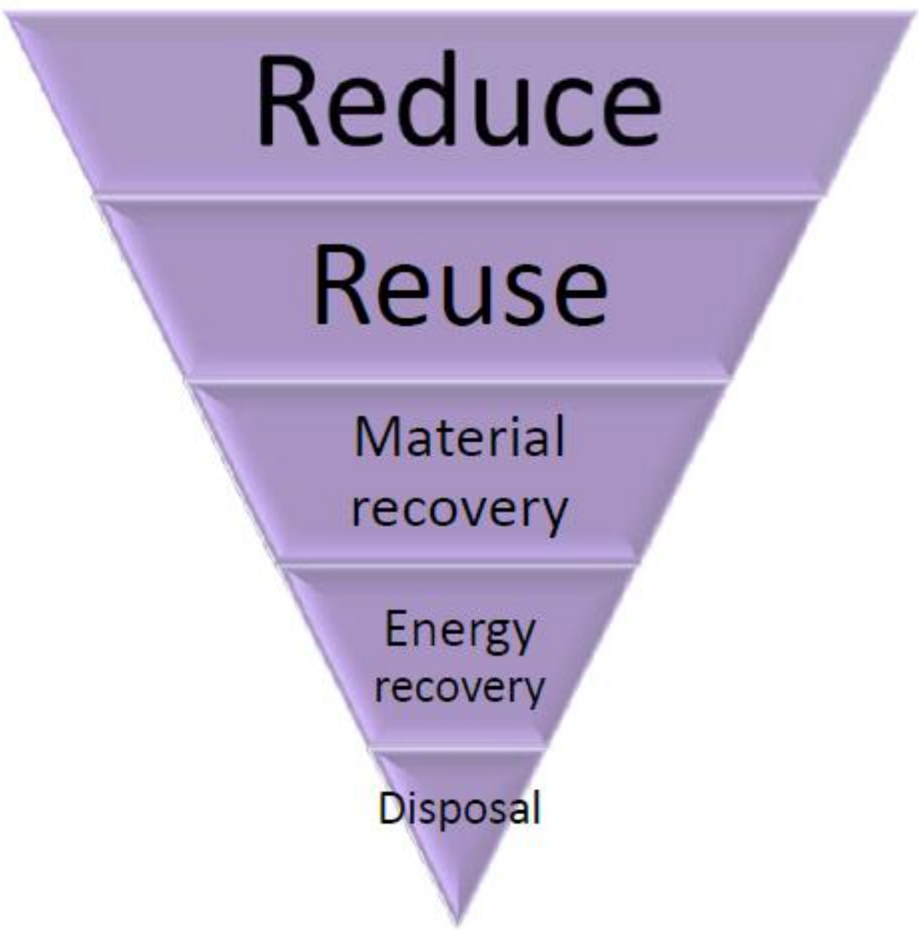


Figure 2.1: Model of Integrated Sustainable Waste Management

Source: Waste management hierarchy (based on Brunner and Fellner, 2007; Finnveden *et al*., 2005; Lang *et al.,* 2007).

The hierarchy consists of a preferred option of waste minimization, material recovery, energy recovery and landfill as the least preferred alternative.

2.3.8.7 Sustainable Waste Management

Sustainable Waste Management Fact Sheet (2013) stressed that Sustainable waste management aims to address these long term pressures through the recovery, recycling, and reuse of resources, and the minimization of waste streams. This includes the management of resources in an environmentally sound and economically effective manner. The Rio declaration on sustainable development (UNCED, 1992) defined sustainable development management as the application of the integrated life cycle management concept in waste management. This was later elaborated by the (UN, 2005) as environmentally sound waste management which must go beyond the mere safe disposal or recovery of wastes that are generated and seek to address the root cause of the problem by attempting to change unsustainable patterns of production and consumption. In effect, the declaration suggests an approach to waste management that incorporates environmental, social and economic perspective unto environmental policy, planning and practice.

However, it is only recently that waste management policies, plans and programmes have begun to consider all these different stand of sustainability. Nilsson-Djerf and McDougall, (2000) argued that for a waste management system to be sustainable, it needs to be environmentally effective, economically affordable, and socially acceptable. For Sustainable waste management a good Integrated Waste Management system approach is the best way to go. It requires government policies that encourage waste prevention, reuse and both materials and thermal recycling recovery and proper disposal options. IWM involves simply the combination of all the waste management techniques in order to minimize waste Arowolo and Sridhar (2005).

Although majority of large cities have administered waste management practices at different levels of sophistication, in some African countries there is no official solid waste management policy. For example, in many Nigerian towns and cities, including Gombe, there is no door to door solid waste collection programme. Roadsides, ditches, drainages, water bodies, empty plots of land, farms, wetlands, uncompleted buildings, etc. are sites observed for dumping of household wastes in most Nigerian cities. This unsanitary and indiscriminate indulgence of the public has been attributed to the ineffectiveness of waste management of the environment by the government (Ojo, 2008). However, the issue of proper waste management is not just a government task but is a shared responsibility that includes the citizens and households, who are the main end-users of waste management facilities and services. When reorganizing solid waste management systems, understanding the role of households, their attitudes, their waste handling practices and their interactions with other actors in the waste system is therefore essential (Oosterveer *et al.,* 2010; Oberlin, 2011).

2.4 SOLID WASTE MANAGEMENT STRATEGIES

Solid Waste Management involves managing activities associated with generation, storage, collection, transfer and transport, processing and disposal of solid wastes in an environmentally compatible manner with due considerations of the principles of economy, aesthetics, energy and conservation. For an urban center with rapid urban migration, poor solid waste management practices are considered as disastrous. Solid waste management strategies can be broadly classified into three groups, viz; the public sector, the private sector and the community sector. Each of these stakeholders is seen as enjoying a comparative advantage in the performance of certain roles, as outlined below:

In Nigeria there are two major approaches to waste management. They are private and public arrangements. The private system is a contractual arrangement between an individual or group of persons who undertake waste disposal as a business venture and the waste generator. This system is common among the high and medium Income households who can afford the charge. The public system is more conventional. This is a situation where government establishes a waste disposal agency whose responsibility it is to collect waste from waste generators and dispose them at disposal depots. Some cities adopt the combination of the two systems particularly when the public system is ineffective to cope with the volume of waste generation; the private system is adopted to compliment the efforts of the public arrangement. This hybrid arrangement is quite common in Nigerian Cities such as Enugu, Port Harcourt, Aba, Owerri, Ibadan and Kano (FMHE, 1983). The hybrid system has many attributes which support its adoption. While the public system is under state government control and supervision, the private system, because of its profit motive tries to offer satisfactory service so as to get more customers and enlarge its area of operation. This motive in turn ensures that efficiency is maintained (Omuta, 1988).

Meanwhile, in many cities in developing countries, collection rates remain low and the quality of collection services are poor. Waste collection services are generally non-existent in poorer neighbourhoods such as slums. While there are some successful examples where the private sector and communities are involved in waste management services, in many cities of developing countries, involvement of these segments of society is still very limited. The wastes collected typically end up in open dumps, where they may be burnt, and in some cases are deposited in illegal dumping sites. Omuta (1988) further argued that involvement of resident community and individuals can bring about a better process of solid waste management.

2.4.1 The Public Sector

This sector comprises of Government institutions that are directly or indirectly involved in providing and managing urban infrastructure services. The major role of this sector as seen by Schuttenbelt, *et al.,* (1994) is "… to create competitive pressures for more effective and efficient service delivery…" it should, further "…enable, facilitate, regulate and monitor partnership arrangement." In most cities of the developing world, solid waste management is the responsibility of the municipal government, but because service delivery is inefficient, initiating other strategies has been a common practice. The limitations to this strategy are weak incentives for efficient resource use because the operators lack authority in accessing or collecting solid waste user charges. Such operators depend on the municipality to finance the majority of their operations. Solid waste management is generally accorded a low priority in collection coverage and has low percentage of local government budgets, low public awareness by the local councils, complete absence of professional management staff and poor management practices.

Therefore, government remains the most important partner in urban facilities management not only in the convectional of approaches but also in the participatory management practices. The convectional public management of waste is seen by Kant and Berry (2001) to be the most efficient irrespective of the nature of the waste to be managed or the socio-economic conditions of the people. However, emerging literature on solid waste management suggests that involvement of professional collector teams and resident organizations can prove effective in solid waste management rather than the public institutions only.

2.4.2 The Formal Private Sector

This sector involves the organized private sector partaking in waste management activities. This sector has access to financial resources more readily and the potential ability to operate more efficiently, (Schuttenbelt, *et al.,* 1994). The private sector is capable of playing a role in financing and providing certain infrastructural services that provides for and coordinate effective waste management strategies so as to safeguard the human living and working environment (Adebola, 2006). The privatization of certain infrastructure services is seen as the key to reform and the solution to urban infrastructure provision problems. Given their potential for lower production costs improved efficiency in service delivery and greater capacity to maintain capital equipments, private enterprises have advantages over governmental agencies.

Privatization of solid waste management is increasingly becoming attractive to governments in developing countries, where most municipal budgets go on waste management (Schubeler, 1996). The deficiency in private service delivery includes insufficient public awareness and little ability to generate the necessary public participation in planning, administering or monitoring, managerial deficiencies and weaknesses in local authorities that make it hard to carry out policy reform measures; and lack of experienced and competent personnel to administer and manage the privatization process. Although, private solid waste entrepreneurs work all over a city, most activity is concentrated in residential neighborhoods and biased towards middle and higher income household who can be relied upon to pay for services. Little or no private sector solid waste collection activity occurs in low income areas, due to inability to pay rather than lack of access to these areas. Large firms usually serve wealthy areas, while small firms generally serve a single, middle or lower-middle income neighborhood. Governments should therefore adopt an enabling approach to supporting private agents in enhancing equity. However, Cheema (1996) sees the need for a regulatory framework that protects the interest of the public, particularly the poor and that incorporates safety and environmental concerns.

2.4.3 Informal Private Sector

This sector consists of the individuals, families, groups and small enterprises that carry out unregistered and unregulated activities. The nature of their involvement in solid waste management makes it difficult to integrate. Many families make a living out of this sector which is made up of door to door collectors and “scavengers” at waste collection depots, traders and dealers in waste materials. The informal sector uses cheap well-trained laborers; they recover up to 30% of the total waste that is collected, through sorting and recycling activities. The activity of the sector can cause a lot of health and environmental problems during waste collection, sorting and recycling as those activities are done with bare hands and very primitive techniques. The informal private sector functions informally outside the formal framework (Rogerson, 2001). Therefore, partnership between the government and the community could improve the performance of the activities of the informal sector by recognizing, assisting and organizing these informal groups.

2.4.4 The Community Sector

This sector also known as the popular sector comprises the community and its representatives in the form of NGOs and CBOs. The existence of strong and vibrant civil organizations like NGOs and CBOs is a most crucial factor in effective popular participation and by extension, sustainable development (Cheema, 1996). The salient characteristics of these organizations are discussed below:

2.4.4.1 Non-Governmental Organizations NGOs

These are private, voluntary, non-profit making organizations that operate independent of national governments. They are composed of professionals and are known to provide support to community based development, serve as technical instruments between government and the people, advocate, create public awareness and generally serve as catalysts for development in collaboration with CBOs. The role of NGOs as partner organisations in waste management systems include serving as an umbrella organisation under which CBOs operate and acting as a channel for donor financing. As partner, NGOs can sometimes confer a degree of credibility and perspective on the informal sector in the eye of the municipality.

In recent times, NGOs have been criticized for doing little to build the capacity of the people they work with (Mitlin, 2001; Desai, 1995). Increasingly there is widespread recognition of difficulties in relations between NGOs and grassroots organisations than was once thought. NGOs have been known to impose their agendas on some of the local self – help organisation they work with. Another problem is the NGOs reliance on traditional and community leadership which use these contacts to reinforce their position (Desai, 1995).

2.4.4.2 Community Based Organizations CBOs

These normally take root from communities and most community initiatives are channelled through them. A CBO is usually an organization of people with common interests, activities and functions. Factors underlying the formation of such organizations usually include residential and social services. These organizations make up for their lack of sophistication and strong financial base through their creative energies. This group evolved naturally in response to the failure of the public sector to provide for the needs of the people (Stren and White, 1989).

The community and its representatives have direct interest in waste management, as residents, service users and tax payers. Because communities in the low-income areas generally receive marginal or no services in terms of public transport, electricity, drinking water, sanitation, drainage and also of waste removal, they sometimes take the initiative to organise CBOs with the direct goal of self-help and improving living conditions. Such CBOs may receive external assistance in the form of technical and or financial aid from different agencies.

CBOs mainly participate in primary waste collection systems, separation at source, and implementation of programmes. CBOs may also take a role in the actual provision of service, including operations and maintenance, and even in the construction of services. However, there are problems commonly associated with letting CBOs carryout local services. These are associated with the difficulties to grow and become formalized as part of partnership in urban administration (Rakodi, 1997).

2.5 MEASURES FOR PERFORMANCE ASSESSMENT

Solid waste management assessment is undertaken to measure performance of a scheme with the main aim of improving existing strategy and practices (Anschutz, 2004). The approach will be that of assessment of the institutional aspects of the solid waste management framework. The evaluation indicators as set by Schubeler et al (1996) is adopted to provide a general impression of the institutional structures, arrangements for solid waste management as well as organizational procedures and the capacity of responsible institutions.

2.5.1 Effectiveness

Schubeler, *et al.,* (1996) defined effectiveness in service outcome as the degree to which stated objectives are achieved. Stakeholders' direct or indirect involvement may result in a better match between what users want and what providers offer (Schubeler, 1996). Solid waste services are considered effective if there is safe removal of all the wastes generated. Effective solid waste collection produces health related, economic and environmental benefits, among others (Klundert and Anshutz, 1995).

For households, effectiveness is related to the extent to which service delivery corresponds to the real needs and demands of society. Solid waste management by stakeholders are considered effective if they increase access to, reliability and quantity of waste collection of all the waste generated and safe disposal of the waste.

2.5.2 Efficiency

According to Johnson (1994), efficiency is the measure of work achieved relative to the energy expanded. This physical concept has been appropriated for analysis of capitalist economies by relating the volume of output to input, usually measured in monetary terms.

This concept is applied to all productive and non-productive activities within a capitalist economy as a means of evaluating performance and providing targets for its improvement.

Project efficiency measures the relationship between a given output and its cost and inputs (Narayan, 1995). Also project efficiency might mean the achievement of a high performance by cost reduction, doing more with less (Schubeler, *et al.,* 1996). For solid waste management programmes by service providers, cost and inputs are very important for sustainability of actions.

Stakeholders' service is efficient when the cost of service provision in relation to collection is minimal and when the benefits of clean streets are balanced by all users paying a minimum level of cost to keep them that way. Thus, efficiency is related to the ability to implement a programme well. It is to achieve the desired result with the minimum use of resources, time and effort and thus measures the competence of the system.

2.6 GLOBAL BEST PRACTICES OF SOLID WASTE MANAGEMENT

Manila and Cairo are cities well known for their innovative programmes in waste management. Informal waste pickers in Cairo became organized by an NGO involved in urban environmental governance. Sponsor money and the idea came from the World Bank and the project resulted in waste recycling business and improved living conditions. The poor groups called Zabbaleen were already informally active in the field but became more organized and supposedly more pride of their situation, and this development intervention has served internationally as a model for developing cities.

In Germany, they adopted the end-of-pipe approach (EOP) in the management of solid and other environmental wastes. The strategy is called 'end-of-pipe' because it is base on the concept of reduce, reuse and recycle (3R). The objective of the strategy is; to reduce MSW generation; enhance MSW management (segregation, collection, transportation, and process in the final disposal) towards healthy & clean environment. The private operators are fully responsible for the collection, transportation, disposal and recycling activities while the government guide, regulate and monitor the activities. The residents separate and reduce trash at source and sell the recyclable materials to agents of the operators.

In Pakistan, city workers and managers were frustrated by the fact that the household waste containers were never placed on the street in the right place for the collection. No amount of punitive enforcement or discussions seemed to fix the problem, until a local NGO with a gender focus thought of asking the women about their opinions. It turned out that the women were in a double bind: the men in the family refused to take the trash out themselves, claiming it was a dirty job and therefore the job of the women. But the women were in purdah and were not permitted to leave their household compounds or have contact with men, so taking the trash to the designated corner was forbidden to them. The NGO worked with the households and together they came up with a solution: children would take the trash to the corner: either children from the household or street children who would receive nominal payment. Women were permitted to talk with children, so this was no problem. Until a deep cultural and social analysis was performed, no amount of money or equipment could solve the problem.

The Municipal Corporation of Greater Mumbai (MCGM) has adopted innovative mechanisms for waste collection in slum areas – such as the Slum Adoption Scheme – wherein local community-based organizations (CBOs) are registered and provided a monthly honorarium of Rs 2500 per 1000 population for waste collection and cleaning of small *nallahs* and drains in identified slum areas. The amount of honorarium was reduced to Rs 1800 in the second year and to Rs 370 in the third year. The concept of this scheme is to encourage the community to own up local initiatives in planning and execution at the grass-roots level. As of now, the MCGM has registered about 249 such CBOs, covering about 4.8 million of slum population, and intends to cover 100% of the slums under this scheme by 2006/07.

Another scheme being implemented is the Advance Locality Management (ALM) system, which entails extensive interaction and involvement of the MCGM with local neighborhood groups in the wards. At present, there are about 584 such ALM street committees in the 24 wards of the city, focusing on 'zero' garbage. The focus is on reduction of waste, storage, and disposal, involving rag pickers for collection and disposal of solid waste.

Bangalore's residential waste generation is estimated at 363 gm per capita per day. The city has entered into two kinds of service contracts— one for primary waste collection from the doorstep and transportation to the disposal site through small contractors and another for integrated treatment and disposal of waste through payment of tipping fees to expert agencies. In the first kind of arrangement, 66% of the city has been divided into 61 groups, and contracts are given for primary waste collection in waste tricycles/handcarts and direct transfer to a vehicle (owned by the contractor) and transportation to the disposal site. Each contractor manages two or three health wards of the city at the most. With this arrangement, the ULB is now spending 50% of what it would cost to undertake the task departmentally. In another contract for the treatment and disposal of 1000 tonnes of waste per day, land and solid waste is to be given by the Bangalore Municipal Corporation (BMC) to the private operator, who is expected to make an investment of about Rs 250–300 million to set up the facility. The corporation is not expected to pay for waste treatment, but a tipping fee of Rs 195 per tonnes of rejects has been agreed upon.

Furthermore, sustainable waste management systems are frequently beyond the reach of a developing country's municipal government acting alone. The examples given reinforce the conclusions that the various actors as defined in the previous section already play an extensive role in solid waste management. Neither the municipalities, nor the formal and informal private sectors, NGOs and the community can solve the waste problems alone (Ukoje, 2011).

The most successful initiatives occur where a mixture of public, private and community involvement has come to being, either through evolution or by deliberate design. The intervention of a NGO or CBO can often facilitate the development of partnership which the partners themselves could not manage to arrange. These types of organization can thus have a crucial role in catalyzing partnership or institutionalization of formal sector activities. An important aspect of forming partnerships is the recognition that some form of external stimulus, generally a combination of initiatives from NGOs, local consultancy firms, or universities, is necessary for informal sector activities to achieve formal recognition by the municipality. Left to themselves, low-income groups are unlikely to initiate seeking recognition or institutionalization of their activities with informal waste management structures (Ukoje, 2011).

2.7 OVERVIEW OF SOLID WASTE MANAGEMENT IN NIGERIA

Waste management is a growing public concern in Nigeria. In many cities of the country, waste management is poor and solid wastes are dumped along roadsides and into open areas, endangering health and attracting vermin. In Nigeria, there is a steady increase in waste quantity and variety due to population growth and industrialisation (Imam *et al*., 2007) while the basic solid waste management system based on collection, transportation and disposal remains highly inefficient and ineffective, especially in the urban centres (Ayotamuno and Gobo, 2004). Nigeria is the most populous and the tenth largest country in Africa with a population of over a hundred and fifty million people across a landmass of 923,768 square kilometres (WDI, 2010).

Statistics show that the population growth rate of Nigeria as at 1991 was 3.0% and an urban growth rate of about 5.5% per annum, while the average waste generation rate is put at 0.49 kg per day. Urban centers in Nigeria has also witnessed a steady rise in waste generation due to urbanization and increase in population, for instance Abuja the nation's capital generates between 0.55-0.58 kg of waste per person per day, and Lagos state one of the most populous cities in the world generated 4 million tons of waste in 1995 and by year 2000, the quantity of municipal solid waste generated in Lagos metropolis alone was estimated to have increased to 998, 081 tons while Minna the Niger state capital generates about 90 tons of solid waste per day among others. These have put enormous pressure on the ability of the public sector to collect all the wastes generated.

Currently, the level of solid waste collected in Nigerian cities averages between 30-50 percent of waste quantities generated (UNSN, 2001). As a result, a large proportion of the solid waste generated remains uncollected. Large parts of the cities, particularly, the low income areas receive little or no attention of the public sector. The fundamental deficiency of the solid waste management is attributed to government's failure to assume basic responsibility in raising sufficient funds to provide acceptable levels service (Onibokun and Kumuyi, 1999; Ajadike, 2001). While all the waste generated in developed countries are collected, in the developing countries, most of the waste produced are not collected (Cointreau, 2006). For cities to be relatively clean, at least 75 percent of the waste should be collected (UNDP, 2005).

2.7.1 Environmental Legislation in Nigeria

Nigeria operates a three tiers system of government made up of federal, state and local government with distinct functions accorded to each tier based on constitution (Afon, 2007). The milestone Federal legislation on environmental protection in Nigeria was the decree 58 of 1988, which established the Federal Environmental

Protection Agency (FEPA) to control the growing problem of waste management and pollution in Nigeria (Walling *et al*., 2004; Imam *et al*., 2008). Solid waste management is constitutionally the responsibility of the local government but the state government steps in to complement their efforts especially in state capitals such as Kaduna, Lagos and Port-Harcourt (Afon, 2007). Despite their effort, the solid waste management scheme in Nigeria is characterized by a system fraught with lack of accountability and refuse filled spaces, drains and roads (Dauda and Osita, 2003; Walling *et al*., 2004).

Environment legislation in Nigeria can be viewed broadly under two time-related categories. First, is the legal regime, which existed in the years, preceding 1988? The other consists of particular legislation, consequent guidelines and standards, and regulation introduced since the creation of the Federal Environmental Agency by Decree No. 58 of 1988. By Decree 58 of 1988, the Federal Government created the Federal Environmental Agency (FEPA). Decree 58 of 1988 was amended by FEPA (Amendment) Decree No. 59 of 1992. This legislation vests in FEPA overall responsibility for the protection and development of the environment, biodiversity conservation and sustainable development of Nigerian's natural resources in general and environmental technology, including initiation of policy related to environmental research and technology, among other function. (S.4 Decree No. 59 1992)

The Federal Ministry of Environment administers and enforces environmental laws in Nigeria. It took over this function in 1999 from the Federal Environmental Protection Agency (FEPA), which was created under the FEPA Act.

Pursuant to the FEPA Act, each state and local government in the country set up its own environmental protection body for the protection and improvement of the environment within its jurisdiction. Municipal solid waste management is a major responsibility of state and local government environmental agencies. The agencies are charged with the responsibility of handling, employing and disposing of solid waste generated. The state agencies generate fund from subvention from state governments and internally generated revenue through sanitary levy and stringent regulations with heavy penalties for offenders of illegal dumping and littering of refuse along streets (Ogwueleka, 2003).

Solid waste management has emerged as one of the greatest challenges facing state and local government environmental protection agencies in Nigeria. The volume of solid waste being generated continues to increase at a faster rate than the ability of the agencies to improve on the financial and technical resources needed to parallel this growth. Ogwueleka (2009) observed that solid waste management in Nigeria is characterized by inefficient collection methods, insufficient coverage of the collection system and improper disposal while Babayemi and Dauda (2009) decried the complete lack of efficient and modern technology for the management of waste. A brief review of waste handling practices in Nigeria is given below:

2.7.2 Solid Waste Generation and Composition

The generation and disposal of household solid waste have become an increasing problem in urban areas due to increasing population, high density, urbanization, industrialization, the inefficiency of the collecting systems, and lack of political will on the part of the government. The estimated waste generated per person in a day is 0.49 kg with households accounting for 90% of the urban waste (Solomon *et al*., 2009). It has a high organic content consistent with waste generated in developing countries such as Ghana, China and Jordan and Palestine (Qdais, 2007; Al Khatib *et al*., 2010; Zhang *et al.,* 2010; Fobil *et al*., 2010). The composition of waste in Nigeria suggests a recyclable content of over forty percent with recycling rate estimated at 8-22%, carried out by the informal sector (Wilson *et al.,* 2009).

Furthermore, cities in Nigeria, being among the fast growing cities in the world (Onibokun and Kumuyi, 1996) are faced with the problem of solid waste generation. The implication is serious when a country is growing rapidly and the wastes are not efficiently managed. Waste generation scenario in Nigeria has been of great concern both globally and locally. Of the different categories of wastes being generated, solid wastes had posed a hydra-headed problem beyond the cope of various solid waste management systems in Nigeria (Geoffrey, 2005), as the streets experience continual presence of solid waste from household activities. Various researchers have undertaken to study solid waste generation pattern in Nigeria, but most of the studies are usually a case study of a particular state or locality in Nigeria; and it seems the awareness about solid waste generation in several other cities are obscured.

The quantity of solid waste generated in urban areas in industrialized countries is higher than in developing countries; still municipal solid waste management remains inadequate in the latter. Solid waste in developing countries differs from developed countries. Most developing countries, Nigeria, inclusive have solid waste management problems different from those found in industrialized countries in areas of composition, density, political, and economic framework, waste amount, access to waste for collection, awareness and attitude. The wastes are heavier, wetter and more corrosive in developing cities than developed cities.

The waste generation rates ranged from 0.66 kg/cap/d in urban areas to 0.44 kg/cap/d in rural areas as opposed to 0.7-1.8 kg/cap/day in developed countries (Cointreau, 1982). The waste generation rate is typical of low income towns. The rate of waste generation is highly influenced by the population income. In Nigeria 25 million tonnes of municipal solid waste are generated annually. Waste densities and moisture are much higher in developing countries which require different technology and management systems (Cointreau *et al*., 1984). The density of solid waste in Nigeria ranged from 250 kg/m_3 to 370 kg/m_3 higher than solid waste densities found in developed countries. Density defines the number of capacity of waste storage and collection facilities required. High density reduces the effectiveness of compaction vehicles for waste transfer.

2.7.3 Temporary Storage

Waste is temporarily stored without separation at the point of generation within households or at communal disposal sites in urban cities in Nigeria. It is a key aspect of the management strategy as it determines to a large extent the efficiency and effectiveness of collection. Within and around households, waste is stored in various sizes of bins and bin bags by the more affluent population and in used baskets and buckets by the less affluent (Abdullahi *et al*., 2008). Unlike Abuja, the capital city in Nigeria, most environmental agencies have not made provision or specified collection containers (Imam *et al*., 2008).

More than 50% of the population in the cities uses communal disposal sites as temporary storage. Waste is transferred from point of generation to these sites situated within each area by household members or contracted private collectors (Dauda and Osita, 2003). The communal disposal sites are open dumps characterized by uncontrolled emissions, presence of rodents and strong odour.

2.7.4 Waste Collection and Transportation

In developing countries, local authorities spend 77-95% of their revenue on collection and the balance on disposal (Ogwueleka, 2003), but can only collect almost 50-70% of municipal solid waste (MSW). In the past, the focus has been on the technical aspects of different means of collection and disposal (World Bank, 1992), but recently, attention has been on enhancing institutional arrangement to service delivery, with a special emphasis on privatization (Cointreau, 1994). Nigeria is presently experimenting with the privatization of this sector. The Federal Government has instituted National Integrated Municipal Solid Waste Management Intervention Programme in seven cities of Nigeria. The seven cities are Maiduguri, Kano, Kaduna, Onitsha, Uyo, Ota, and Lagos. Lagos state government established municipal solid waste management policy to encompass private sector participation in waste collection and transfer to designated landfill sites.

Collection and transport involves both separate or co-mingled collection of solid waste and recyclables; and the transportation to processing and disposal facilities. Collection covers the emptying of bins or/and bin bags within or around the settlement area; and transport refers to the haulage of the collected waste to the disposal facility or treatment plant (Den Boer *et al*., 2007). Collection is carried out in various ways in different areas in Nigeria. This includes direct collection by the state or local government or indirect collection by appointed private contractors and/or informal waste managers for a fee. The various ways include:

- Kerbside collection – waste is collected from kerbs of households, where the households are responsible for bringing out the waste to the kerbsides on or before collection days (Abdullahi *et al*., 2008; Imam *et al*., 2008; Agunwamba, 1998).

- Receptacle or communal centre collection – The communal centre is usually an open space of shallow trench where waste is dumped directly on the ground or in a few cases equipped with large bins into which the waste is discharged and eventually collected (Imam *et al*., 2008; Dauda and Osita 2003).
- Door-to- door or house-to-house pick up – The waste is kept temporarily within the properties concerned and generally collected from within the premises on a contract basis between householders and private organisations (Abdullahi *et al*., 2008; Sangodoyin 1993).

Waste is typically transported by Lorries, tippers, loaders, trucks and tractors by formal sector (Dauda and Osita, 2003; Imam *et al*., 2008) and using hand pushed carts and wheel barrows by the informal sector.

2.7.5 Resource Recovery and Recycling

The composition of waste in Nigeria suggests a recyclable content of over 40% despite the high decomposable fraction. Recycling rate is estimated at 8-22% of total waste with paper contributing 5-15%, metal 10-40%, and plastics and glass 20-40% and 25-70% respectively (Wilson *et al*., 2009).

Resource recovery and recycling implemented in Nigeria is quite significant and compares well with many developed countries (Wilson *et al*., 2009). It is mainly carried out by the informal sector and data is generally scarce and difficult to generate (Wilson *et al*., 2009) as the sector is basically unregistered and unregulated and characterised with lack of planning, implementation and performance measurement and their appropriate documentation (Ogu, 2000).

The waste reduction and recycling activities carried out by the informal sector includes door to door itinerant buying of paper, metals, glass and plastics directly from source (Wilson *et al*., 2009) and scavenging from waste containers, communal dumps and final disposal sites (Kofoworola, 2007). Itinerant buyers like waste pickers use waste items directly and/or sell to middle men or recycling companies (Wilson *et al*., 2009).

2.7.6 Waste Treatment and Disposal

Waste management is a critical issue worldwide. Open, unregulated dumps are still the predominant methods of waste disposal in most developing countries. The waste disposal option in Nigerian cities is predominantly open dumping followed closely by open burning (Osita and Dauda, 2003; Ogwueleka, 2009). Other disposal options are open dumping, open burning and composting (Dauda and Osita, 2003; Imam *et al.,* 2008; Ogwueleka, 2009). The formal treatment of waste on the disposal site is usually open burning to reduce the quantity (Imam *et al*., 2008).

From the review of the literature above, it is important to note that 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) for managing solid waste. But in Nigeria open dump sites and landfills are mainly used for final waste disposal. Also, there are two main modes of solid waste collection system in Nigeria 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 the Local Governments (Felix, 2010). However, the Gombe State Environmental Protection Agency (GOSEPA) is challenged by factors such as inadequate funds to support waste management, inadequate equipment to support waste storage, collection and disposal, low collection coverage services. This forms the basis of the conceptual framework of the study that focuses on these key issues, namely: primary waste collection method and final disposal, and the integrated solid waste management concept. Household solid waste management is the focus of the framework.

Therefore, in the solid waste management stream, the issues been considered are: the integrated waste management options (segregation, incineration, composting and landfill) and the role stakeholders play (State government/GOSEPA, CBOs, NGOs, formal and informal private operators and the waste generators - the households) in managing solid waste. It is important to recognise that, the major portion of solid waste comes from domestic sources. However its proper collection and disposal depends heavily on the availability of good household/communal dustbins and attitudes of the people. The waste that is disposed off from the households has to be collected and transported for final disposal, then it is segregated, composted, incinerated or land filled. The collection and transportation depends heavily on equipments and funds, which if readily available to the stakeholders, there will be effective solid waste management.

2.8 SOLID WASTE MANAGEMENT IN GOMBE

Gombe state was created out of the then Bauchi state on 1st October 1991 with its headquarters situated in Gombe. The town has an area of 52km^2 and a population of 266,844 persons according to 2006 population census (NPC, 2006), today the population is projected to be 399,531 persons using 3.2% growth rate (National Population Commission).The rise in the population levels also brought about with it rapid economic growth and consequently the rise in the living standards of the people. Wastes and other contaminants from residential and other land uses in Gombe town are highly visible.

Over the years, solid waste disposal has become a major problem in the town. Therefore, indiscriminate dumping, irregular collection of waste generated and inadequate resources are the key problems facing solid waste management in Gombe. In Gombe, the authorities entrusted with the task of collection of waste generated per day, collects less than half of the waste generated in many part of the town. This leaves a backlog of tones of waste uncollected a day. This has resulted in littering, heaping of waste and overflowing of skips with waste in the town most especially in the low income neighborhoods and peri urban areas such as Ajiya, Bajoga, Bolari, Dawaki, Kagarawal and Shamaki, etc.

2.8.1 Categories of Solid Waste Generation in Gombe

With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly particularly in developing countries and its composition changing. In Gombe the following types of wastes and trash are generated. The biodegradable includes food and kitchen waste such as meat trimmings, vegetable peelings, papers, etc and the non-biodegradable items such as glass, tin, plastic bottles, other plastics etc. These particular wastes are common in the residential areas.

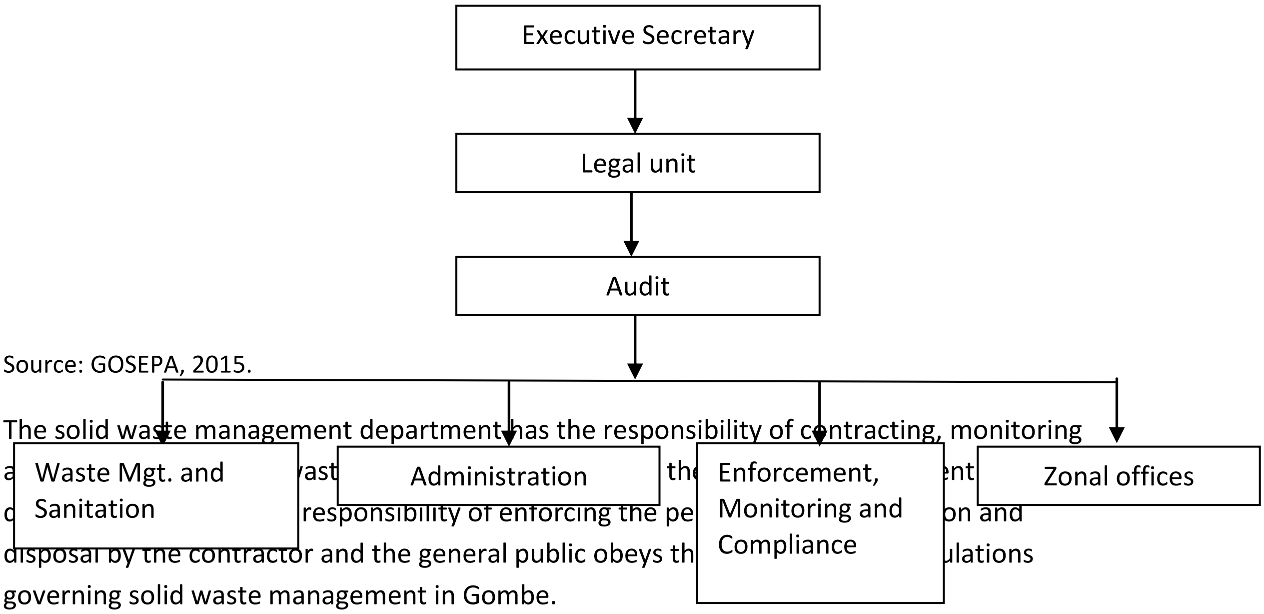
2.8.2 Administrative Framework

Waste management in Gombe town is been handled by both formal and informal sectors. The trend of solid waste management has been administered at different levels of government by different establishments, agencies and parastatals as follows;

Gombe State Ministry of Environment: - Through GOSEPA is primarily in charge of setting up guidelines for solid waste management in the state, environmental quality standards and related penalties and fines, and ensuring compliance for pollution control. It is also responsible for the overall policy formulation, implementation, monitoring, inspection and prosecution of defaulters of all environmental offences throughout the state.

Gombe State Environmental Protection Agency (GOSEPA):- Established by edict No. 3 of 1997 and came into force on 10th June, 1997 to take over and replace the activities of the defunct task force on Environmental Sanitation. Till date, GOSEPA holds the responsibility of solid waste management in the state. But with increase in complexity and volume of waste generation and to improve the sanitation condition in the state, the Gombe state government entered into public-private partnership based on contract with Inex Cleaners Limited. The partnership is on collection, transportation and disposal of the solid waste generated in the town.

Figure 2.2: Administrative framework for Gombe State Environmental Protection Agency (GOSEPA)



Source: GOSEPA, 2015.

The solid waste management department has the responsibility of contracting, monitoring a[illegible] wast[illegible] the[illegible] ent[illegible] d[illegible] responsibility of enforcing the pe[illegible] on and disposal by the contractor and the general public obeys th[illegible] ulations governing solid waste management in Gombe.

Gombe Local Government Council: - Created 1976 by Decree No. 1 of 1976 refuse management is a statutory function assigned to it by the 1979 and 1989 constitution of the Federal Republic of Nigeria Decree No. 12 of 1989, under its primary health care department.

The Community Based Organizations (CBOs):- Carried out sanitation services at monthly intervals and usually involve evacuation of waste block and public drains evacuation.

Informal Private Operators: - Unregistered operates within the low and medium density areas like the G.R.A and Federal lowcost. Collection of waste by these operators depends on the income of the owner of the waste to be able to pay the amount charged.

In Gombe, waste collection is carried out by both public and private sectors, although the effectiveness of this is largely a function of location; and where the collection is done by private sectors, it is a function of income of the owner of the waste to be able to pay the amount charged. The system adopted by the agency is the public bin collection system. This comprises of the collection from different residential areas and deposited in the public bins located strategically along street corners of the town.

2.8.3 Stakeholders Involved in Solid Waste Management in Gombe

Solid waste management is a complex task, which depends as much upon organization and cooperation between numerous public and private sector actors as it does upon appropriate technical solutions. Thus, a wide range of individuals, groups and organizations are concerned with SWM as service users, service providers, intermediaries and/or regulators.

According to Bernstein (2004), a stakeholder in solid waste management is a person or an organization that have an interest or a stake (Bernstein, 2004; Klundert and Anschutz, 2001) stakeholder in solid waste management differs for every city. However, Klundert and Lardinios (1995) identified main stakeholders in solid waste management in developing countries to include: National Government, Municipal Governments, the formal private sector, informal private sector, CBO_S, NGO_S, individuals and households.

The stakeholders involved at Federal level include National Environmental Standards and Regulations Enforcement Agency (NESREA), Federal Ministry of Environment (FMOE), Federal Ministry of Environment, Housing and Urban Development (FMEHUD) and at the state level Gombe State Environmental Protection Agency (GOSEPA), Gombe State Ministry of Environment and Gombe Local Government.

The Community Based Organizations (CBOs), service users (Households), the formal private contractor like Inex Cleaners Limited and the informal private operators also partake in solid waste management.

2.9 SUMMARY

This chapter describes the conceptual framework, processes and strategies of solid waste management. It also focused on solid waste management which resolves around developed and developing countries with particular reference to Nigeria. This covers best practices and models that promote waste reduction, reuse and recycling activities.

This chapter further examined the household solid waste management in Gombe and the role of agencies responsible for its management.

The management of waste in Gombe is carried out by the Gombe State Environmental Protection Agency, (GOSEPA) as well as the Ministry of Environment in conjunction with Gombe Local Government and the Private Contractors. However; these agencies have been overwhelmed by the increasing rate of waste generation, collection and disposal problems due largely to over stretched facilities, shortages of manpower and lean budget. Therefore, successful solid waste management will require a holistic program that will integrate all the technical, economic, social, cultural, and psychological factors that are often ignored in solid waste programs.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

Certain key issues were identified in relation to the objectives of the study which are relevant to the study of solid waste management. These issues are: availability of waste management facilities, household waste disposal, waste collection and final disposal as well as capacity of waste management authorities in managing solid waste in Gombe. Based on these, an appropriate methodology was developed to collect relevant data.

3.2 DATA REQUIRED AND SOURCES

The types, sources, as well as methods of collection of various data needed for the study are presented below in this section;

3.2.1 Types of Data

The types of data to be obtained include the institutional framework, processes and strategies of solid waste management in Gombe, Base map of Gombe, solid waste generation, storage, collection and disposal, socio-economic characteristics of the population, profile of agencies and location of dump sites in the study area.

3.2.2 Sources of Data

Data were sourced from the management staff of various agencies, such as GOSEPA, Ministry of Environment, Gombe Local Government, formal private contractor especially Inex Cleaners Limited, and the informal private operators that are operating in low and medium density residential areas, CBOs, household heads, waste collectors and Google map.

3.2.3 Methods of Data Collection

Secondary data were obtained from the library and internet sources. To review existing literature; the researcher sourced for material in order to provide framework, interviews schedules and as a guide for field surveys.

Primary data were obtained from household heads, field surveys and oral interviews with Gombe State Environmental Protection Agency (GOSEPA) staff, Inex Cleaners Limited, Informal private operators, CBOs and waste collectors etc.

3.3 PRIMARY DATA COLLECTION

At this stage, preliminary field visits were made, followed by the administration of questionnaires, and oral interviews were conducted to elicit information from respondents.

3.3.1 Preliminary Field Visit

A preliminary field visit was carried out to collect data on the existing waste management system and socio-economic characteristics of the households and other agencies involved in solid waste management. The field observation involved scouting through the study area to assess waste primary generation and disposal, collection and transportation, sorting, treatment and final disposal; activities of GOSEPA staff, Inex Cleaners Limited and Informal Private Operators. During this process, pictures were taken of heaps of solid waste dumped at various corners of the study area which is included in the report of analysis of data. The field survey involved physical observation and map presentation.

3.3.2 Questionnaire administration

The spatial and socio-economic characteristic of the households in the study area was investigated. Therefore, household data were collected through questionnaire administration. The data that were collected include types of solid waste generated, place of disposal, availability of bins for storing waste, mode of collection and payment for collection, distances covered to dispose of waste, waste separation practices and the risk of improper waste management etc.

3.3.3 Interviews

Oral interview were conducted to assess performance of the existing waste management system with GOSEPA staff and Inex cleaners limited. Data on policies, institutional capacity, financing mechanism, technology and stakeholders' participation were collected.

Information was also gathered through personal interview with the informal private operators, operating in high and medium income neighborhoods of Gombe. Also, the informal waste collectors like the scavengers, rag pickers and the wheel barrow boys, CBOs were interviewed.

3.4 SECONDARY DATA COLLECTION

This covers the review of relevant literature on the concept, processes and strategies of solid waste management, best practices and models that promote waste reduction, reuse and recycling activities in Gombe. The secondary data include, project reports and documents, survey reports, internet source, maps, population etc.

3.5 SAMPLING FRAME

The Gombe urban area is divided into wards based on political and socio-economic considerations. In order to achieve spatial spread in the data collection simple random sampling method was adopted. Four wards out of the total number of eleven wards in Gombe urban area were selected on the basis of density that is Low, Medium and High. The selection was based on the spatial variation of the population across the Gombe urban area. Government Reservation Area (G.R.A) is marked out as a low density residential area that accommodates the high income earners; Federal lowcost is marked out as a medium density residential area that accommodates the medium income earners while Ajiya and Kagarawal wards form the center of the traditional setting and peri urban area of Gombe is marked out as a high density residential areas that accommodates the low income earners.

Table 3.1: Selected wards based on density

No.	Wards	Density	No. of Houses
1.	G.R.A	Low	455
2.	Federal lowcost	Medium	1213
3.	Ajiya	High	1177
4.	Kagarawal	High	2692

Source: PHC Unit of Gombe L.G & (Authors) 2015.

These four wards adequately represent the various socio-economic groups obtainable in Gombe; and reliable and valid conclusions can be reached from data obtained from these wards.

3.5.1 Sample Size

A total of two hundred (200) structured questionnaires were administered on household heads in the selected wards. The sample size was distributed such that equal number of households is taken from all the selected wards. The selection of equal number of households was to provide a manageable number of samples and a uniform spread throughout. This is more so as to reduce costs, simplify management and control of the quality of the interviews. Therefore, the sample size was kept within reasonable limits.

3.5.2 Sampling Technique

In selecting respondents, a combination of simple random sampling and systematic random sampling method were employed. Random sampling was used to select wards based on density while systematic random sampling was used to select household heads. The criteria used for selecting wards are to allow for complete coverage of the Low, Medium and High density residential areas and the rate of waste generation.

G.R.A, Federal lowcost, Ajiya and Kagarawal are the sampled areas where the questionnaires were distributed. Fifty (50) questionnaires were administered to household heads in each of the neighborhoods at interval of five. After every five houses, a house was selected for questionnaire administration until the fifty household heads are obtained. Four field assistants (one from each ward) were trained to administer the questionnaires.

The selection of interviewees was basically purposive sampling (Tongco, 2007) as specific key informants were targeted. Key informants are individuals who because of their position or experience have a greater knowledge of what is being investigated than the average person (Streiner, 2013). Therefore, interviews were conducted with key staff of GOSEPA, Inex Cleaners Limited, Gombe Local Government, and individual informal private collectors and CBOs. The directors of Waste Management and Sanitation Department, GOSEPA and Primary Health Department of Gombe Local Government, two representatives of Inex Cleaners Limited, three chairmen of CBOs, forty- eight informal waste collectors were interviewed.

3.6 Method of Data Analysis

Analysis of the data that were collected was done using descriptive statistical tools to generate percentages, frequency tables and mean scores. The frequency table is used to show the distribution of the variables across households and neighborhoods. Descriptive statistics using frequency tables show the level of generation and volume of waste in relation to population densities across the Gombe urban area. Data were presented using charts, tables, and plates. Measures for performance assessment were also used to assess the solid waste management system and the agencies responsible for its management.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

In this chapter the spatial distribution of population and the socio-economic characteristics of households in the study area were examined. Also, the assessment of household solid waste management practices and the role of agencies responsible for its management in Gombe were analysed and discussed.

4.2 SOCIO-ECONOMIC CHARACTERISTICS OF HOUSEHOLDS IN GOMBE

4.2.1 Educational level of Respondents

The survey revealed that about 30% of the household heads have been educated beyond secondary school level, whereas 23% and 20% of the household heads have been educated to secondary and primary school levels respectively. About 27% of the household heads have attained other levels of education as the only form of education.

Table 4.1: Educational level of Household heads

Level of Education	G.R.A		Federal Lowcost		Ajiya		Kagarawal		Total	Percentage
	N	%	N	%	N	%	N	%	N	%
Tertiary	30	60	23	46	4	8	3	6	60	30
Secondary	14	28	15	30	9	18	8	16	46	23
Primary	4	8	8	16	14	28	14	28	40	20
Other	2	4	4	8	23	46	25	50	54	27
Total	50	100	50	100	50	100	50	100	200	100

Source: Field survey, 2015.

The above table shows that educational levels have influence on waste management. The higher the level of education one attained, the more conscious one is toward proper waste management. At the high and medium income neighborhoods such as G.R.A and Federal lowcost, majority of the household heads about 60% and 46% have been educated up to tertiary education than the low income neighborhoods. This shows that the residents of the high and medium income neighborhoods can easily accept changes and awareness on proper waste management than the residents of the low income neighborhoods.

4.2.2 Occupation of Respondents

With regards to the occupational structure, the survey revealed that about 38% of the household heads are majority civil servants, while about 32% and 20% of the household heads are engage in business and farming respectively. About 10% are unemployed as shown in figure 4.1.

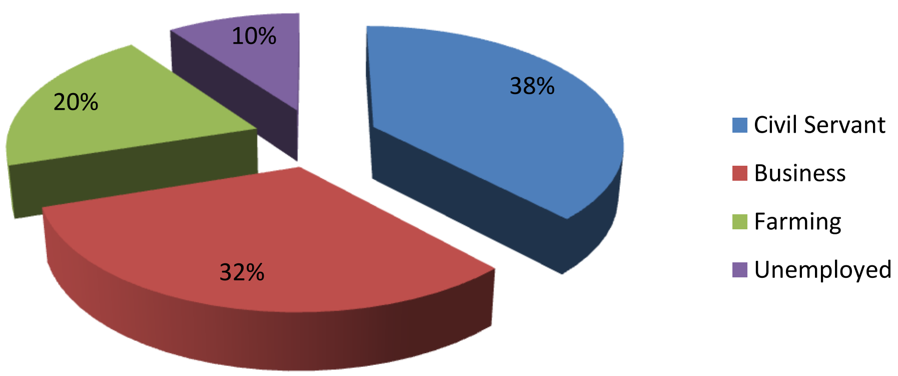


Figure 4.1: Occupation of household heads

Source: Field survey, 2015.

The study revealed that the occupational pattern of the households in the study area have influence on the rate of waste generation and composition as the high and medium income neighborhoods, who are majority civil servants generate more waste such as food and paper wastes than the low income neighborhoods who are majority farmers and traders (Table 4.5).

4.2.3 Monthly Income of Respondents

Generally, majority of the household heads earn less than N5, 000 monthly representing about 38.5%, while about 36.5% of the household heads earn between N5, 100 to N20, 000 monthly. About 25% of the household heads earn more than N20, 000 and above monthly.

Table 4.2: Monthly Income of Household heads

Monthly Income	G.R.A		Federal Lowcost		Ajiya		Kagarawal		Total	Percentage
	N	%	N	%	N	%	N	%	N	%
< 5000	2	4	3	6	36	72	36	72	77	38.5
5,100-20,000	12	24	39	78	12	24	10	20	73	36.5
>20,000	36	72	8	16	2	4	4	8	50	25
Total	50	100	50	100	50	100	50	100	200	100

Source: Field survey, 2015.

However, there are variations within the neighborhoods. Ajiya and Kagarawal neighborhoods have majority of their residents earning less than N5, 000, while G.R.A and Federal Lowcost neighborhoods earn between N5, 100 to N20, 000 and above. This shows that residents of the high and medium income neighborhoods can afford to pay for commercial waste collection services than the low income neighborhoods. Also, income level have influence on the rate of waste generation that is the higher the income of the residents, the more they consume and the more they generate (Table 4.4).

4.2.4 Households Size of Respondents

About 47.5% of the household heads surveyed have more than 7 people, while 40% of the household heads are made up of 4-6 people, the remaining 12.5% consist of 1-3 people as shown in table 4.3.

Table 4.3: Households family size

Households size	G.R.A		Federal Lowcost		Ajiya		Kagarawal		Total	Percentage
	N	%	N	%	N	%	N	%	N	%
1-3	15	30	5	10	3	6	2	4	25	12.5
4-6	30	60	26	52	13	26	11	22	80	40
Above 7	5	10	19	38	34	68	37	74	95	47.5
Total	50	100	50	100	50	100	50	100	200	100

Source: Field survey, 2015.

Ajiya and Kagarawal neighborhoods have more than 60% of their households with 7 people and above, while G.R.A and Federal Lowcost have 60% and 52% of their households with 4-6 people. The different population densities have influence on the waste generation, collection and disposal in the study area. This shows that Kagarawal neighborhood, with the highest population has the highest generation of waste (Table 4.4). Also, there are no designated collection points and disposal is done openly on available spaces (Plate 1).

4.3 WASTE MANAGEMENT PRACTICES AT HOUSEHOLDS LEVEL

4.3.1 Waste Generation by the Households

The survey revealed that the average waste generation by the households in Gombe is 0.27kg per capita per day with 0.26kg in the low income neighborhoods, 0.28kg in the medium income neighborhoods and 0.29kg in the high income neighborhoods, as shown in table 4.4. Using the average per capita rate of waste generation for the wards, the daily and annual volumes of domestic waste generation is about 11,820.24kg and 4,314,387.6 respectively (Table 4.4). Waste generation is higher in the high and medium income neighborhoods. This may be due to the high income level of the residents which makes it quite possible for them to purchase more items than the residents of the low income neighborhoods.

Table 4.4: Rate of waste generation by Households – per capita

Wards	Per capita kg/Day	Population	Daily Generation (kg)	Annual Generation (kg)
G.R.A	0.29	3,640	1,055.6	385,294

Federal Lowcost	0.28	9,704	2,717.12	991,748.8
Ajiya	0.26	9,416	2,448.16	893,578.4
Kagarawal	0.26	21,536	5,599.36	2,043,766.4
Total	0.27	44,296	11,820.24	4,314,387.6

Source: GOSEPA & Field Survey, 2015.

The average rate of waste generation for Nigerian cities is 0.45kg per capita per day (UDBN, 1999). The highest rate of 0.77kg per capita per day is recorded for Asaba while the lowest rate of 0.25kg per capita per day is for Jos (NEST, 1991). Therefore, the average rate of waste generation in Gombe is 0.27kg per capita per day.

Table 4.5: Types of waste generated by households/day

Types of waste Generated	G.R.A		Federal Lowcost		Ajiya		Kagarawal		Total	Percentage
	N	%	N	%	N	%	N	%	N	%
Food waste	16	32	14	28	15	30	15	30	60	30
Paper waste	12	24	13	26	11	22	11	22	47	23.5
Bottles and Tins	11	22	12	24	10	20	10	20	43	21.5
Other waste	11	22	11	22	14	28	14	28	50	25
Total	50	100	50	100	50	100	50	100	200	100

Source: Field survey, 2015.

Table 4.5 reveals that in the low income neighborhoods, such as Ajiya and Kagarawal, food wastes and other wastes such as rags, rubbers, aluminium, polythene bags, leather wastes constitutes the largest components of solid waste generated by the residents. They constitute 30% and 28% respectively. Paper wastes constitute 22%, while bottles and tins waste amounted to only 20% of the total waste generated.

In the medium income neighborhoods such as Federal Lowcost, food wastes are the largest waste component constituting 28% of the total solid waste. This is followed by paper wastes with 26%. Bottles and tins waste constitute 24% while the category classified as others such as rags, rubbers, alminium, polythene bags, leather wastes constitutes 22%.

In the high income neighborhoods such as Government Reservation Area (GRA), food wastes constitute 32% of total waste. This is followed by paper waste with 24%. The category classified as others such as rags, rubbers, alminium, polythene bags, leather wastes constitute 22% while bottles and tins constitutes 22%.

The result of the solid waste data reveals that there is a high percentage of food and paper generated as a waste resulting from the process of preparation as well as after consumption. The differences in the type of waste among the wards reflect the differences in standard of living and consumption pattern between the wards. It is therefore evident that most wastes generated in the study area are biodegradable. This agrees with the findings of Wolf (2004) that most wastes generated in growing cities of developing countries are biodegradable waste (food, paper etc).

4.3.2 Method of Waste Storage

The survey revealed that majority of the household heads representing 40% made used of open ground; 25% used polythene bags; 13% used baskets; 10% used drums while 8% and 4% made use of cartoons and sacks respectively as shown in table 4.6

Table 4.6: Method of Waste Storage by household heads

Storage facilities	G.R.A		Federal Lowcost		Ajiya		Kagarawal		Total	Percentage
	N	%	N	%	N	%	N	%	N	%
Drums	6	12	7	14	3	6	4	8	20	10
Polythene bags	23	46	22	44	3	6	2	4	50	25
Sack	1	2	2	4	2	4	3	6	8	4
Open ground	9	18	9	18	31	62	31	62	80	40
Basket	8	16	7	14	6	12	5	10	26	13
Cartoon	3	6	3	6	5	10	5	10	16	8
Total	50	100	50	100	50	100	50	100	200	100

Source: Field survey, 2015.

This shows that G.R.A and Federal lowcost neighborhoods 46% and 44% of their households use polythene bags. This may be as a result of the waste commercial services rendered by the formal and informal private operators that supplied storage materials for waste storage. While Ajiya and Kagarawal neighborhoods 62% of their households use open ground as their storage facilities.

4.3.3 Solid Waste Separation

The survey revealed that waste is temporarily stored without separation at the point of generation within households. This indicates that household heads do not find it feasible to separate their waste and as such, never tried waste separation before. In order to facilitate separation of waste, households are supposed to use different containers for biodegradable and non-biodegradable solid waste.

4.3.4 Waste Re-use

The practices of waste re-use revealed that about 37% of the household heads reused plastic bags; 34% of the household heads reused plastic bottles; while 29% of the household heads reused paper bags. These items were sold either to scavengers or directly to the industries and those who do not sell theirs at all either dumped them in the bin or reused them for other purposes. However, in the low income neighborhoods households pick out the valuable wastes for re-use and utilize one storage container for all types of solid waste.

4.3.5 Solid Waste Disposal by Households

The disposal of household solid waste is one of the functional elements in the management of waste. The survey revealed that about 39% of the household heads which constitutes a majority dumped their wastes in open space; 27% dispose of their waste in nearby drainage; 15% make use of vacant plot; 14.5% burn their wastes while the remaining 4.5% use the collection point as shown in table 4.7 below.

Table 4.7: Methods of Waste disposal by households

Waste disposal	G.R.A		Federal Lowcost		Ajiya		Kagarawal		Total	Percentage
	N	%	N	%	N	%	N	%	N	%
Vacant plot	9	18	6	12	7	14	8	16	30	15
Burning	8	16	8	16	6	12	7	14	29	14.5
Collection point	_	_	6	12	3	6	_	_	9	4.5
Drainage	14	28	11	22	14	28	15	30	54	27
Open space	19	38	19	38	20	40	20	40	78	39
Total	50	100	50	100	50	100	50	100	200	100

Source: Field survey, 2015.

The waste handling methods practiced in the study area revealed that household heads dispose of the waste mostly in open space, drainages and vacant plots, which contribute to poor sanitation, unsightly environment and clogging of storm water channels. Furthermore, burning of waste within neighborhoods causes' pollution, creates environmental and health hazards to the residents.

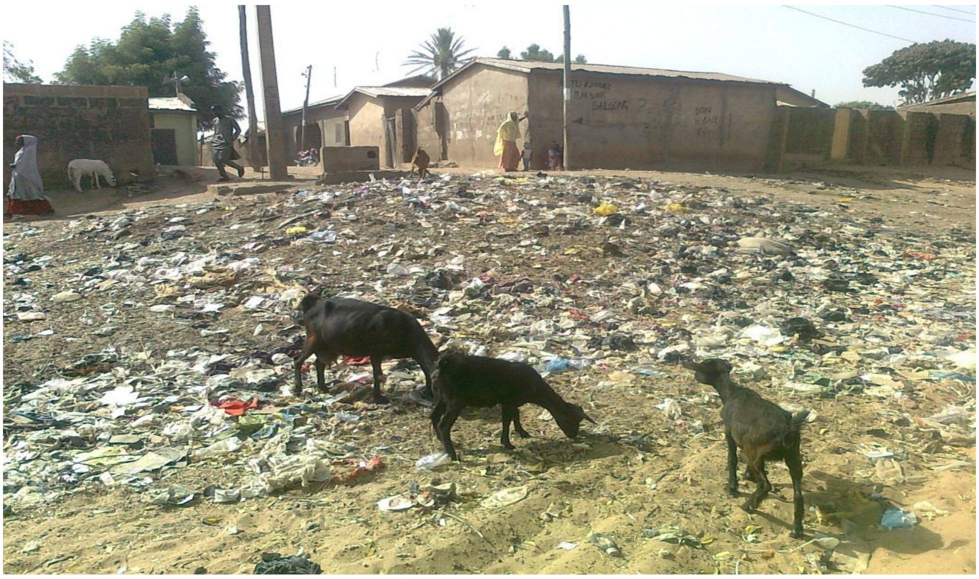


Plate I: Indiscriminate dumping of waste at Kagarawal
Source: Field survey, 2015.

Plate 
II: uncollected waste from constructed waste bunker at Ajiya ward
Source: Field survey, 2015.

4.3.6 Frequency of Waste Collection

The survey revealed that about 32% of the household heads do not have their wastes collected at all; 22% had theirs collected once a week; 19% of the household heads had their wastes collected twice a week; while 27% had their wastes collected daily as shown in table 4.8.

Table 4.8: Frequency of Waste Collection

Frequency	G.R.A		Federal Lowcost		Ajiya		Kagarawal		Total	Percentage
	N	%	N	%	N	%	N	%	N	%
Daily	28	56	26	52	_	_	_	_	54	27
Twice a week	11	22	13	26	9	18	5	10	38	19
Once a week	10	20	9	18	12	24	13	26	44	22
Not collected	1	2	2	4	29	58	32	64	64	32
Others	_	_	_	_	_	_	_	_	_	_
Total	50	100	50	100	50	100	50	100	200	100

Source: Field survey, 2015.

From the above distribution, this shows that G.R.A and Federal Lowcost have their wastes collected daily as a result of the waste commercial services rendered by the formal private contractor, the Inex Cleaners Limited and the informal private operators. While Ajiya and Kagarawal had their wastes either not collected at all or collected occasionally by the government agency GOSEPA.

4.3.7 Payment by households for solid waste collection

The survey revealed that household heads that are unable to move their wastes to collection centres utilize formal and informal private sectors for waste collection, particularly in the high and medium income neighborhoods such as G.R.A and Federal lowcost where most of the informal private operators operate. For the service rendered, households pay the waste operators an agreed sum of money which ranges from N500 to N1000 per month. While at the low income neighborhoods such as Ajiya and Kagarawal, which are majority low income earners are not used to paying waste management services and are reluctant to pay. This may be as a result of the majority of the household heads that is; about 72 percent earns less than N5000.00 per month (Table 4.4). Also, majority of the household heads think that it's government responsibility to collect waste and disposed of.

4.4 FRAMEWORK FOR SOLID WASTE MANAGEMENT IN GOMBE

4.4.1 Existing Institutional Framework

Gombe State Environmental Protection Agency (GOSEPA): Established by edict No. 3 of 1997 and came into force on 10th June, 1997 to take over and replace the activities of the defunct task force on Environmental Sanitation. GOSEPA holds the responsibility of solid waste management in the state. It regulates and monitored activities, which sometimes necessitates the enactment of legislations. The guidelines set by the Ministry of Environment (FMOE, 2000, p.15); the state governments are to be responsible for:

- Imposing recycling responsibilities on industries and business
- The supervision and enforcement of bye-laws
- The promotion of environmental matters within individual states
- The provision of land for waste management infrastructure; and
- Assisting in capacity building.

GOSEPA also collaborate and manage contracts between Gombe Local Government and private sector operators in solid waste management.

Gombe Local Government: Local governments represent the third tier of government, and are constitutionally empowered to handle solid waste management (FGN, 1991 pg 151). The local government council was created in 1976 by Decree No. 1 of 1976, refuse management is a statutory function assigned to it by the 1979 and 1989 constitution of the Federal Republic of Nigeria Decree No. 12 of 1989, under its primary health care department. The functions as specified by UDBN (1998, p.148) include the following:

- The identification of strategic and convenient sites for the placement of bins or erecting refuse depots;
- Collaboration with other agencies to collect and dispose refuse of all kinds;
- The provision of support services in other aspects of environmental sanitation;
- Monitoring the spread of disease and epidemic and facilitate appropriate remedies;
- The maintenance of government equipment and facilities for waste management.

The Gombe Local Government have at one time provided and maintained communal depots and collected household solid waste for disposal on a regular basis. Now, solid waste collection from communal depots and disposal is very irregular. This is due to inadequacy in finance, equipments and human resources for waste management. The Local Government now collaborates with GOSEPA in collection, transportation and disposal of waste.

Plate III: Gombe L.G. Communal Depot
Source: Field survey, 2015.

4.4.2 Public Sector

Presently the Gombe State Environmental Protection Agency (GOSEPA) which is in charge of solid waste management in Gombe lacks the necessary equipments and trained man power needed for waste collection and disposal, coupled with poor funding of the agency.

4.4.2.1 Staff and Their Responsibilities

The Gombe State Environmental Protection Agency (GOSEPA) is presently under staffed and lacks trained and skilled manpower (GOSEPA, 2015).

Table 4.9: Solid Waste Management Personnel and Units

Unit	No. of Staff	Percentage (%)	No. Required
Health inspection	6	8	12
Waste collection	23	30.7	18
Road sweepers	21	28	28
Drivers	6	8	8
Others	19	25.3	24
Total	75	100	90

Source: GOSEPA, 2015.

The agency has five (5) departments with over 75 staff; the majority of the staff comes from the waste management and sanitation department which constituents mostly labourers and are poorly educated; furthermore, the labourers are mostly casual workers. They have little or no technical background or training in environmental management issues.

Table 4.10: Staff Qualification

Designation	Number	Percentage (%)	Qualifications
Health officers	4	5.3	Degree; B. Tech Environmental Management, B. Tech U.R.P, HND in Environmental Health Technology.
Assistant health officers	11	14.7	Diploma in Environmental Health Management.
Environmental Technicians	12	16	Certificate in Environmental Health Management.
Labourers	42	56	Primary/ Non formal
Drivers	6	8	School certificate
Total	75	100	

Source: GOSEPA, 2015.

The implication of this is that plans are poorly prepared and enforcement is not carried out effectively. Therefore, the agency required additional 8 drivers, 28 labourers and 54 trained staff for effective waste management in the area and to address the issue of poorly educated work force.

4.4.2.2 Financial Framework

The agency largely depends upon government subvention and internally generated revenue through sanitary levy and penalties for offenders of illegal dumping and littering of refuse along streets. The agency therefore got a total estimate of financial allocation of N120, 000,000.00 million for 2010. This has continued to decrease over the years. The allocations include operating expenses, personnel emolument and costs of waste evacuation. With the decline, the agency is unable to meet salary and running expenses to carry out their daily routine to properly manage solid waste in Gombe (Table 4.11).

Table 4.11: Budgetary Allocation for GOSEPA (in millions ₦)

Years	Allocation for GOSEPA
2010	120,000,000.00
2011	100,000,000.00
2012	52,000,000.00
2013	10,000,000.00
2014	16,700,000.00
2015	17,100,000.00

Source: Ministry of finance, Gombe State.

There is no separate allocation for solid waste management as shown on the table above. Adequate finance is a sound bases for any organization to carry out its functions for an effective and efficient service delivery. Money is required to maintain and pay workers, purchase sufficient equipment use in managing waste.

4.4.2.3 Equipments used for waste collection and disposal

Currently, Gombe State Environmental Protection Agency (GOSEPA) is facing shortage of equipments. Most of the equipments being used for waste collection and disposal are either not enough or broken down which affect the efficiency of operation. The equipments are pay loaders, tractors, sweepers and compactors etc.

Table 4.12: Equipments Available for Waste Collection and Disposal

Types of equipments	No. Available	Non-functional	No. Required
Tippers	-	-	2
Pay loaders	4	-	2
Tractors	5	3	2
Compactors	4	2	2
Sweepers	10	7	4

Source: GOSEPA, 2015.

In addition to the above, the agency has several equipments such as wheel barrows, shovels, diggers, rakes, cutlasses and other supporting equipments. Therefore, due to non-availability of these equipments the agency collects only 5,818.18kg/day out of the 11,820.24kg/day of waste generated in the study area.

Although the GOSEPA has five tractors and four compactors for transporting waste to the final disposal site along Gombe-Bajoga road, only two of the tractors and two of the compactors are functioning properly. Each of the two tractors and compactors make two trips per day, this shows that only 16,000kg out of the total 107,873.37kg of waste generated in the entire town is being evacuated to the final disposal site. Therefore, additional twelve (12) vehicles are needed for the evacuation of the remaining 91,873.37kg of the generated solid waste.

4.4.2.4 System of Refuse Collection and Disposal

Waste collection in Gombe is carried out by both the public and private sectors and is done in form of communal depots. Presently there are several collection points designated across the Gombe urban area to facilitate collection of solid wastes (Figure 4.2). Yet, there has not been regular collection and efficient management of solid waste, even with the involvement of private sector in the collection and disposal process. This is as a result of inadequacy in the provision of funds to buy the necessary equipments needed for waste collection and disposal, man power and resources. Furthermore, some neighborhoods that are not accessible and densely populated are left unserviced and without official designated collection points, particularly in the low income neighborhoods` such as Kagarawal and Malam Inna (Figure 4.3). This remains a challenge to both individuals and agencies involved in household solid waste management in Gombe.

The mode of final disposal is open dumping which gives rise to environmental, social, and public health problem. Once the waste is collected, it is taken to the officially designated final disposal sites located outskirt of the town with no proper treatment or landfill procedure.

4.4.2.5 Official Collection System

The Gombe State Environmental Protection Agency (GOSEPA) is in charge of collection and disposal of waste in Gombe. Although there are forty officially designated collection points in form of communal depots in Gombe as shown in Figure 4.2. There are no incineration points and transfer stations as the wastes are directly taken from the collection points to the disposal sites. These collection points are inadequate and unevenly distributed within the neighborhoods. The collection points are not well organized as some are not fenced and not regularly attendant to. Collection of waste is irregular due to inadequacy of equipments, man power and resources. At the high income neighborhood like G.R.A no official collection system in place while at the low income neighborhoods such as Ajiya and Kagarawal has few or no collection points at all. Instead undesignated collection points were created within these neighborhoods (Plate 1).

The final disposal method of waste practiced by the GOSEPA is the use of open dumpsites and burning in order to reduce the quantity of the waste, this is done without any regard for pollution control. This confirms the findings of Osita and Dauda, 2003; Ogwueleka, 2009 that the waste disposal option in Nigerian cities is predominantly open dumping followed closely by open burning. The agency has two officially designated dumpsites for the final disposal of waste located at the outskirt of the town along Gombe-Bajoga road (Plate 4). The distance covered by the agency to dispose of waste is more than 4km from the town. At the final disposal sites all categories of waste are dumped without proper sorting and treatment mechanism in place and disposal are not monitored, as dumping takes place at several points away from the disposal sites even by the road side.

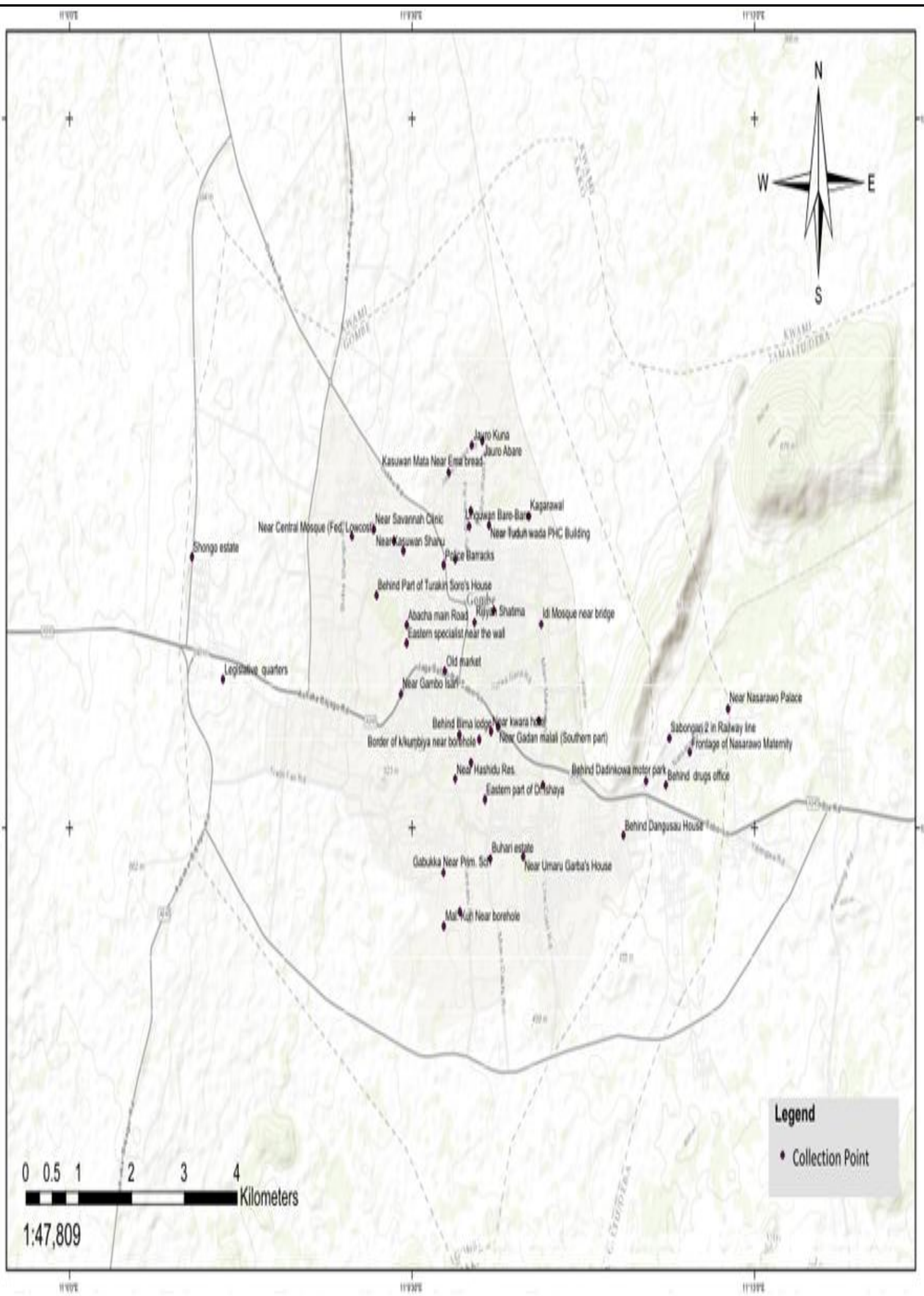


Figure 4.2: Gombe Urban Area Existing Refuse Collection Points **Source: Field Survey, 2015**

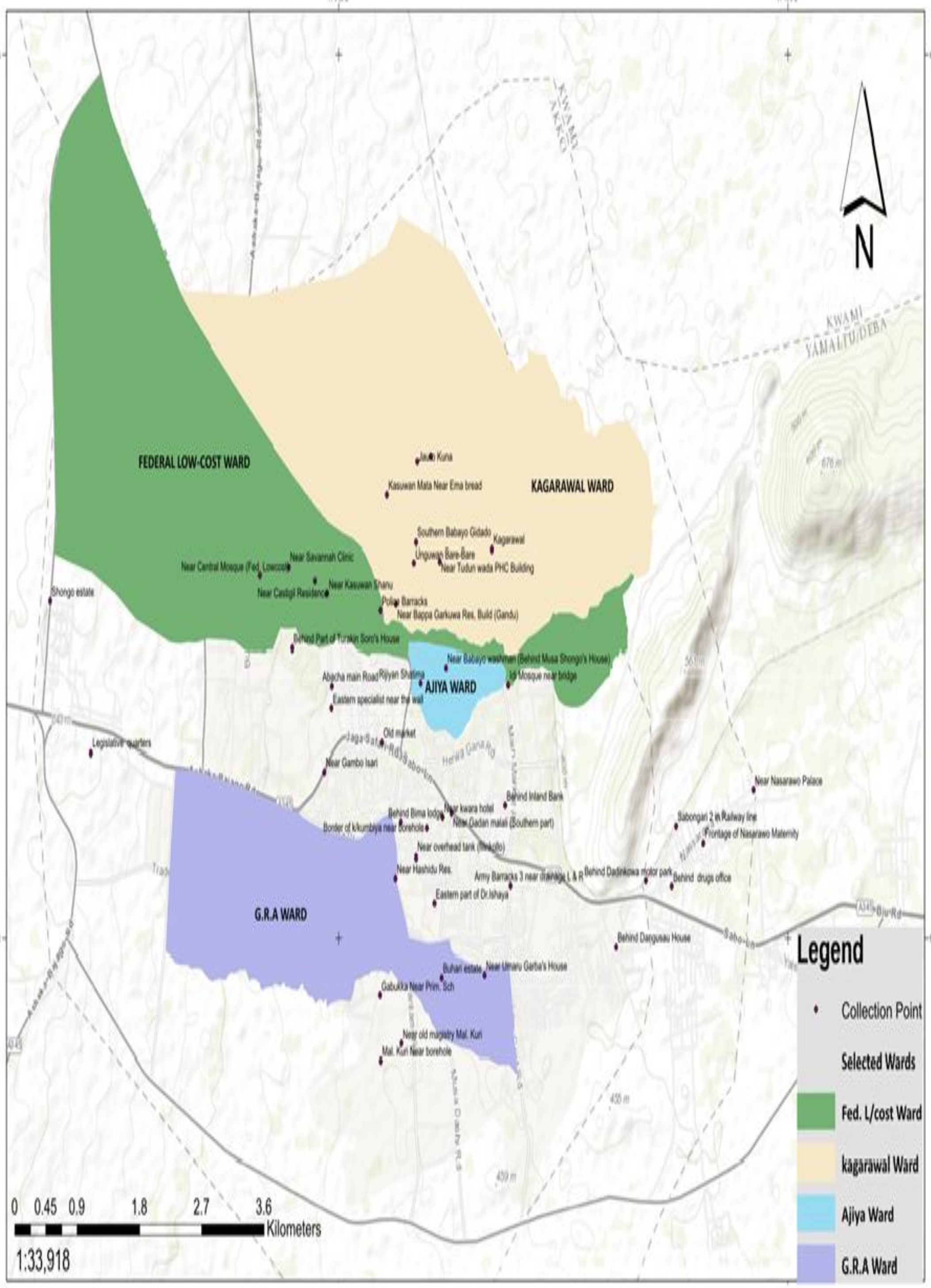


Figure 4.3: Four Selected Wards of Gombe Urban Area **Source: Field Survey, 2015**

Plate IV: GOSEPA Solid Waste Disposal site at Gombe-Bajoga road
Source: Field survey, 2015.

4.4.3 Formal Private Contractor

With increase in complexity and volume of waste generation and to improve the sanitation condition in the state, the Gombe state government entered into public-private partnership with Inex Cleaners Limited. The partnership is on collection, transportation and disposal of the solid waste generated in the town. The Inex Cleaners Limited is the only contracting private firm that has been contracted to carry out collection and disposal of solid waste. The city is zoned into neighborhoods; some of the neighborhoods are directly controlled by GOSEPA and allocated some to Inex Cleaners Limited. Yet, collection is irregular; this is linked to poor equipments and insufficient monitoring and control of the garbage collection operation by the policy regulators.

The Inex Cleaners Limited undertakes door to door collection services for a fee of N1000 monthly after payment of N1000 for registration. Collection is usually done on daily basis; houses that are serviced are supplied with polythene bags and have receptacle bins for waste storage. The firm has one dumpsite located along Gombe-Bajoga road and the method of final disposal is sanitary landfill, although it is not properly sited, designed and constructed interms of provision of weighbridge, gas recovery system and leachate collection system. It simply involves dumping of the waste in the landfill and once the collected wastes are thrown, they are covered with the soil and leveled with bulldozer. The site is managed by a security men and operators.

Plate V: Receptacle Bin at G.R.A
Source: Field survey, 2015.

Plate VI: Inex Cleaners' Limited Disposal site at Gombe-Bajoga road
Source: Field survey, 2015.

4.4.4 Informal Private Operators and Waste Collectors

It was observed that there are several informal private operators, operating in high and medium income neighborhoods. Most prominent of these operators are Josy Waste Management Services and EV Domestic Waste Evacuation Services. The collection is on door to door basis with a payment of N1000.00 monthly. Collection is usually done on weekly basis and this is achieved with the use of open dumps stationed at individual premises that required their services. While the informal waste collectors in Gombe are usually scavengers and itinerants (Yaro boys) who are engaged in collection of reusable and recyclable items from storage bins and disposal sites. The collection and transportation of wastes from households to communal dumpsites is done by young boys (Yaro boys) who engage in house to house collection for a small token fee of N20 charge. These children dispose the waste mostly in drainages and illegal dumpsites close to the area in which the house is located and others move around with wheel barrow, carts and cartons collecting wastes from various households. The implication of this is that it contributes to poor sanitation in the area, because much of the refuse is littered about before reaching the disposal sites. The collectors are also exposed to health hazards since they operate without protective equipments like noise guard, hand gloves etc.

4.4.5 Community Based Organizations (CBOs)

There are few community based organizations in Gombe that are involved in solid waste management. These include Ajiya Youth Community Based Organization, Shamaki Community Based Organization etc. The CBOs carry out sanitation services at monthly intervals and usually involve evacuation of waste heaps and drains evacuation in the neighborhoods. The CBOs lack equipments for collection and disposal process. However, they collaborate with GOSEPA in the evacuation of the wastes to final disposal site.

4.5 PERFORMANCE OF AGENCIES RESPONSIBLE FOR SOLID WASTE MANAGEMENT

In order to assess the role of agencies responsible for household solid waste management in the study area, interviews were carried out among the GOSEPA staff. From the result of the interview, it was observed that the existing waste management system lacks proper funding, equipments, man power, and private participation. The criteria adopted in this assessment are guided by the efficiency of the agencies in solid waste collection and disposal.

The consistency and timeliness of service delivery with regards to solid waste management is the key criteria employed in assessing efficiency. Efficiency of solid waste management is measured by the rate of collection, the rate of waste generated daily at each of the wards and volume collected or uncollected daily, mode of waste collection, frequency of waste collection and final disposal.

4.5.1 Rate of Waste Collection

The rate of waste collection measures the quantity of waste collected as a percentage of the total amount generated. The daily quantity of waste generation in the selected wards is 11,820.24kg/day as shown in table 4.13.

Table 4.13 Rate of daily generation/collection & uncollected in the selected wards

Wards	Daily Generation (kg)	Daily Collection (kg)	Daily Uncollected (kg)	% of Daily Collection
G.R.A	1,055.6	1,045.6	10	99

Federal Lowcost	2,717.12	2,263.68	453.44	83
Ajiya	2,448.16	1,054.36	1,393.8	43
Kagarawal	5,599.36	1,454.54	4,144.82	26
Total	11,820.24	5,818.18	6,002.06	

Source: Field survey, 2015.

From the outcome of the performance assessment of the Gombe State Environmental Protection Agency (GOSEPA), the existing equipments and staff requirement are grossly inadequate as shown in Table 4.10 and 4.12. This affects the rate of waste collection as the total amount of waste generated in the study area is 11,820.24kg/day and only 5,818.18kg/day is collected, thereby leaving a leftover of 6,002.06kg/day. This constitutes 49 percent of the waste generated. The variation across the wards shows that the high and medium income neighborhoods have their waste collected daily as this is so because of the private operators operating in these neighborhoods. In the low income neighborhoods such as Ajiya and Kagarawal, the rate of waste collection is low as about 2,448.16kg and 5,599.36kg is generated and only 1,054.36kg and 1,454.54kg is collected, leaving a backlog of 1,393.8kg and 4,144.82kg of the accumulated waste across these neighborhoods. Therefore, if the rate of waste collection is regular across all the wards, then service can be said to be efficient.

4.5.2 Mode of Waste Collection

The mode of collection determines whether the service is easily accessible to households or not. This includes the house to house collection and communal depots collection. The house to house collection is undertaken by the private contractor and informal waste operators while the communal depots collection is undertaken by the government agencies and some of the informal waste collectors.

Table 4.14: Method of Solid Waste Collection

Wards	House to House Collection	Communal Depot
G.R.A	50	-
Federal Lowcost	43	7
Ajiya	18	32
Kagarawal	12	38
Total	123	77

Source: Field survey, 2015.

From the table above, the high and medium income neighborhoods such as G.R.A and Federal lowcost are largely covered by the house to house collection service. The residences have receptacle bins for waste storage. At the low income neighborhoods such as Ajiya and Kagarawal not all the houses are serviced by the house to house collection. Though there is the presence of informal waste collectors in these areas but not all the informal waste collectors partake in the house to house collection, most of them collect waste at the communal depots. Therefore, the mode of waste collection by the Gombe State Environmental Protection Agency (GOSEPA) is inefficient. This is due to non participation of the agency in house to house collection. Also, the communal depots are open dumps characterized by uncontrolled emissions, presence of rodents and strong odour as depicted in plate 2.

4.5.3 Frequency of Waste Collection by households

Solid waste requires immediate collection once it is generated. This is so if there is adequate provision of funds to buy the necessary equipments needed for collection, man power and resources to efficiently evacuate the waste from the human environment.

Table 4.15: Frequency of Waste Collection by households

Wards	Daily	Twice a week	Once a week	Not collected
G.R.A	28	11	10	1
Federal lowcost	26	13	9	2
Ajiya	-	9	12	29
Kagarawal	-	5	13	32
Total	54	38	44	64

Source: Field survey, 2015.

From the above table, the high and medium income neighborhoods had their waste collected daily. This is as a result of the house to house collection service by the formal contractor and informal operators. While the low income neighborhoods such as Ajiya had their waste collected once or twice a week and Kagarawal not collected at all. Therefore, the GOSEPA do not undertake regular collection. This is due to inadequate and the absence of official designated household refuse collection points in this areas.

4.5.4 Final Disposal

The safe disposal of solid waste involves waste treatment and sanitary disposal. However, solid waste treatment takes place at the final stages of the management system and is related to disposal. Waste treatment close to the source of generation lowers the risk of contamination and prevents environmental problems at the point of waste disposal. Waste treatment and final disposal involves waste sorting, composting and sanitary landfill.

The survey reveals that the final disposal method of waste disposal practiced by GOSEPA is open dumping, followed by open burning to reduce the quantity without proper treatment and separation mechanism in place. This confirms the findings of Imam et al., (2008) that the formal treatment of waste on the disposal site is usually open burning to reduce the quantity. Therefore, the entire components are disposed of together and there is no organized programme for waste composting.

The formal private contractor that is the Inex Cleaners Limited has one sanitary landfill that is not properly designed and constructed interms of provision of weighbridge, gas recovery system and leachate collection system. This shows that there is no proper waste treatment and separation at the point of final disposal. The wastes are dumped in an open burrow pit, covered with soil and leveled with bulldozer. Although, there is prompt disposal of waste by the private contractor. While the informal private operators and the waste collectors dump waste illegally within the urban areas, only few of the informal operators such as the Josy Waste Management Services and the EV Domestic Waste Evacuation Services take their wastes to the official disposal sites. Therefore, this shows that the final disposal method of waste by the agencies in the study area is not safe disposal which causes health and environmental hazards.

4.6 SUMMARY

This chapter assessed the household solid waste management system in Gombe with respect to the role of agencies responsible for its management. The household solid waste management system in Gombe is faced with a lot of challenges as most of the households generate huge amount of wastes which are not properly collected and disposed of. Households disposed of their wastes in open spaces, vacant plots, drainages etc as some burned their wastes in order to reduce its quantity which in turn affects the quality of air within the environment. Furthermore**,** this chapter assessed the performance of agencies with respect to efficiency measures. The performance does not meet with expectation with regards to the level of waste collection and safe disposal. The GOSEPA is the agency responsible for handling solid waste in Gombe, the agency among several other functions is to locate, construct and maintain solid waste dumpsites and sanction defaulters. However, it was observed that the agency lacks the institutional framework, proper funding, equipments and manpower which in turns result to poor performance of the agency.

CHAPTER FIVE

SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION

This chapter presents the summary of findings, recommendation and conclusion. The summary is aimed at highlighting the issue of household solid waste management practices and the role of agencies responsible for its management in Gombe. Recommendations were made in order to proffer useful policy options for the improvement of the situation.

5.2 SUMMARY OF FINDINGS

Based on the analysis of the data, the following are the major findings:

a) Solid Waste Management Practices at Household Level

Proper handling of waste at households' level constitutes the first step to effective waste management. Therefore, waste handling practices at the household level in Gombe is improper. This is as a result of indiscriminate dumping of households waste within the neighborhoods most especially in the low income neighborhoods such as Ajiya and Kagarawal where there are few or no official designated collection points. Therefore, residents of these areas resort to the use of open ground for storage, dumping of waste in open spaces, drainages and vacant plots. Burning in order to reduce the quantity of waste generated. Furthermore, there is no waste separation at the point of generation within households as all the components of waste are stored together in one receptacle. The house to house collection system by the formal and informal private operators is more accessible to households than the communal depots method by the public sector.

b) Role of Agencies Responsible for Solid Waste Management in Gombe

The Gombe state environmental protection agency (GOSEPA) is the agency vested with the responsibility of handling solid waste management in Gombe. Despite effort to tackle this problem, still heaps of these wastes are clearly seen all over the town thereby making the city dirty. This shows that the agency has not been able to tackle the problem of solid waste within the town.

Poor funding of the agency is one of the main reasons for irregular collection and disposal of waste in Gombe. Lack of funds has forced the Gombe State environmental protection agency to maintain few staff on a permanent basis. The waste management fee is insufficient to cover for waste management. Therefore the agency does not have adequate capacity to handle the increasing solid waste mainly due to limited budgets. The existing equipments for solid waste management were grossly inadequate in comparison with the population of the study area.

Lack of manpower and trained staff to run solid waste management programme in Gombe, the Gombe State Environmental Protection Agency (GOSEPA) is currently understaffed and the staffs are poorly trained workers. Majority of the GOSEPA staff have little or no functional background or training in environmental management issues, so the operations result is ineffective and inefficient solid waste management. Also, there is no reliable measurement of generated waste within the study area.

The private sector is not fully involved into the management system as there is only one contracted private firm, that is the Inex Cleaners Limited and the role of the informal sector has not been recognised by the agency responsible for solid waste management in Gombe.

Waste collection and the disposal by the formal and informal sectors, and CBOs are in response to the low performance of the public sector. These sectors are engaged by the household for collection of waste at a price while the CBOs generally are involved in environmental cleaning and sanitation. Though there is remarkable improvement in the collection, especially recyclable materials but the level of collection still remain low than the level of generation.

The increasing uncooperative attitude of the households toward waste management practices, most especially in the low income neighborhoods as shown in plate 1 and 2.

There is no public awareness and enlightenment campaigns as regards to the dangers of poor waste management practices.

Inadequate and inappropriate siting, design, operations and maintenance of collection points and disposal sites as the final disposal method is open dumping without proper treatment and landfill procedures.

Therefore, the overall performance assessment of the agencies responsible for solid waste management in Gombe was not efficient.

5.3 RECOMMENDATIONS FOR IMPROVEMENT

Based on the findings of this study, the following strategy options were recommended for efficient and effective management of solid waste in Gombe. This will include the following:

a) Community participation: There should be actively community participation and involvement of community based organizations in solid waste management since Gombe has few community based organizations. It is recommended that the government should encourage participation through involving the residents and CBOs in decision making on solid waste management process. Also, Non-Governmental Organizations should be more involved in the planning and execution of solid waste management in the state.

b) Payment for waste management: The low income neighborhoods such as Ajiya and Kagarawal should be made to pay for disposing their waste. Also, generators should be made to pay for solid waste collection charges.

c) Pay as you throw principle: This should be introduced but 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 agencies.

d) Public-private partnership: The private sector should be actively involved; Informal waste collectors can be incorporated into public-private partnership as government alone cannot provide the necessary funds to tackle solid waste management in the area. Yet, the presence of informal sector remains un-integrated into the formal waste management system in Gombe. Therefore, there is need for the government to regulate and register the activities of the informal sector. They should be involved in collection activities, waste recovery and supply of recovered materials for recycling and street sweeping.

e) Adequate Resourcing of Waste Management Agencies: The waste management agencies such as GOSEPA should be adequately resourced interms of funding, personnel and equipments by the Gombe State Government to ensure efficient and effective waste management in the area.

f) Monitoring and Supervision: There should be regular monitoring and supervision of agencies by GOSEPA to determine the extent of coverage, frequency of collection, rate of collection and safe disposal.

g) Use of Integrated Solid Waste Management Model: This should be adopted to ensure efficient and effective solid waste management in the area. Residents should be encouraged to separate the waste generated into their various components before final disposal. Waste can be disaggregated into plastic, metals, 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 land filled those that cannot be subjected to any of the above mentioned methods.

h) Use of Appropriate Technology: The GOSEPA disposal sites should be provided with sanitary landfill facilities to avoid open dumping and open burning. The Inex Cleaners landfill site should be upgraded and properly designed in accordance with environmental standards. These include the weighbridge, gas recovery system and leachate collection system. Perhaps it is necessary for the government to device improved techniques for solid waste management.

5.4 CONCLUSION

The study revealed that as a result of population growth, waste generation is higher than collection which leads to waste accumulation overtime, thereby, degrading the environment. Disposal in open space, drainages and vacant plot remains the most commonly used method of waste disposal and waste collection is irregular and non collection in some areas especially in the low income neighborhoods. Waste collection is constrained by lack of equipments, trained and skilled manpower, coupled with poor funding of agencies involved in solid waste management. Wastes are not treated before disposal at the final dumping sites. Waste minimization and recycling has not gone beyond the practice of picking and sorting through heaps of refuse or garbage by the informal waste collectors. Waste sorting does not take place at both household level and official dumpsites. Payment for waste management services is not popular in the low income neighborhoods as residents display varying attitude towards the issue and negative attitudes of the populace towards waste collection and disposal. It is however important to educate them on the importance of paying for waste management services and in keeping their environment clean as it will facilitate the process of solid waste management.

5.5 CONTRIBUTION TO KNOWLEDGE

This study provides the understanding of household solid waste management in Gombe and the roles agencies play in its management. It also provide the strategies to tackle the problems such as community participation, payment for waste management, public-private partnership, adequate resourcing of waste management agencies, use of integrated solid waste management model etc.

5.6 SUGGESTIONS FOR FURTHER RESEARCH

Further in-depth research should be carried out on household solid waste management in the study area. Focusing on higher level of integrated solid waste management options such as reuse, recycling and composting which contribute to economic development effort.

REFERENCES

Abdullahi, Y. A. A., J C; Ahmad, A S; Sirajo, M Z; Bala, I A. (2008). *Developing an integrated sustainable municipal solid waste management for a rapidly growing urban city: A case study of Abuja, Nigeria.* Paper presented at the

POSTCON: 1st Post gradute researchers' conference on 'Meeting the environmental challenges in coastal regions of Nigeria'. Dundee, Scotland.

Abel, O. A. (2009). An Analysis of Solid Waste Generation in a Traditional African *City:* The Example of Ogbomoso, Nigeria. Environment and Urbanization, *SAGE Journals*, 19(2): 527- 537.

Adebola O.O (2006). 'The roles of the informal private sector in Integrated Solid Waste Management (ISWM) in Lagos, Nigeria. A developing country." Proceeding of the 21st International Conference on Solid Waste Technology and Management. Philadelphia.

Adejoke, D.S. (1989) Waste management within the context of sustainable development. Proceedings of National Conference on Development and Environment Ibadan.

Afon, A. (2007). Informal sector initiative in the primary sub-system of urban solid waste management in Lagos, Nigeria. *Habitat International, 31*(2), 193-204.

Afon, A., & Okewole, A. (2007). Estimating the quantity of solid waste generation in Oyo, Nigeria. *Waste Management & Research, 25*(4), 371.

Agunwamba, J. (1998). Solid waste management in Nigeria: problems and issues. *Environmental management, 22*(6), 849-856.

Ajadike, J.C. (2001). Urban solid wastes: Problems and management in Nigeria, In: G.E.K. Ofomata and P.O. Phil-Eze (Eds.). Geographical Perspective on Environmental Problems and Management in Nigeria. Department of Geography, UNN.

Al-Khatib, I., Monou, M., Mosleh, S., Al-Subu, M., & Kassinos, D. (2010). Dental solid and hazardous waste management and safety practices in developing countries: Nablus district, Palestine. *Waste Management & Research, 28*(5), 436.

Al-Khatib, Issam, A., Monou, M., Salam, A. F. Abu, Zahra., Shaheen, H. Q., Kassinos, D. (2010). *Solid waste characterization, quantification and management practices in developing countries.* A case study: Nablus district- Palestine, Journal of Environmental Management 91 (2010)1131-1138

Al-khatib I, Arafat H.A, Basheer T, Shawahneh H, Salahat A, Eid J, Ali W (2007). Trends and problems of solid waste management in developing countries: A case study in seven Palestinian Districts. *Waste Management*, 27(12): 1910-1919.

Arowolo .A. and M.K.C. Sridhar, (2005). Options in Urban Waste Conversion: Organo-Mineral Fertilizers to Integrated Waste Management. The Experience So Far. A Paper Presented At One-Day Technical Session Organized By Ogun Sate Ministry Of Environment.

Ayotamuno, J., & Gobo, A. (2004). Municipal solid waste management in Port Harcourt, Nigeria: Obstacles and prospects. *Management of Environmental Quality: An International Journal, 15*(4), 389-398.

Awomeso, J., A. Taiwo, A. Gbadebo, and A. Arimoro. (2010). "*Waste disposal and* pollution management in urban areas: A workable remedy for the environment in developing countries." American Journal of Environmental Sciences 6(1): 26-32.

Babayemi JO, Dauda KT (2009). Evaluation of solid waste generation categories and disposal. *Journal of Applied Sciences and Environmental Management,* 13(3): 83-88.

Balzerek, H. (2001a): *The New State Capital Gombe*. In: Berichte des Sonderfers Chungs Bereich 268, band 14, 161-168, Frankfurt.

Balzerek, H., W. Fricke, J. Heinrich, K.M. Moldenhauer and M. Rosenberger (2003): Man-Made flood disaster in savannah town of Gombe/NE Nigeria. The natural hazard of gully erosion caused by urbanization dynamics and their peri urban footprints. In: Erdkunde.94-109 Bonn.

Batagarawa, R.L (2011): Sustainability Appraisal of Waste Management in Nigeria: *Development and Evaluation of an Index Based Tool.* Ph.D. Dissertation, Department of Civil Engineering, University of Portsmouth.

Bernstein, J. (2004). Social Assessment and Public Participation in Municipal Solid *Waste Management: Took Kit.* Urban Environment Thematic Group. The World Bank, Washington, D.C http//www.worldbank.or/urban/uswm/socialassesstoolkito.pdf

Chattopadhyaya S., Duttad A., Ray S. (2011). Municipal solid waste management in Kolkata India: A Review. *Waste Management,* 29(4): 1449-1458.

Cheema, G.S (1996) Innovative Urban Management Practices. The Urban Age; Innovation in Urban Management. Vol.3 No.4 p11.

Cointreau, S. J., (1982). Environmental management of urban solid waste in developing countries: a project guide. Urban Development Technical paper No 5. The World Bank, Washington, DC. June .

Cointreau, S.J., Gunnerson, C.G., Huls, J. M., and Seldman, N.N., (1984). Recycling from municipal refuse: A state of the Art Review and Annotated Bibliography, World Bank Technical paqper N0 30. The World Bank, Washington, DC.

Cointreau-Levine, S., (1994). Private sector participation in municipal solid waste management service in developing countries. Vol. 1. The formal sector-UNDP/UNCHS/ The World Bank-Urban Management Programme. 52 pp.

Dauda, M., And Osita, O.O.,(2003). Solid waste management and reuse in Maiduguri, Nigeria. 29th WEDC International Conference towards the Millennium Development Goal, Abuja.

Den Boer, J., Den Boer, E., & Jager, J. (2007). LCA-IWM: A decision support tool for sustainability assessment of waste management systems. *Waste Management, 27*(8), 1032-1045.

Denison, R.A. and Ruston, J. (1990): Recycling and Incineration. Island Press, Washington D.C.

Desai, V. (1995). Filling the Gap: An Assessment of the Effectiveness of Urban *NGOs*, ODA (UK), Institute of Development Studies, University of Sussex, Sussex, 136 pages.

Döberl, G., Huber, R., Brunner, P. H., Eder, M., Pierrard, R., Schönbäck, W., Hutterer, H. (2002). Long-term assessment of waste management options-a new, integrated and goal-oriented approach. *Waste Management & Research, 20*(4), 311.

Federal Government of Nigeria (FGN) (1999): The constitution of the Federal Republic of Nigeria. Federal Ministry of Information, Lagos, Nigeria.

Federal Ministry of Environment (2000) Blueprint on Municipal Solid Waste, Kaduna, Nigeria: Nation House Press Limited.

Felix, P. (2010): Solid Waste Management in Ghana: The case of Tamale Metropolitan Area. Department of Planning, Kwame Nkrumah University of Science and Technology.

FMHE (1983), Federal Ministry of Housing and Environment: The State of the Environment in Nigeria, Division of Environmental Management, Lagos.

Fobil, J., May, J., & Kraemer, A. (2010). Assessing the relationship between socioeconomic conditions and urban environmental quality in Accra, Ghana. *International Journal of Environmental Research and Public Health, 7*(1), 125-145.

Finnveden, G., Johansson, J., Lind, P., & Moberg, Å. (2000). *Life Cycle Assessments of Energy from Solid Waste*. Stockholms University.

Geoffrey, I. N. (2005). The urban informal sector in Nigeria: towards economic development, environmental health, and social harmony. Global Urban Development Magazine 1(1).

Gidarakos, E., Havas, G., & Ntzamilis, P. (2006). Municipal solid waste composition determination supporting the integrated solid waste management system in the island of Crete. *Waste Management, 26*(6), 668-679.

GOSEPA, (2015). Gombe State Environmental Protection Agency (GOSEPA)

Gombe L.G (2015). Gombe Local Government Council: Department of Public Health

Imam, A., Mohammed, B., Wilson, D., & Cheeseman, C. (2008). Solid waste management in Abuja, Nigeria. *Waste Management, 28*(2), 468-472.

Johnston, R.J. (1994). *The Dictionary of Human Geography*. Blackwell, Oxford.

Kant, S. and A. Berry, (2001). A Theoretical model of optimal forest resource regimes. Journal of Theoretical and Institutional Economics 157, p.331-335.

Kreith, F. (1994). *Handbook of Solid Waste Management.* McGraw Hill, USA.

Klundert, A., & Anschütz, J. (2001). *Integrated sustainable waste management - The concept: Tools for decision makers.* Retrieved from http://www.eawag.ch/forschung/sandec/publikationen/swm/dl/integrated_Sustainable__Solid_Waste.pdf

Klundert, A., & Lardinois, I. (1995). *Community and private (formal and informal) sector involvement in municipal solid waste management in developing countries*.

Kofoworola, O. (2007). Recovery and recycling practices in municipal solid waste management in Lagos, Nigeria. *Waste Management, 27*(9), 1139-1143.

Leton, TG; Omotosho, O (2004). Landfill operations in the Niger delta region of Nigeria. Engineering Geology 73(1-2): 171-177.

Medina, M. (2002), "Municipal Solid Waste Management in the third world cities: Lessons learned and a proposal for improvement. J. of Human Settlement Development vol 1

Medina, M. 2010. "Solid Wastes, Poverty and the Environment in Developing *Country Cities: Challenges and Opportunities."* United Nations University, World Institute for Development Economics Research.

Mitlin, D. (2001). Civil society and urban poverty: examining complexity. In :*Environment and Urbanization*. Vol. 13, No. 2. October 2001, p. 151-165.

MNES, (2001). Annual Report 2000-2001. Ministry of Non-Conventional Energy Sources, (MNES), Government of India, New Delhi.

Momoh, J.J. and Oladebeye, D.H. (2010). Assessment of Awareness of Attitude and Willingness of People to Participate in Household Solid Waste Recycling Programme in Ado-Eketi, Nigeria, in the Journal of Applied Sciences in Environmental Sanitation.

Najm, M. A., El-Fadel, M., Ayoub, G., El-Taha, M., & Al-Awar, F. (2002). An optimisation model for regional integrated solid waste management I. Model formulation. *Waste Management & Research*, *20*(1), 37.

Narayan, D. (1995). The Contribution of People's Participation: Evidence from 121 Rural Water Supply Projects. Environmentally Sustainable Development Occasional Paper Series No., World Bank, Washington, D.C.

NEST. (1991), *Nigeria's Threatened Environment: A National Profile.* Nigerian Environmental Study/Action Team. Intec Printers Ltd. Ibadan.

Nilsson-Djerf, J. and McDougall. F. (2000). Social Factors in Sustainable Waste Management, Warner Bulletin, 73, 18-20

NPC. (2006). Population and Housing Census of the Federal Republic of Nigeria. Priority Tables (LGA) National Population Commission Volume II.

Nwude, M.O, Igboro, S.B, Umar Ibrahim and Okuofu, C.A (2011). *Evaluation of Solid Waste Managemant in Kaduna Metropolis, Nigeria.*

Oberlin, A. (2011). The role of households in solid waste management in East Africa capital cities. Dissertation. Wageningen: Wageningen Academic Publishers.

Ogu, V. (2000). Stakeholders' partnership approach to infrastructure provision and management in developing world cities: lessons from the Sustainable Ibadan project. *Habitat international*, *24*(4), 517-533.

Ogwueleka, T.C., (2003). Analysis of urban solid waste in Nsukka, Nigeria. Journal of Solid Waste Technology and Management, **29** (4): 239-246.

Ogwueleka (2009), "Municipal Solid Waste Characteristics and Management in *Nigeria.* Iran J. Environ health Sci. Eng 2009 vol. 6 No 3 pp 173-180

Ojo, O (2008). State of the Environment in Nigeria. Proceedings of the First National Environment Summit "Greening the Environment for Sustainable Economic Development. Federal Ministry of Environment, Housing and Urban Development. Transcorp Hilton, Abuja. 20th – 21th April, pp 60 – 61.

Omuta, GE.D (1988), "Urban Solid Waste Generation and Management; Towards an Environmental Sanitation Policy" in P.O Sada and F.O. Odemerho (eds), *Environmental Issues and Management in Nigerian Development*, Evans Brothers Ltd (Pub), Ibadan.

Onibokun, AG; Kumuyi, AJ (1996).Urban poverty in Nigeria: towards sustainable strategies for its alleviation. Centre for African Settlement Studies and Development, Ibadan, Nigeria. CASSAD Monograph Series 10. pp. 1-2.

Onibokun, A. (1999). *Managing the monster: urban waste and governance in Africa*: International Development Research Centre.

Oosterveer, P., Spaargaren, G. (2010). Meeting Social Challenges in Developing Sustainable Environmental Infrastructures in East African Cities. In: Social Perspectives on the Sanitation Challenge. Dordrecht: Springer.

Qdais, A. (2007). Techno-economic assessment of municipal solid waste management in Jordan. *Waste Management*, *27*(11), 1666-1672.

Rakodi, C. (1997). Global forces, urban change and urban management, In: Rakodi, C. (Ed.). The Urban Challenge in Africa: Growth and Management of Its Large Cities, United Nations, University Press, Tokyo.

Rathi S. (2005) Alternative approaches for better municipal solid waste management *in Mumbai, India.* Waste Manag. 2006; 26(10):1192-200. Epub 2005 Nov 8.

Rogerson, C.M. (2001). The waste sector and informal entrepreneurship in Developing World Cities. *Urban Forum*, vol.12 No.2.

Salhofer, S., Wassermann, G., & Binner, E. (2007). Strategic environmental assessment as an approach to assess waste management systems. Experiences from an Austrian case study. *Environmental Modelling & Software, 22*(5), 610-618.

Schubeler, P. (1996) Participation and Partnership in Urban Infrastructure Management. UMP vol. 19.

Schutenbelt, P. and Jens Lorentzen (1994). Public-Private Partnerships in Municipal Infrastructure Services. *The Urban Age Privatization and Cities.* Vol. 2 No.4 pp10.

Senkwe and Nwale (2000): Assessment of the Factors Influencing the Generation and Disposal of Urban Household Solid Waste in Africa: The Nigerian Perspective.

Solomon, U. U. (2009). The state of solid waste management in Nigeria. *Waste management (New York, NY), 29*(10), 2787.

Sridhar, M.K.C (2008). Environmental Health and Sanitation. Proceedings of the First National Environment Summit "Greening the Environment for Sustainable Economic Development. Federal Ministry of Environment, Housing and Urban Development. Transcorp Hilton, Abuja. 20^{th} – 21^{th} April, pg 264.

Stanley A.M, Andrew S.S, Dania A.A, Sani I.F (2011): An Assessment of Household Solid Waste Disposal Practices in Sabon Gari, Zaria. ATBU Journal of Environmental Technology 5,1.

Streiner, D.L. (2013). A guide to the statistically perplexed: selected readings for clinical researchers. Toronto: University of Toronto Press.

Stren, R. and R. White (Ed.) (1989). African Cities in Crisis: Managing Rapid Urban *Growth.* West view Press, Boulder, Co. USA.

Sustainable Waste Management Fact Sheet, (2013).

Tchobanoglous, G., Theisen, H. and Vigil, S. (1993). Integrated Solid Waste: Engineering principles and management issues. McGraw-Hill Publishing company, USA.

Tongco, M.D.C. (2007). Purposive Sampling as a Tool for Informant Selection. A Journal for Plant, People and Applied Research, 5, 147-158.

Tsiboe, I.A. and Marbell, E. (2004): A Look at Urban Waste Disposal Problems in Accra. Roskilde University, Denmark.

UDBN (1998), Urban Solid Waste Management Scheme (National Stakeholders Consultative Workshop) for PTF November 23-27, 1998. Abuja, Nigeria.

Ukoje J.E (2011). Analysis of the Determinants of Participation of Stakeholders in Solid Waste Management in Zaria, Nigeria

UN (United Nations) (2005). Agenda 21: retrieved 01-03-2015 from http://un.org/esa/suatdevldoc/agenda 21

UNCED (United Nations Conference on Environment and Development (1992). Agenda 21. Geneva.

UNDP (2005), *Guidelines for Solid Waste Management*. Draft Guideline. Pakistan Environmental Protection Agency.

UNEP, 2005a. *Global Environment Outlook* (GEO) 3 Data Portal, United Nations Environment Programme. <http://geodata.grid.unep.ch/> Accessed 21-11-2011

UNFPA, 2011. *The state of world population*. The United Nations population fund. Van de klundert et al (2003). *Waste, solid wastes* – Academia.edu. www.academia.edu/1514341/APPLICATIO...

United Nations System in Nigeria, (UNSN, 2001), *Nigeria Common Country Assessment*. Shearson Limited.

UN-HABITAT, 2003. *The Challenges of Slums.* Global Report on Human Settlement. London: Earthscan

United States Environmental Protection Agency (USEPA) (1999). State and Local Solutions to Solid Waste Management Problems. (http://www.epa.gov). Accessed on 18th July, 2009 68

USPS (2000): Solid Waste Management Plan for Thimphu City, Bhutan, Draft version, April 2000 .Bhutan: Urban Sector Programme Support Secretariat.

Walling, E. W., A; Warren, E; Warsley, B; Wilhelm, E. (2004). Municipal Solid waste management in developing countries: Nigeria, a case study. Retrieved from http://www.dnr.cornell.edu/saw44/NTRES331%2004

Wilson, D., Araba, A., Chinwah, K., & Cheeseman, C. (2009). Building recycling rates through the informal sector. *Waste Management, 29*(2), 629-635.

Wolf, S. (2004). Municipal Solid Waste Management in Developing Countries: Nigeria. A Case Study. NTRES 314.

World Bank, (1992). World Development Report, Development and Environment, New York. Paper No 13.

Zeng, Y., & Trauth, K. (2005). Internet-based fuzzy multicriteria decision support system for planning integrated solid waste management. *Journal of Environmental Informatics, 6*(1), 1-15.

Zerbock, O. 2003. *Urban Solid Waste Management: Waste Reduction in Developing Nations.* School of Forest Resources & Environmental Science, Master's International Program, Michigan Technological University.

APPENDIX I

DEPARTMENT OF URBAN AND REGIONAL PLANNING

FACULTY OF ENVIRONMENTAL DESIGN

AHMADU BELLO UNIVERSITY, ZARIA.

SAMPLED INTERVIEW QUESTIONS: FOR PUBLIC INSTITUTIONS

INTRODUCTION

I am a post graduate student of Ahmadu Bello University, Zaria from the Department of Urban and Regional Planning, conducting a research on Assessment of Households Solid Waste Management in Gombe. All information provided shall be treated in absolute confidence. Thank you.

Date:………………………………………………………………………………………

Name of Agency/Department in charge of solid waste:……………………………......

1. What is your Mandate?..

2. Area of coverage…………………………………………………..…………………

3. What category of solid waste do you deal with?

(a) Household waste (b) street (c) Educational waste (d) Health waste (e) Industrial waste (f) Commercial waste (g) Hotel (h) Market and Motor Park.

4. What role do you play in solid waste management process?

(a) Collection, Transportation, and Disposal

(b) Collection, Transportation, Disposal and Treatment.

(c) Collection, Transportation, Disposal, Treatment and Recycling.

(d) None of the above

(e) Other (Specify)………………………………………………………….……..

5. How do you organize solid waste management?

(a) Public delivery (b) Private delivery (c) Public Private delivery (d) CBOs (e) NGOs.

6. What is the total amount of solid waste generated per day in coverage area?.............

7. Total amount able to evacuate per day?...

8. What are the common types of waste generated?...

9. What is the composition of the waste?..

10. Method of collection?

(a) Door to Door (b) Roadside (c) Neighborhood (d) Other (specify)………………….

11. What problems do you face during the collection?...

12. How often do you go round to collect solid waste?

(a) Daily (b) Twice a week (c) Once a week (d) Not collected (e) Others (specify)

………………………………………………………………………………………..

13. What is the cost of collection per week? ~~N~~...

14. Where do you dump the waste?...

15. What is the distance to the final disposal site in kilometers………………….........

16. Is the distance a problem?

(a) Yes (b) No

If Yes, mentioned the problem……………………………………………………….

17. How do these problem affect the frequency of waste disposal at the site?................

18. Do you engage in waste sorting?

(a) Yes (b) No

If Yes, Where do you do the sorting?

(a) Source (b) collection point (c) Dumpsite (d) Other (Specify)……………………..

19. Do you engage in treating of waste?

(a) Yes (b) No

If Yes, How do you treat it?..

20. Please list all equipments available in your Agency/Department that can be use in solid waste management?

No.	Equipments	Functional	Non-functional
1.			
2.			
3.			
4.			
5.			

21. Which other Agency do you collaborate with in solid waste management?.............

22. If any, what is the nature of your collaboration?...

23. What is the total number of staff in your Agency in solid waste management?........

24. Number of collection points in your area of coverage?..

25. Number of dumpsites in your area of coverage…………………………………….

26. In your own view what are some of the problems facing the Department in terms of managing waste?..

………
………

27. How can the problems be solved?..

……
…….

APPENDIX II

DEPARTMENT OF URBAN AND REGIONAL PLANNING

FACULTY OF ENVIRONMENTAL DESIGN

AHMADU BELLO UNIVERSITY, ZARIA.

SAMPLED QUESTIONNAIRES: FOR HOUSEHOLD HEAD

INTRODUCTION

I am a post graduate student of Ahmadu Bello University, Zaria from the Department of Urban and Regional Planning, conducting a research on Assessment of Households Solid

Waste Management in Gombe. All information provided shall be treated in absolute confidence. Thank you.

Date:……………………………………………………………………………………….

1. Occupation of household head…………………………………………………….

2. Level of education

(a) Tertiary (b) Secondary (c) Primary (d) Other (Specify)…………………………….

3. Monthly income…………………………………………………………………...

4. No. of persons in Household ………………………………………………………..

5. Solid waste generation per day…………………………………………………….

6. What types of waste do you generate?..

7. How do you store your household waste at home?

(a) Drums (b) Polythene bags (c) Sack (d) Open ground (e) Basket (f) Cartoon

8. How far is Government dustbin from your home?...

9. Where do you dump your household waste?

(a)Vacant plot (b) Burning (c) Collection point (d) Drainage (e) Open space

10. Who collects your solid waste?

(a) GOSEPA (b) Inex cleaners (c) Informal waste collectors (d) CBOs (e) Other (Specify)…………………………………………………………………………..

11. Method of collection

(a) Door to Door (b)Road side (c) Neighborhood level (d) Other (specify)……………

12. How often is your waste collected in a week?

(a) Daily (b) Twice a week (c) Once a week (d) Not collected (e) Others (specify)…...

13. Do you pay for waste collection system? (a) Yes (b) No

If Yes, please specify how much ₦…………………………………………………..

If No, why?...

14. Do you engage in waste sorting? (a) Yes (b) No

If No, Why?..

15. Do you reuse any waste items? (a) Yes (b) No

16. What do you reuse?

(a) Plastic bags (b) Plastic bottles (c) Paper bags (d) Other (Specify)………………….

17. Is solid waste a problem in your neighborhood? (a) Yes (b) No

If Yes, please specify why………………………………………………………………

18. Which of these environmental problems is in your neighborhood?

(a) Rubbish heap (b) Dirty streets (c) Waste in open drains (d)Rubbish fires (e) Flies and Mosquitoes (f) Other (Specify)…………………………………………………..

19. Do you think that the above mentioned problems can be improved?

If Yes, how?..

If No, why not?...

20. Who do you think should be responsible for solid waste collection?

(a) Individual (b) GOSEPA (c) Both

21. What do you think would improve waste collection?.....................................…

22. Would you participate in improving waste collection? (a) Yes (b) No

If Yes, how?..

If No, why?...

APPENDIX III

DEPARTMENT OF URBAN AND REGIONAL PLANNING

FACULTY OF ENVIRONMENTAL DESIGN

AHMADU BELLO UNIVERSITY, ZARIA.

SAMPLED INTERVIEW QUESTIONS: FOR INFORMAL WASTE COLLECTORS

INTRODUCTION

I am a post graduate student of Ahmadu Bello University, Zaria from the Department of Urban and Regional Planning, conducting a research on Assessment of Households Solid

Waste Management in Gombe. All information provided shall be treated in absolute confidence. Thank you.

Date:……………………………………………………………………………….

1. Types of waste collector………………………………………………………...

2. From who do you collect your waste?……………………………………………..

3. How much are you paid for the collection?……………………………………….

4. How many of you operate on this neighborhood?…………………………………...

5. Where do you take your waste to?

(a) Collection points (b) Drainage (c) Open spaces

6. Do you engage in waste separation?

If Yes, where do you take the recycled material to?…………………………………

7. What type of recyclables do you collect?..

8. How much do you sell them to the buyer?…………………………………………...

APPENDIX IV

DEPARTMENT OF URBAN AND REGIONAL PLANNING

FACULTY OF ENVIRONMENTAL DESIGN

AHMADU BELLO UNIVERSITY, ZARIA.

SAMPLED INTERVIEW QUESTIONS: FOR CBOs AND NGOs

INTRODUCTION

I am a post graduate student of Ahmadu Bello University, Zaria from the Department of Urban and Regional Planning, conducting a research on Assessment of Households Solid Waste Management in Gombe. All information provided shall be treated in absolute confidence. Thank you.

Date:……………………………………………………………………………………….

1. Name of Organization…………………………………………………………………..

2. What is your Mandate…………………………………………………………………..

3. Do you participate in solid waste management?...

If Yes, what role do you play?...

If No, why……………………………………………………………………………….

4. Do you have any relationship with any Government Office?

If Yes, please specify the form of relationship………………………………………….

If No, why……………………………………………………………………………….

5. Do you collect wastes?...

If Yes, how do you organize collection?...

Where do you dispose of the waste collected?...

6. Why is the problem of waste persisting in the neighborhood?...................................

7. Please, give suggestions towards an effective management of household solid waste collection in Gombe…………………………………………………………..........