ASSESSMENT OF SOLID WASTE MANAGEMENT IN SAMARU ZARIA, NIGERIA

BY

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DECLARATION

I, **ADENIYI Toyin Funmilayo** hereby declare that the work in this dissertation titled **"Assessment of Solid Waste Management in Samaru Zaria, Nigeria"** presented to the Department of Geography, Ahmadu Bello University, Zaria is the result of my own research and it has not been presented in any form, anywhere for the award of a degree in any institution.

All literature herein referenced and cited have been duly acknowledged. All shortcomings in this are entirely my responsibility.

_____	_____	_____
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CERTIFICATION

This project report/thesis/dissertation titled 'Assessment of Solid Waste Management in Samaru' meets the regulations governing the award of Masters' Degree of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

I dedicate this work to the Holy Spirit; my best friend, for the grace and wisdom to carry out this research.

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ABSTRACT

This study examines the existing solid waste management structure in Samaru, Nigeria with a view to recommending strategies that would usher in efficient solid waste management techniques and culture. The research gathered data from two main sources: Primary and secondary sources.Data were collected through the use of questionnaires administered to the waste generators and interviews of employees of relevant waste management agencies such as: Kaduna State Environmental Protection Agency (KEPA), Private Environmental Care Takers (PECT) while four hundred copies of structured questionnaires were distributed randomly among selected households. Also obtained from field work were data of samples (solid waste) from selected dump sites. The result indicated that the state agencies in charge of solid waste management are not functioning properly. This could be closely linked with the lack of equipment, trained and skilled manpower, coupled with poor funding of these agencies and also the attitude of the waste generators towards solid waste management. At the moment, 73% of the residents in Samaru use self collection and disposal methods. The result also indicates that 50% of the residents are willing to pay for improved solid waste management system. Waste segregation takes place mostly at the final dumpsite. Solid wastes are not dumped at the designated sites. 60% of the residents are aware of the public health risk of improper waste disposal. Most of the wastes generated are Food and fruit remnants, Paper and cardboard, Textile materials, Plastic materials, Metal scrap Bottle and Glass, Polythene; Nylon and Tin cans. The study also suggests ways by which solid waste management can be improved upon in Samaru and beyond and also proposed a conceptual frame work for waste management.

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

Waste is defined as materials of solid or semi solid character that the possessor no longer considers of sufficient value to retain (Gilpin, 1976).The New York State Department of Environmental Conservation (2007) also defined solid wastes in simple words as any discarded (abandoned or considered waste-like) materials. There are different types of waste: municipal waste (including household and commercial waste), industrial waste (including manufacturing), hazardous waste, construction and demolition waste, mining waste, waste from electrical and electronic equipments, biodegradable municipal waste, packaging waste, and agricultural waste. Solid wastes can be solid, liquid, and semi-solid or containerized gaseous material. Also, there are various sources of waste: residential, industrial, commercial, institutional, construction and demolition waste; municipal services manufacturing process, agriculture.

Municipal solid waste (MSW) is defined to include refuse from households, non-hazardous solid waste from industrial, commercial and institutional establishments (including hospitals), market waste, yard waste, and street sweepings. MSW is defined by Cointreau (1982) as non-air and sewage emissions created within and disposed of by a municipality, including household garbage, commercial refuse, construction and demolition debris, dead animals, and abandoned vehicles. Municipal solid waste is generally made up of paper, vegetable matter, plastics, metals, textiles, rubber, and glass (USEPA, 2002).

The solid waste management problem in Nigerian cities is becoming more alarming. The volume and range of solid wastes generated daily in Nigeria has been

increasing within the last few years. This is mainly due to the high population growth, urbanization, industrialization and general economic growth (Ogwueleka, 2004).

Cities are regarded as the most efficient agents of production (Hardoy, Mitlin and Satherthwaite, 2001). This population increase compounds the problems of solid waste management. Worse still, government agencies responsible for managing solid wastes, especially in urban areas are either nonexistent or ineffective.

Urban land use becomes complex as the city grows in population and physical size and so does the solid waste generation increase in volume and varieties. Urban land uses vary from residential, commercial, industrial, institutional; and others, with each category generating its own peculiar type of solid waste. However, residential land use constitutes the single most important generator of solid waste in Nigeria urban areas (Adegoke, 1990). Because of the complexity of the household wastes, the socio-economic structure of the urban population becomes a major determinant of the spatial structure of solid waste problems in our cities. Uwadiegwu (2003) in a study noted that the quantity of municipal solid waste produced depends upon the living standard of the residents, urbanization and industrialization.

Okoye (2004) identified household size, income level, level of technological advancement and socio-economic status as factors that affect the quantity of solid waste generation, but however, noted that a single factor may not on its own constitutes a difference in the quantity of waste generated by a household. Afon (2005), in a study of waste generation in Oyo State, Nigeria, discovered that as education, income and social status increase, per capita waste generation declines. This, he explained is partly influenced by the differences in employment/livelihood pattern in the area. On the main

cause of solid waste crises in Nigeria, Igbodobe and Anyata (2009) identify the problems of insufficient available data, funding, poor understanding of solid waste management and residents' attitude.

It is common for most of the solid waste generated in urban areas to be collected and dumped indiscriminately within or on sites outside the city without site preparation. Sule, (2001), however, observes that the type of waste disposal method adopted in any particular area depends largely on the prevailing local conditions such as availability of open space, accessibility and attitude of the people. From a global perspective Ali *et al* (1999) reiterates that disposal practice vary from city to city and country to country. As a panacea, Dung-Gwon and Magaji (2007) stressed that enforcement of waste management legislation is required as a proper policy and planning framework for waste management. Urbanization directly contributes to waste generation, and unscientific waste handling causes health hazards and urban environment degradation.

Nigeria has undergone a rapid urbanization during the past fifty years. The numbers of urban dwellers are expected to double between 1987 and 2015 (Ogwueleka, 2004). Urbanization implies the expansion of slum areas and the creation of new ones. Population growth intensifies the pressure on urban infrastructure in many cities in Nigeria that are already overburdened with the provision of urban services. Most cities lack the resources to meet the demand for services such as water, sanitation and solid waste management. The insufficiency of services results in a deterioration of the urban environment in the form of air, water and land pollution that poses risks to human health and the environment. Many municipalities see solid waste management as a problem of equipment, particularly how to obtain and maintain technologically advanced compactor

trucks, hydraulic−compressor containers, and transportable containers and transport vehicles. In developing countries, with insufficient technical services, spare parts and maintenance budgets, when such technically sophisticated equipment breaks down, the entire system fails. The waste generated by a community reflects its way of life, its wealth and its culture. Some communities use and discard great quantities of paper, others throw organic materials away. Restaurants dispose of quantities of food that is still fresh but however, it might be very valuable to the owner of animals. Thus, what is waste to one person might be a valuable resource for others.

Solid waste disposal is the disposal of normally solid or semisolid materials, resulting from human and animal activities that are useless, unwanted, or hazardous. Solid wastes typically may be classified as garbage, rubbish, ashes, large wastes, dead animals, sewage treatment solids, industrial waste, mining waste and agricultural wastes.

Municipal solid waste disposal is a major concern in developing countries like Nigeria as high poverty, population growth, and high urbanization rates combine with ineffectual and under-funded governments to hamper efficient management of wastes (Cointreau 1982, Doan 1998). In most cities and large towns in Nigeria, solid waste is not only heaped in huge quantities on refuse dumps but also thrown and made to lie around in piles in the street and in small illegal dump on any piece of unused land. Most third world countries have worst cases than industrialised countries which have the money and technical know now and public attitudes to control and manage their waste to some degree.

The common waste disposal methods are Sanitary landfill which is the disposal of waste material or refuse by burying it in natural or excavated holes, depressions,

incineration*;* burning the refuse to ashes. There is also the compost heaps where the refuse is left to degrade by aerobic micro organism and its used as fertilizer, then the resource recovery, a process of recovering energy and reusable materials from solid waste before decomposition or landfill. The resources also goes further to be utilized by the principle of 3Rs (reduce, reuse and recycle) (Taiwo, 2011).

Considerable percentage of urban waste in Nigeria is deposited on either the roads, or roadsides, unapproved dumpsites, in waterways drainage system, or in open sites, which adversely affect environmental friendliness. In fact, solid waste poses various threats to public health and adversely affects flora and fauna as well as the environment especially when it is not appropriately collected and disposed (Geraldu, 1995). Thus, the adjacent areas including high ways, farmlands, forest plantation, etc, are encroached upon which has a toll on biodiversity conservation (Hardy and Seatterwaite, 1992). Municipal solid waste management (MSWM) refers to the collection, transfer, treatment, recycling, resources recovery and disposal of solid waste in urban areas. The goals of municipal solid waste management are to promote the quality of the urban environment, generate employment and income, and protect environmental health and support the efficiency and productivity of the economy.

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. Per capita rate of MSW production in Nigeria is about 49million kg per year (Cyget, 2002; Aboyade, 2004) and the main components of these wastes are organic materials, paper, plastics/rubbers, textiles, and metals (Ojolo, 2004). According to All Sites Engineering (Ogwueleka, 2009), 320kg of waste is generated per month in

Kaduna state. The main purpose of solid waste management is to minimize the adverse effects on the environment. The steps involved are collection, disposal and utilization of solid waste.

Collection of waste includes gathering the waste, transporting it to a centralized location, and then moving it to the site for disposal. The collected waste is then separated into hazardous and non-hazardous materials. Before the final disposal of the solid wastes, it is processed to recover the usable resources and to improve the efficiency of the solid waste disposal system. The main processing technologies are compaction, incineration, and manual separation. The appropriate solid waste disposal method has to be selected, keeping in view the objectives of economic viability and not constituting a health hazard. It should also not cause adverse environmental effects or result in unpleasant sight, odour and noise.

Improper handling of the solid waste is a health hazard for the workers who come in contact with the waste. The environment is also affected in that if solid wastes are not treated properly, decomposition and putrefaction may take place, causing land and water pollution when the waste products percolate down into the underground water resources. The organic solid waste during decomposition may generate obnoxious odours. Stray dogs and birds may sometimes invade garbage heaps and may spread it over the neighbourhood causing unhygienic and unhealthy surroundings. 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 generate revenue through sanitary levy and

stringent regulations with heavy penalties for offenders of illegal dumping and littering of refuse along streets (Ogwueleka, 2003). But despite all the efforts and initiatives, the management of waste continue to pose different challenges. Managing waste in Nigeria is a problem due to many factors, including lack of adequate funding and excessive population, lack of trained / professional waste managers, and lack of effective monitoring and control.

Also, at the core of the problems of solid waste management are the absence of adequate policies, enabling legislation, and an environmentally stimulated and enlightened public. Government policies on the environment are piecemeal where they exist and are poorly implemented. Public enlightenment programs lacked the needed coverage, intensity, and continuity to correct the apathetic public attitude towards the environment. Up to now the activities of the State environmental agencies have been hampered by poor funding, inadequate facilities and human resources, inappropriate technology, and an inequitable taxation system. Successful solid waste management in Nigeria 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.

1.2 Statement of the Research Problem

In recent years, there has been a phenomenal increase in the volume of wastes generated daily in the country. This is due to a number of reasons including the increasing population growth rate, increasing urbanisation, industrialisation and economic growth. In addition, many urban areas of Nigeria lack effective waste management systems. As a result, most urban households resort to the haphazard

dumping, burning and/or burying of solid wastes. (Agunwamba, Egbuniwe and Ogwueleka 2003).

Agunwamba (1998) stated that the problem of waste management in Nigeria is due to the absence of public policy, enabling legislation and an environmentally stimulated and enlightened public. Appropriate policy and institutional mechanism for implementation of waste management strategies are critical for sustainable waste management. Where the policy is poor or the public is not properly sensitized or there are no proper enforcement of laws and regulations, waste management is a problem or challenge.

Urban solid waste management in Nigeria is constitutionally the responsibility of the third tiers of government, that is, the local government council. Financial, material and human resources that have been committed to waste management by this tier of government have not matched this responsibility. This is evident by the poor management of many landfill sites and soil and groundwater pollution due to often mixing of household, industrial and toxic waste (UNEP, 2000). In view of the environmental situation described above in many urban areas, many Nigerian cities have been described as dirty, unsanitary, and aesthetically displeasing in the world (Mabogunje, 1996). It is evident that management of solid waste remains a key issue to be addressed in this country.

In Armenia, collection, transportation, treatment and disposal of municipal solid waste have been neglected for several years because of inadequate resources. The existing institutions are inadequately equipped in terms of skills and capital resources to

effectively manage the waste problems (NEAP, 1998). Waste collection and transportation activities are quite poor organised.

Waste generation is primarily a function of people's consumption patterns and thus is based on their socioeconomic characteristics. Low-income groups and the very poor typically generate low volumes of organic waste. In Tashkent, Uzbekistan, for example, there is little food to go around and the parts that are not consumed by the household members are used for the domestic animals or composted to amend the garden soil. Those who are somewhat better off may share leftovers as well as old clothing with those more needy (Bernstein 1999).

The World Bank poverty and social impact assessment for Cashmere Sector Improvements, 2004, further stated that waste generation is also influenced to an important degree by people's attitudes toward waste: their patterns of material use and waste handling, their interest in waste reduction, the degree to which they separate wastes, and the extent to which they refrain from indiscriminate dumping and services. Attitudes may be positively influenced through awareness building campaigns and education about the negative aspects of inadequate waste collection with regard to public health and environmental conditions, and the value of effective disposal. Such campaigns also should inform people of their responsibility as waste generators and of their rights as citizens to adequate solid waste management services (Kudat, 1988).

Refuse dumps have now taken over roads that link to various parts of Zaria especially in Samaru. Frequent users of the Samaru roads in Hayin Dogo, Danraka, Samaru market and some other parts of Samaru always have to contend with the sight of human and cattle excreta, and refuse dumps that have almost taken over the roads.

Despite the efforts put in by KEPA and Ahmadu Bello University in managing waste in Samaru it still faces the waste management problem. A major premise responsible for the poor management of waste in the Samaru area is the absence of a well defined management structure.

Therefore the research problem seeks to assess the way waste in Samaru, Zaria is managed towards providing a better way of solid waste collection and disposal, and proposing an institutional framework that will help the government agency for a better solid waste management structure.

1.3 Aim and Objectives of the Study

The aim of this research is to assess the functionality of the municipal solid waste management structures in Samaru. The study has the following objectives, to:

i. Characterize the current municipal solid waste (quantity and characteristics) in the study area.
ii. Assess the functionality of the existing institutional structure(s) for solid waste management in the study area.
iii. Develop an organogram of municipal waste management in the study area.

1.4 The Scope of the Study

This study focused majorly selected locations; Hayin Dogo, Samaru new extension, Tagwae engine and Danraka. Other final dumpsites such as the ones situated in Zango, Bassawa and Bomo road were also looked into and a better way of managing them will be recommended. Data on the characteristics of wastes of these dumpsites were collected. The volume of dirt in Samaru is overwhelming. The roads and drainages are littered with different kinds of waste like carrier bags (paper and plastic; which is like

80% of the wastes in Samaru) ,rags, yard sweepings, charcoals, pieces of wood, cans of food and drinks alike, sachet water bags, cattle and human faeces to mention but a few.

1.5 Justification of the Study

The wastes in Samaru spoil the aesthetics of Samaru, especially as an academic environment. The major reason for this is poor waste management. Waste management is an important and integral part of our society and therefore needs to be acknowledged as one of the few things that may help to preserve the beauty and splendour of Samaru, Zaria, for future generations. Waste generation increases with population expansion and economic development. Improperly managed solid waste poses a risk to human health and the environment. Uncontrolled dumping and improper waste handling causes a variety of problems, including contaminating water, attracting insects and rodents, and increasing flooding due to blocked drainage canals or gullies. In addition, it may result in safety hazards from fires or explosions.

Improper waste management also increases greenhouse gas (GHG) emissions, which contribute to climate change. Planning for and implementing a comprehensive program for waste collection, transport, and disposal—along with activities to prevent or recycle waste—can eliminate or at least reduce these problems. This study examines the need for effective municipal solid waste management in Samaru in order to achieve a clean and hygienic environment. Samaru residents especially those who live in Hayin Dogo, Danraka, and Samaru market battle with refuse dumps situated in drainages, road networks, along the streets, as well as adjacent to residential buildings.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Waste is everyone's problem and is not only confined to less developed neighbourhoods or to developing countries and the poorer nations. Waste has in fact become such an important part of human ecological footprint, that our very existence is threatened by its contribution to global warming and the associated environmental degradation. The leading industrial countries in the world have recognised that continued waste generation cannot be offset by improved land filling techniques, but that alternative policies, practices and technologically advanced disposal methods need to be developed and implemented (Spamer,2009). A lot has been said, written, and demonstrated about the inadequacies in solid waste management and its associated problems. According to the United Nations Conference on Human Settlement report, one third to one-half of solid waste generated within most cities in low- and middle-income countries, are not collected. They usually end up as illegal dumps on streets, open spaces, and waste lands (UNCHS 1996).The problem of solid waste has become the nation's most serious environmental problem. In recent years, the problem has become so aggravating that between 1977 and 1982, a total of nine conferences and meetings of local governments, commissioners were organised in various States across the nation to discuss problems of refuse collection and disposal (FMHE, 1983).

A research on the evaluation of solid waste management policy in Benin, by Kalu *et al* (2009) stated that Solid waste disposal constitutes a nuisance and creates a breeding ground for pests and diseases in Benin metropolis. Study was undertaken to assess how the policy on solid waste management had faired in waste disposal. The findings reveal

that solid waste policy has not faired very well in Benin metropolis despite the fact that there is a considerable level of awareness among the public on the unpleasantness of filthy environment. In conclusion *Kalu et al* said that awareness campaign, payment of bonus for well sorted out disposed solid wastes and technically desirable managed dump sites should be the main strategies of environmental solid waste policy in Benin City.

In this chapter the current solid waste management policies, practises and opinions in other countries of the world, as well as in Nigeria is looked at. Not only does this enable us to put our own situation in perspective, it also will help us propose a feasible institutional framework for solid waste management in the study area.

2.2 Solid Wastes Definitions and Classifications.

American Public Works Association (1975) defined solid waste as useless unwanted or discarded material with insufficient liquid content to be free flowing. Because of its 'sticky' nature, therefore, solid waste has the quality of accumulating, and physically insulting the environment, if not well managed. It is this propensity that sets solid waste apart from other forms of waste. Thus, it has been established that even in the smallest villages, solid waste management is generally accepted as a major aspect of the indigenous community organisation and traditional home management. Hopskinville (1976) explained that solid wastes are residuals from homes, businesses and institutions, and referred to it as trash garbage, rubbish, refuse, discards and throwaways that enter a local system for collection and disposal. Feacham *et a*l (1976) explained that solid waste can be classified in different ways. The first is the division of solid wastes or refuse into two broad groups; domestic and industrial solid waste. Secondly, simple system that recognizes three categories of solid wastes namely animals, vegetables and minerals.

Adedibu, (1983) stated that solid wastes are non-gaseous and non-liquid wastes resulting from a wide range of community, industrial, commercial and agricultural activities. He further grouped solid waste into eight classes namely: domestic, municipal, industrial, agricultural, institutional, pesticide, residential, and hazardous wastes. These classes of solid waste relate to their origin, as depicted in Table 2.1

Table 1.2: Solid Waste Classification

CLASSIFICATION OF SOLID WASTES	DESCRIPTION	SOURCES
Food waste (garbage)	Wastes from the preparation, cooking, and serving of food. Market refuse, waste from the handling, storage, and sale of produce and meats and vegetable combustible (primary organic) paper, cardboard, cartons	Households, institutions and commercial such as hotels, stores, restaurants, markets, etc.
Rubbish	wood, boxes, plastics, rags, cloth, bedding, leather, rubber, grass, leaves, yard trimmings Non-combustible (primary inorganic) metals, tin cans, metal foils dirt, stones, bricks, ceramics, crockery, glass bottles, other mineral refuse	Households, institutions and commercial such as hotels, stores, restaurants, markets, etc.
Ashes and Residues	Residue from fires used for cooking and for heating buildings, cinders, clinkers, thermal power plants	households, industries etc
Bulky waste	Large auto parts, tyres, stoves, refrigerators, others large appliances, furniture, large crates, trees, branches, palm fronds, stumps, foliage	Auto repair shops, households eetc
Street waste	Street sweepings, dirt, leaves, catch basin dirt, animal droppings, contents of litter receptacles	Streets, sidewalks, alleys, vacant lots, etc.
Dead animals	Small animals: cats, dogs, poultry etc. Large animals: horses, cows etc	Poultries, cattle ranches, households etc
Construction & demolition Waste	Lumber, roofing, and sheathing scraps, crop residues, rubble, broken concrete, plaster, conduit pipe, wire, insulation etc.	Construction and demolition sites, remodelling, repairing sites
Industrial waste & sludge	Solid wastes resulting from industry processes and manufacturing operations, such as food processing wastes, boiler house cinders, wood, plastic and metal scraps and shaving, etc. Effluent treatment plant sludge of industries and sewage treatment plant sludge, coarse screening, grit & septic tank	Factories, power plants, treatment Plants, etc.
Hazardous wastes	Hazardous wastes: pathological waste, explosives, radioactive material, toxic waste etc	Households, hospitals, institution, Stores, industry, etc.
Households, hospitals, institution, stores, industry, etc.	Tree-trimmings, leaves, waste from parks and gardens, etc.	Parks, gardens, roadside trees, etc.

Source : Bhide and Sundersan, (1983)

Generally, solid waste management can be classified into three categories. They are municipal solid waste, industrial solid waste and hazardous solid waste (Oladipo 2012)

Municipal solid waste: These are defined to include refuse from households, non-hazardous solid (not sludge or semisolid) waste from industrial and commercial establishments, and refuse from institutions (including non-pathogenic waste from hospitals), market waste, yard waste and street sweepings. Sometimes, construction and demolition debris is also included (Oladipo, 2012).

Industrial Waste: Industrial waste is generally referred to as a material from a manufacturing process that has no value to the manufacturer and that has to be disposed of in some manner. With rising economic standards and with many imported consumer goods (particularly food items), Nigerians increasingly have access to packaged goods, often using plastics, which makes waste disposal difficult. The development and widespread use of new packaging substances such as plastics have improved the standards of living for millions, but they have also introduced new threats to the environment, as typified by the histories of dichlorodiphenyltrichloroethane (DDT) and polychlorinated bi-phenyls (PCBs). Thus, industrial development also brings in its wake problems of environmental pollution that often need abatement. In Nigeria, the four most industrialized States are Lagos (home to approximately 60% of the Nigerian industries), Rivers, Kaduna and Kano. Collectively, these States share approximately 80% of the Nigerian industry. Cleanup of industrial waste is costlier than prevention. The lowest level in the hierarchy (avoidance, utilization, minimization, recycle, reuse etc.) and the one that all other levels strive to eliminate is remediation of the impacts of waste

discharged to the environment. The key industries in Nigeria are cement and asbestos, fertilizer and agro-chemicals, metallurgy and mining, tanneries, textiles and petroleum and petro chemicals. At present, the petroleum industry contributes over 85% annually to Nigeria's foreign exchange revenues. Environmental pollution from these industries is regulated by National Environmental Standards and Regulations Enforcement Agency (NESREA) and various state and other regulatory agencies. Among these agencies, the relationships are overlapping and not harmonized for regulatory environmental enforcement. (Oladipo, 2012).

Hazardous Waste: A special class of waste known as hazardous waste, mostly discharged into the environment from industrial and related sources attracts special attention and management considerations because of their harmful nature to man and other components of the ecosystem. A waste classified as hazardous waste, by definition and convention usually has one or more of the following four characteristics: ignitability, corrosivity, reactivity and toxicity. These definitions show that a wide range of substances of different physical forms (liquid, gaseous, solid, or in solution) fall into the class of hazardous materials which may become waste. Hazardous wastes have been known to cause serious environmental and epidemiological disasters as a result of the lack of or inadequate handling and management of these wastes (Oladipo, 2012).

According to Chaz (2002), four pounds of trash a day are generated by each man, woman and child in cities of developing countries in Africa. These wastes include substantial amounts of paper and cardboard (40%) as well as yard waste (18%), metals (9%), plastics (8%), and other products. Where does it all go? More than 70% of this material is buried directly in landfills. He further classified solid wastes into steel cans,

yard wastes, high density polyethylene, newspapers and aluminium packaging. He concluded that for solid waste effective collection, disposal, recycle, reuse and renewal it has to be segregated into biodegradables and non-biodegradables. Biodegradable wastes are waste materials that are capable of being broken down by micro- organisms into simpler substances or basic element which include organic waste, Examples include; kitchen waste, vegetables, fruits, flowers, leaves from the garden and paper. Non-biodegradable waste can be further segregated into recyclable wastes; plastics, paper, glass, metal, etc.

The above indicates the various dimensions of waste classification and the need for an agreed classification scheme. However, whatever classification is put in place, the issue of management is critical.

2.3 Waste Management

Waste management is the collection, transportation, and disposal of garbage, sewage, and other waste products. Waste management encompasses management of all processes and resources for proper handling of waste materials, from maintenance of waste transport trucks and dumping facilities to compliance with health codes and environmentalregulations(http://www.buisnessdictionary.com/definition/waste management, 2013)

Most of the wastes generated in most municipalities are not collected. They usually end up as illegal dumps on streets, open spaces, and wastelands. Despite the importance of adequate solid waste management to the urban environment, the performance of many city authorities in this respect leaves much to be desired. According to Malombe (1993), irregular services rendered to producers of refuse by municipal

councils compel them to find ways of disposing of refuse. He observed that the main methods adopted by the producers are burning, composting, or indiscriminate dumping. Incineration creates both gaseous emissions and ash, which may contain metal or hazardous compounds such as carbon monoxide, hydrocarbons and particulate matter (Murray and Raymond, 1984). Composting is an aerobic microbial driven process that converts solid wastes into stable, sanitary humus. Uchegbu (1998) pointed out that the major reason for processing refuse is for volume reduction. He further explained that as a result of low level technology, lack of finance and high level of illiteracy in the developing countries, open dumps are much in practice. The closure of existing open dumpsites and the introduction of sanitary landfills are of urgent priority. Even when complementary disposal technology such as composting and incineration are practised, a landfill is still required and is the backbone of any sustainable disposal system (UNEP, 2003). Sanitary landfill could be used in filling up borrow pits, valleys, erosion, gully sites, and other depressions; thus, using refuse to reclaim land. In general, no method of disposal can totally destroy the hazardous components of wastes. Each method leaves a residue of some kind (Nuclear Regulatory Commission, NRC 1983).

Levin and Morris (1983) explained that over a long period of time it may be impossible to prevent the release of toxic leachates or gases from the landfill. Toxic leachate from the landfill pollutes the ground water and soil. Smith(1996) stated that improperly prepared and operated sites may result in toxic heavy metal, hazardous, pollutants and products of aerobic decomposition seeping from the site into underground aquifers and subsequently polluting urban water supplies. Also the leachate from these toxic heavy metals can also degrade the soil, it can cause the soil to be acidic and the soil

cannot be used for agricultural purposes again. He concluded that open dumping reduces the aesthetic value of the environment and causes street litters. It also poses as a potential hazard to human health. It brings about rats, flies, etc which can transmit disease and cause epidemic in the environment. Chaz , (2002) stated that the unsightly dumpsites of municipal solid wastes are characterized by various non-biodegradable household petrochemical products such as polythene bags, plastic containers, Styrofoam, packages and the tyres.

WHO (1971) stressed that solid waste management is an important facet of environmental hygiene and needs to be integrated with total environmental hygiene planning. Its storage, collection, planning and disposal can lead to short-term risks. In the long term, there may be dangers arising particularly from the chemical pollution of water supplies. Management of solid waste reduces or eliminates adverse impacts on the environment and human health and supports economic development and improved quality of life. A number of processes are involved in effectively managing waste for a municipality. These include monitoring, collection, transport, processing, recycling and disposal (UNEP, 2000).

Monitoring involves constant examination and recording of the waste components and quantity of waste disposed over a period of time and also the compliance of the waste generators to the waste management policies (Bellany, 2007). Collection is the component of waste management, which comprises lifting, and removal /passage of a waste material from the source of production to either the point of treatment or final disposal. Collection of generated solid waste is the crucial part in MSW management. Efficiency in collecting solid waste and segregating it decides how well solid waste is

managed. Collection includes not only the gathering of solid waste, but also the transport of these materials, after collection, to the location where the collection vehicle is emptied. This location may be a material processing facility, a transfer station or a landfill disposal site (http://en.wikipedia.org/wiki/s).

Processing is preparing MSW materials for subsequent use or management, using processes such as baling, magnetic separation, crushing, and shredding. The term is also sometimes used to mean separation of recyclables from mixed MSW. Recycling is the process of transforming materials into raw materials for manufacturing new products, which may or may not be similar to the original product. Disposal is the final handling of solid waste, following collection, processing, or incineration. Disposal most often means placement of wastes in a dump or a landfill (UNEP, 2009).

2.4 Early Practices of Solid Waste Management

According to Tchobanoglous et al (1993: 17-18), the most commonly recognized methods for the final disposal of solid wastes were: dumping on land, canyons and mining pits, dumping in water, ploughing into the soil, feeding to hogs, reduction and incineration

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

Burning of dumps is also common in peri-urban and rural communities in Ghana and in many other less developed countries. A study carried out in Ado-Ekiti in Nigeria by Momoh and Oladebeye (2010) showed that, the methods of solid waste disposal

include dumping of waste in gutters, drains, by roadside, unauthorized dumping sites and stream channels during raining season and burning of wastes on unapproved dumping sites during the dry season.

This has gone to confirm that the practices of solid waste disposal in the 1950s still exist today and the study area is not an exception. On the other hand, Momoh and Oladebeye's (2010), assessment of waste situation in Ado-Ekiti in Nigeria is questionable, as they did not further explain what brought about the indiscriminate dumping. It could be that people dumped the waste anyhow because they were no dustbins for the people to store their waste for collection.

2.5 Integrated Solid Waste Management Concept

Integrated waste management includes all policies, practices, techniques and technologies related to the collection, transport, processing and/or disposal of waste materials (Spamer, 2009).

Various waste management concepts are used, and these include the "3 R's" (Reduce, reuse, recycle). Extended Producer Responsibility (EPR) and the Polluter Pays Principle (PPP). EPR requires that companies that manufacture, import and/or sell products, are held responsible for the proper disposal of these products after their useful life. End-of-life disposal costs of products will be included in the market price for the product. With PPP, the polluting party is held responsible for the costs incurred to restore the negative impact of its actions on the environment. The United Nations Environment Programme (UNEP) defined integrated waste management as "a framework of reference for designing and implementing new waste management systems and for analysing and optimizing existing systems" (Seadon, 2006: 1327).

Integrated MSW management is defined in the U.S. Environmental Protection Agency's (US EPA) *Decision-Makers' Guide to Solid Waste Management* as "a practice of using several alternative waste management techniques to manage and dispose of specific components of the MSW stream. Waste management alternatives include: source reduction, recycling, composting, energy recovery and land filling" (United States, 2008, pg 9).

Business dictionary.com (2013) defined 'Source reduction', also known as 'waste prevention' or pollution prevention, as the elimination of waste before it is created. It involves the design, manufacture, purchase or use of materials and products to reduce the amount or toxicity of what is thrown away. Recycling is the collection, processing, and reuse of materials that would otherwise be thrown away. Materials ranging from precious metals to broken glass, from old newspapers to plastic spoons, can be recycled. The recycling process reclaims the original material and uses it in new products (Redmond, 2008, Hartman, 2009). Recycling is resource conservation activity and it may offer a greater return for many product in energy saving. The recyclable materials such as paper, plastic and metal are often collected at the source. After collection, these items are sent to factories for recycling (Shapkota *et al*, 2006).waste-to-energy conversion is an Incineration process in which solid waste is converted into thermal energy to generate steam that drives turbines for electricity generators.

The "3 R's" relate to strategies to minimize waste before land filling: reduction of waste generation, reuse of waste materials for different applications rather than disposing of it and recycling waste to extract materials of value for use in the production of new products Four basic, interactive strategies have been identified by the US EPA to manage

waste i.e. source reduction, recycling (including composting), waste-to-energy conversion and land filling (Seadon, 2006: 1330).

Integrated Solid Waste Management (ISWM) as described by Oladipo (2012) is a comprehensive waste prevention, recycling, composting, and disposal program. An effective ISWM system considers how to prevent, recycle, and manage solid waste in ways that most effectively protect human health and the environment. ISWM involves evaluating local needs and conditions, and then selecting and combining the most appropriate waste management activities for those conditions. The major ISWM activities are waste prevention, recycling and composting, and combustion and disposal in properly designed, constructed, and managed landfills (see Figure 2.1). Each of these activities requires careful planning, financing, collection, and transport.



Figure 2.1: Integrated Solid Waste Management
Source: Oladipo 2012

***Waste Prevention*:** Waste prevention also called source reduction – seek to prevent waste from being generated. Waste prevention strategies include using less packaging, designing products to last longer, and reusing products and materials. Waste prevention help reduce handling, treatment and disposal costs and ultimately reduce the generation of pollutants escaping to atmosphere from waste treatment and disposal processes.

***Recycling and Composting*:** Recycling is a process that involves collecting, reprocessing and/or recovering certain waste materials (e.g., glass, metal, plastics and paper) to make new materials or products. Some recycled organic materials are rich in nutrients and can be used to improve soils. The conversion of waste materials into soil additive is called composting. Recycling and composting generate many environmental and economic

benefits For example: they create jobs and income, supply valuable raw material to industry, and produce soil enhancing compost leading to better agricultural productivity.

Disposal (land filling and combustion)-these activities are used to manage waste that cannot be prevented or recycled. One way to dispose of waste is to place it in properly designed, constructed and managed landfills where it is safely contained. Another way to handle this waste is through combustion. Combustion is the controlled burning of waste, which helps reduce its volume. If the technology is available, properly designed, constructed, and managed landfills can be used to generate energy by recovering methane. Similarly, combustion facilities produce steam as a by-product that can be used to generate energy. All of these are very relevant and needed for Nigeria and can be developed using the business model of public private partnership as is being practiced in some other countries.

2.5 The Waste Hierarchy

According to Archana (2009), due to current lavishing lifestyle trade, continuous waste generation is an obvious phenomenon. For better management of solid waste, periodic review of each steps involved in waste management like generation, collection, disposal etc should be conducted & accordingly implementation of "Best Practices" is necessary. Best practices for waste management can be achieved by well-known '3 Rs' principle.

The waste management hierarchy can be traced back to the 1970s, when the environment movement started to critique the practice of disposal-based waste management. Rather than regarding 'rubbish' as a homogenous mass that should be buried, they argued that it was made up of different materials that should be treated

differently – some shouldn't be produced, some should be reused, some recycled or composted, some should be burnt and others buried (Schall 1992). The waste management hierarchy is a concept that promotes waste avoidance ahead of recycling and disposal. The shortened version of the hierarchy, 'reduce reuse recycle' is frequently used in community education campaigns, and has become a well-recognised slogan for waste reduction and resource recovery (John and Helen, 2003).

The 'reduce, reuse and recycle' waste hierarchy comprises the three elements, 'reduce', 'reuse' and 'recycle' (also known as the 3R's).

"Reduce" means to reduce consumption and the amount of waste generated. This includes buying and consuming less, as such also throwing away less. **"Reuse"** is simply the act of using an item again and again in its original form. Reusing items eliminates the need to reprocess materials (whether it is for disposal or for recycling). **"Recycle"** means to give old or used things a new lease of life, by making new things out of the old materials.

The "Reduce Reuse Recycle" hierarchy as seen in figure 2.2 below was developed in order to minimize waste as well as conserve natural resources and extract the most out of already produced goods. The Three 'R's, "Reduce Reuse Recycle", are aligned into a hierarchy to illustrate the most effective plan of action for waste management practices.

Reducing consumption and waste production is the first and most effective step toward producing less waste (consuming less automatically produces less waste). However, there are times when consumption is necessary. In these cases, reuse as much as possible before recycling any remaining materials.



Figure 2.2: The Waste Management Hierarchy
Source :(http://en.wikipedia.org/wiki/Waste_management)

Reduce

It cannot be over-emphasized, that of the three components – reduce reuse recycle – "reducing" (consumption and waste production) is the most effective way to conserve resources and produce less waste. By purchasing much more than we actually need, each and every one of us accumulatively feed the culture of consumerism, and in turn fuel the driving force for manufacturers to produce more and more, in other words, use more resources and create more waste**.** Next in line is "reusing". Reusing products, where possible, is even better than recycling because the item does not need to be reprocessed before it can be used again. There are many ways of reusing things. When purchasing

products, look for the ones that have reusable packaging such as glass jars. Other common sense methods of reusing include wearing and passing on clothing, purchasing used items such as books and household items and reinventing items that no longer serve their original purpose. (All-recycling-facts.com, 2012).Leblanc (2013) defined recycling as the production of new products or materials from used materials or scrap. Recycling is a key strategy in the reduction of solid waste, and the third plank of the waste hierarchy of reduces, reuse and recycle. It is conventional wisdom that the best tact for society is to reduce the consumption of materials, and second best is to reuse the product multiple times, and the third best approach is recycling of the product.

Jones *et al*. (1987) explained that plastics, aluminium, glasses and paper comprise a significant volume of household and office trash but the society has been slow in recycling these materials, He further explained that plastics and papers can be recycled to make products like plastic wrap, soft drink bottles, protective hard hats, tissue paper, serviettes, cards etc.

2.6 Solid Waste Reuse and Recycling in Nigeria

Though waste problem has not been pronounced for long in the less developed countries like Nigeria, it is known that there have been some local methods by which solid wastes were been reused or recycled. The knowledge of waste recycling and reuse is not a new one in the Nigerian context; it is the current sophistication involved that is rather new. Waste facilities in developing countries are minimal but substantial quantities are diverted for recycling (Tajudeen, 2003).

There has been an emergence of biodegradable solid waste in the production of organic fertilizer and possible use in the production of biogas. Some researchers have

studied the great potentials in Nigeria's municipal solid wastes to produce enormous amount of methane gas (Yusuf and Oyewumi, 2008). Mixtures of manure and ashes from burning of urban solid wastes have been used for soil amelioration to boost agricultural productions in Jos (Pasquini and Alexander, 2003). Abeokuta alone generates 2 288m^3 of wood wastes per day from saw mills activities (Aina, 2006). If each state in Nigeria generates equal amount of wood wastes, then 82 368 m^3 of wood wastes will be generated in the country per day, and 30 064 320 m^3 annually. Resource from wood wastes alone could meet more than Nigeria's needs in the wood-based raw materials for such industries as potash industry, since African wood species have been studied to have potentials for generating good amount of potash (Adewuyi *et al.,*
2008).

It was a taboo to waste anything that cost money in Nigeria. So there was reuse culture that have been planted into Nigerians indigenously. Every item used were structured for reuse. Even today, the sachet water that is hawked is used by horticulturist for flower nursery, and paper wrappers are reused. The reuse tradition is what makes old newspaper useful for paper wrappers are reused. The reuse tradition is what makes old newspaper useful for wrapping roasted groundnut and popcorn (guguru) or akara, the popular fried bean cake. Apart from the fact that the reuse culture saves lots of money, it is highly conservative resulting in waste management.USA uses billion disposable diapers each year and they all end up in landfills where they remain entombed for centuries which is less in Nigeria due to the fact that reusable cloth diaper are mostly used.(Ajibade *et al*, 2005). Okoli (1986) aptly stated that notwithstanding the admitted fact that the developed countries experiment at the desired ability of refuse recycling and

reclamation, the practice is to a very high degree in the poorer parts of the developing world and it is done as part of any disposal plan but scavengers and beggars.

2.7 Sustainable Waste Management

Sustainable development is ‘development that meets the needs of the present without compromising the ability of future generations to meet their needs’ (Brundtland Report, 2013). A growing population and development in the region will inevitably increase pressures on the environment with growing waste generation and disposal rates. 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 minimisation of waste streams. This includes the management of resources in an environmentally sound and economically effective manner.

The notion of sustainable waste management has come to mean different things to different stakeholders with different environmental, economic and societal considerations given greater or lesser prominence. For example for some it can simply mean the sustainable management of leachate, and landfill gas is returned to the environment in environmentally accepted fashion (Bruce, 1998).For others such as Tammengi (1999) it means protecting health and environment; minimizing the burden of future generations has been critique for not fully addressing the economic requirement of sustainability

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. Nilson-D Jerf and Mac-Donald, (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).

2.7 Problems of Solid Waste Management

In Nigeria Atsegbua *et a*l (2013) identified some factors as being responsible for penetrating the crises experienced in the management of household waste in Nigeria and summarized them as follows: lack of adequate funding and excessive population, lack of trained/professional waste managers, lack of effective monitoring and control, peculiarity of the Nigerians attitude towards the environment in general, lack of modern technology/lethargy in implementation of efficient waste management methods. It can therefore be said that the main challenges facing solid waste management in Nigeria include: inadequate funds to support waste management, inadequate equipment to

support waste storage, collection and disposal, crude open dumping and burning without air and water pollution control.

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/incinerate/landfill) 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 KEPA 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. Figure 2.4 below illustrates the conceptual frame work of the study.

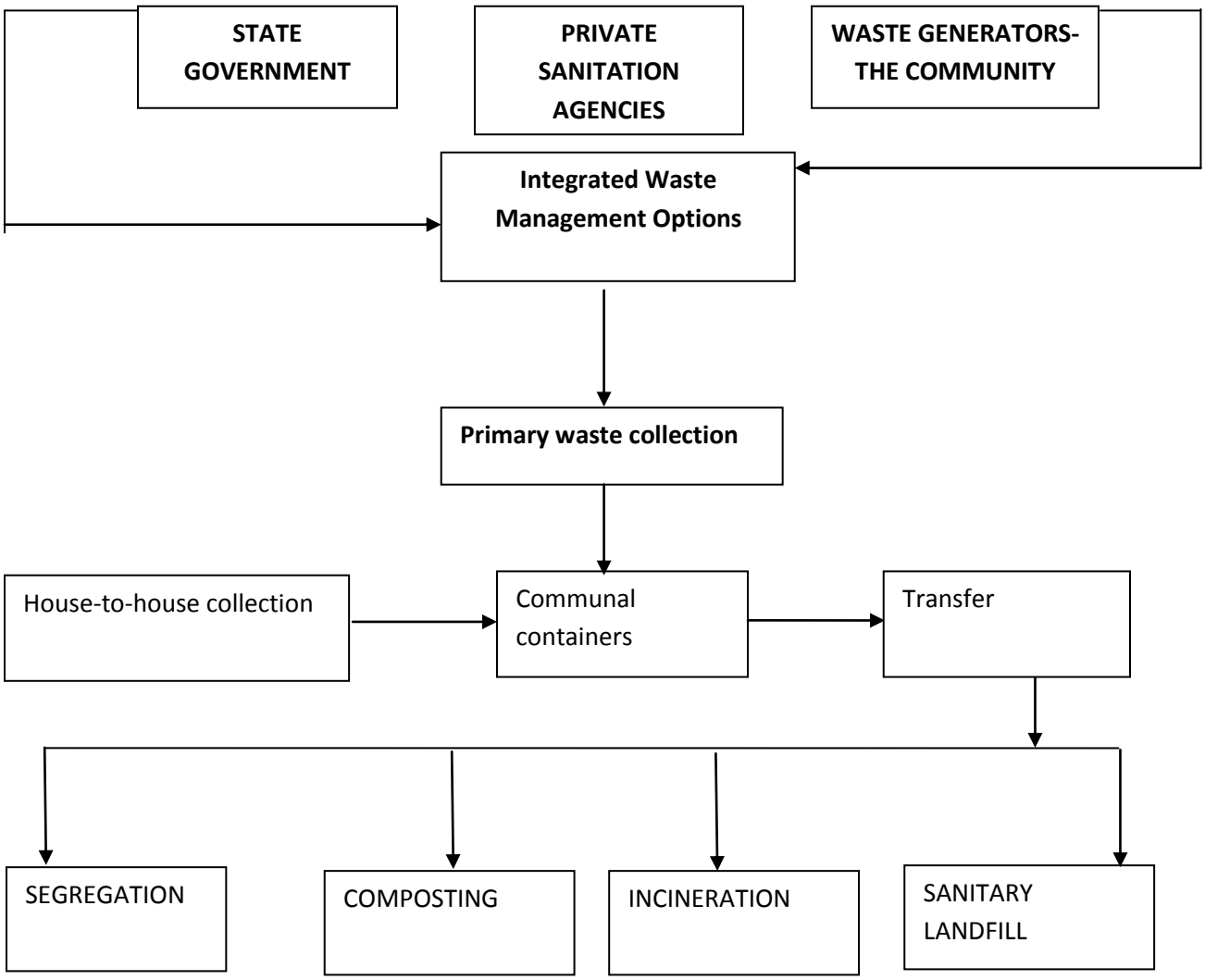


Figure 2.4: Conceptual Framework

From figure 2.4 above, household solid waste management is the focus of the framework. Therefore, in the solid waste management stream, the issues been considered are: the integrated waste management options (segregation, incineration, composting and landfill) and the role stakeholders play (State government/KEPA, private sanitation agencies and the waste generators-the community) 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 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.

CHAPTER THREE

THE STUDY AREA AND METHODOLOGY

3.1 Study Area

Samaru is a growing urban settlement within Zaria. The area has a cosmopolitan characteristic owing to the presence of several educational institutions which attracts people all over Nigeria for academic and employment purposes It is located approximately on latitudes 11^0 10` and $11^0$ 11` North and longitudes 07 ^{0} 37 ` and 7 $^0$ 40` East . The area is found in Sabon Gari LGA located between ABU, Basawa and Bomo (Fig 3.1). The origin of Samaru is although traced to a primordial stream with a tree in a place known as Gangan Uku or old Samaru, its expansion started with the establishment of the Nigerian College of Art, Science and Technology in 1951. Later in 1962 the college was transformed to Ahmadu Bello University (ABU) and this led to a rapid influx of people into the area for both educational and occupational reasons. Today other institutions are added to ABU leading to further increase in population. Samaru has a climate similar to Zaria with a distinct variation in rainy and dry seasons (Sawa and Abdulhamid, 2009).

According to Bako (2006) Samaru is predominantly residential .Samaru as used here includes the settlement behind the rail line to Kaura Namoda known as Hayin Dogo. Using a 3.0 growth rate, the population is expected to be about 5,920 by 2009 .With a population like this occupying 2275 Ha (Bako, 2006) a substantial volume of waste will be generated on a daily basis. However there is no government-authorized waste disposal Infrastructure in the area hence residents dispose waste in open spaces and drainage channels. In fact, presently a “whale back” of waste has been formed behind the old

cemetery along the rail lines separating Samaru from Hayin Dogo due to accumulated deposit of waste. Waste disposal in Samaru is similar to the experience in other urban centres in Nigeria hence used for the study.

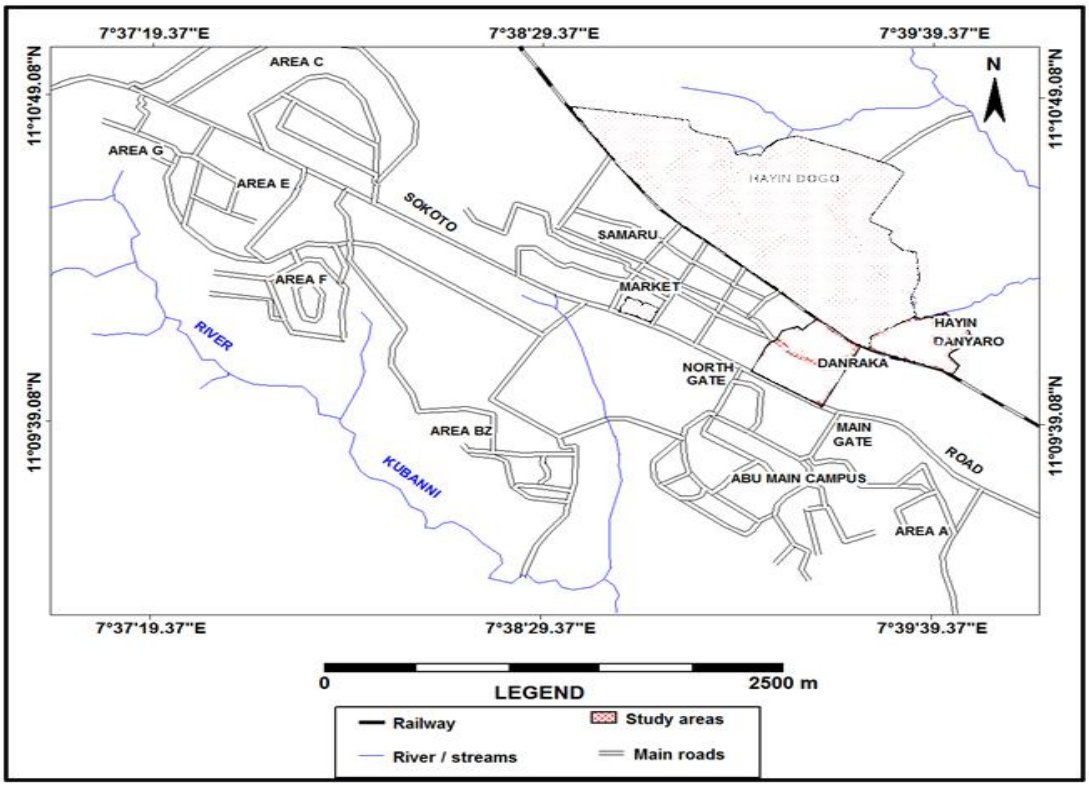


Fig.3.1 Map of Samaru
Source: Modified from Google earth map of Samaru, 2011

3.1.2. Climate

The climatic condition of Samaru is the same with that of the whole Zaria urban region which is that of tropical continental. There are two marked seasons in the area, the dry windy season and the rainy (wet) season. The wet season is usually from April through October with an average rainfall of about 1016mm (http://www.britanicca.com)

3.1.3 Soil and Vegetation

The soil type of the study area is alluvial soil. Also the area constitutes dark vertisol referred to as "fadama" soil (In Hausa language) this soil is classified as hydromorphic soil. The fadama soil is usually found in the upstream and downstream of the stream system, while the alluvial soil is predominately at the middle of the stream. The soil composed of fine grey–brown sands, clay, red sand and gravel. The upper parts of the soil are a mixture of quartz, mica and windblown particles from the harmattan.

The region generally falls within the Guinea Savannah vegetation. The vegetation of the area ought to be northern Guinea Savannah, but because nearly all vegetation within the stream system has been degraded due to man's activities such as intense cultivation, and fuel wool felling, the real climax vegetation is almost absent. What is seen presently are few scattered trees interspaced with tall grasses about 1-15m and 25m respectively. Trees found here includes Isorberlina doka, grass type includes Adropogonaea spp, Schizachirium semiberbe and Monocynbium ceresti (Nyagba, 1986).

3.1.4 Drainage and Geology

The study area is underlain by rocks of a basement complex (igneous and metamorphic) of the Precambrian age. The complex is composed of granodiorite, biotite granite, granite igneiss, ,schist and quantize. They are usually overlain by the overburden materials except in few places where they are exposed as inselbergs whalebacks and platforms. The ground is sandy-clay-loam and permeable. (Alagbe, 2002).

The drainage system focuses on River Galma and Kubanni River. River Galma is a major tributary of Rivers Kaduna and Kubanni, on which Ahmadu Bello University Dam is situated. They are seasonal and supply water to Ahmadu Bello University and its

environs. Samaru stream flows in north south direction through the main campus of Ahmadu Bello University Zaria, situated along a valley west to Samaru village into the Kubanni River. (Yusuf and Shuaib, 2012).

3.1.5 Population

Samaru is predominantly residential. According to the 1991 population census, Samaru had 12,978 people with 7,417 males and 5,561 females. Based on the 3.0 growth rate of the 1991 census, the population of Samaru was projected to about 18,039 by 2009. With such a population growth, it is expected that a substantial volume of waste would be generated daily (Benedine and Yusuf, 2011).

3.1.6 Human Activities

Samaru evolved from a small colonial farming settlement to become a large community, a melting-pot, often referred to as "the University village" (Maplandia.com, 2005).Samaru is considered by some to be a main centre of Hausa agriculture. It's a market town for the surrounding area. It is the home of numerous artisans, from traditional crafts like leather work, dyeing and cap making, to tinkers, print shops and furniture makers (Girhing, 1984). Majority of these people being illiterates careless about the environment and its aesthetics, therefore leading to poor waste management in Samaru community.

3.2 Methodology

3.2.1 Types and Sources of Data

Primary Data

Data were primarily sourced using questionnaires administered to waste generators. Preliminary field investigations and face-to-face interviews of Kaduna Environmental Protection Agency (KEPA) and Private Environmental Protection Agency (PECT) staff. 400 copies of structured questionnaires were distributed randomly in households and shops in Samaru. Data collected through questionnaire survey were on the following variables: Place of disposal, method of disposal, availability of bins for storing waste, mode of collection and payment for collection, segregation practice, and the risk of improper waste management.

The Mathematical method used to determine the number of questionnaires:

Formula: n, N/1+N (e) ^{2} Where n=sample size, N=sample frame (6,000000M) and α represented the margin of error which is 0.05 with confidence level of 5%. By substituting 6, 0000 and 0.08 into the formula: $60000/1+6000000(0.05)^2$; n=399.9

Secondary Data

Secondary data were obtained from books, articles, newspapers and internet sources to review literature.

3.2.2 Techniques of Data Collection/Sampling

i. In selecting the respondents, a combination of simple random sampling and systematic sampling was employed. Random sampling was used to select streets while systematic sampling was used to select households and shops.

ii. The staff of KEPA were interviewed to elicit information about the main sources/characteristics of solid waste in Samaru, the waste disposal techniques and how effective they are.

Danraka, Hayin dogo, were used as sample areas where the questionnaires was distributed, the questionnaires was structured to elicit information leading particularly to determine the kind of collection and disposal of refuse method precisely used in Samaru municipality and how effective they are and also the attitude and perception of the residents in the study area to waste management.

3.2.4 Techniques of Data Analysis

Data was analyzed using descriptive statistical techniques like tabulation, percentages and averages

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.2 Introduction

In the introduction to this research, it was indicated that the aim of this study was to assess the functionality of the municipal solid waste management structures in Samaru. In this chapter the present state of the waste management structure existing in Samaru and its functionality and also the attitude and perception of the waste generators were analysed and discussed.

4.2 Current State of Municipal Solid Waste

Wastes in Danraka, Hayindogo, and Dogo Hiche were collected and it was observed that the dumpsites had more of the following categories of waste: Food and fruit remnants, paper and cardboard, textile materials, plastic materials, metal scrap, bottle and glass, Polythene; Nylon and tin cans.

Samaru been classified as an urban area, its wastes contained more of non-biodegradable than biodegradable wastes. This confirms the findings of Akpu and Yusuf (2011) that conditions of life in the rural areas are poor hence, few manufactured products can be afforded compared to urban areas where standard and quality of life are high and a variety of modern confectionaries are produced in bottles, tin cans and polythene bags and are mostly consumed by urban dwellers. Also the quantity of waste generated is determined by the socio-economic status of the people.

4.3 Method of Waste Collection

The study indicated that the respondents use dustbins, polythene bags to collect solid waste and some create refuse heaps in their surroundings were they pour their wastes. Table 4.3 shows the above distribution

Table 4.3.1: Household Waste Collection

Response	Frequency	Percentage
Dustbin	290	73
Polybag	60	15
Refuse heap in their compounds	50	12
TOTAL	**400**	**100**

Source: Author's field survey 2013

From Table 4.3.1 it shows that a good percentage (73%) of the households in Samaru use dustbins and it was observed that some of the dustbins had no cover so it gets full and overflows and litters the ground and 15% use polythene bags. These dustbins and polythene bags most times are been disposed of by children also known as 'maishara. These children dispose of the waste mostly in drainages and illegal dumpsites close to the area in which the house is located. Some also move around with carts collecting wastes from various household and shops. It was also observed that 12% dump their waste in refuse heaps formed in their compounds. These waste handling methods are a likely contributory factor for poor sanitation in the area, because much of the refuse is littered about before reaching the disposal sites. Most of the refuse is kept close to kitchens and rooms, which may cause diseases like cholera and typhoid fever.

4.4 Methods of Disposal of Household Solid Waste

The disposal of household solid waste is one of the functional elements in the management of waste. Table 4.3.2 below illustrates the methods of disposal of solid waste by respondents in Samaru.

Table 4.3.2: Method of Waste Disposal

Response	Frequency	Percentage
Dumping in nearby dumpsite	130	33
Dumping in nearby drainage	10	2.5
Use of private sanitation agencies	90	22.5
Use of maishara	210	52.5
TOTAL	**400**	**100**

Source: Author's field survey 2013

Table 4.3.2 presents the waste handling methods practiced in the study area. As revealed in table 4.3.2, 52.5% respondents use maishara boys to dispose of their waste.33percentage dump their waste in nearby dumpsite while 22.5% use private sanitation agencies and 2.5% dispose of their waste in nearby drainage.

4.5 Major Problems Related with to the Indiscriminate Dumping of Waste in the Study Area.

Indiscriminate dumping around the residential areas causes a lot of problems that if not urgently attended to can lead to an epidemic in the areas. Table 4.3.4 below shows the various problems.

Table 4.3.4: Problem Related to the Dumpsites in the Study Area

Response	Frequency	Percentage
Public health risk	240	60
Ground water contamination	20	4
It becomes an eyesore with unpleasant odour	100	25
Uncontrolled dumping at area	40	10
Nothing is wrong with the dumpsite	20	5
TOTAL	**400**	**100**

Source: Author's field survey 2013

As shown in Table 4.5, 60% thinks that the urgent problem related to the dumpsite in their neighbourhood is public health risk, 25% of the respondents says it's becoming an eyesore with unpleasant odour,10% agreed that there is uncontrolled dumping at the area where the dumpsite is located and 5% said don't think anything is wrong with the indiscriminate dumping in area.

4.6. The Willingness of the Residents to Contribute to Effective Waste Management

The results in table 4.6 shows that for effective waste management in the study area, 50% of the respondents prefer to pay for their waste collection, 32.5% are of the view that participating fully during the sanitation day every last Saturday of the month will help while 17.5 said they will always bring their garbage to the communal container if provided.

Table 4.3.5: **Willingness to Contribute to Effective Waste Management**

Response	Frequency	Percentage
Bringing my own garbage to the communal container as whatever the neighbourhood identifies as container	70	17.5
Bringing my own and my neighbours garbage to the communal container as whatever the neighbourhood identifies as container	0	0
Ensure my neighbour and I participate in the sanitation every last Saturday of the month	130	32.5
Paying for amount agreed upon by the community for a solid waste collection system	200	50
	400	100

Source: Author's field survey, 2013

From Table 4.3.5 above, 350 respondents agreed that full participation in sanitation day and paying for effective waste collection will solve the waste management problem. Therefore, if the existing structure is effective, the respondents will cooperate.

4.7 Opinions on Responsibility for Ensuring Clean Environment

From the results obtained in Table 4.7, it is evident that 50% of the respondents in the study area are of the opinion that it is the responsibility of both individuals and KEPA to keep the environment clean and 5% is of the opinion that it is KEPA's responsibility while 45% says it is the responsibility of the individuals.

Table 4.3.6: Responsibility for Ensuring Clean Environment

Response	Frequency	Percentage
KEPA	20	5
Individuals/you	180	45
BOTH	200	50
TOTAL	**400**	**100**

With a large percentage of the population thinking that KEPA and individuals are responsible for ensuring clean surroundings, it is likely that the people will support clean up campaigns meant for making the surroundings clean.

4.8 Why Individuals Clean Their Environment

Table 4.3.7 presents the result of the reasons why individuals clean their environment. The result shows that 30% clean their environment because a clean environment means good health. 25percentage do so because they were brought up to do that while 50% are for both reasons.

Table 4.3.7: Reasons Individuals Clean Their Environment.

Response	Frequency	Percentage
Clean environment means good health	100	25
I was brought up to always clean my environment	100	25
All of the above	200	50
TOTAL	**400**	**100**

Source: Author's field survey 2013

Through personal observation its evident that besides the above reasons given by the respondents that both KEPA and the individuals should take responsibility for the

cleanliness of their surroundings, there are others reasons. These includes: to impress the visitors that come to the area, destruction of the area's scenic beauty, and the blocking of drainage channels that will lead to flooding and environmental pollutions.

Table 4.3.8: Other Sundry Questions on Solid Waste Management from Personal Interviews of Waste Generators

Questions		No of respondents		Percentage	
i.	Are you currently separating recyclable waste?	120	320		76
ii.	Would you be willing to separate recyclable goods?	350	90		21
iii.	Are you currently separating compostable goods	90	340		79
iv.	Do you normally participate in the environmental sanitation every last Saturday of the month?	170	250		60

Only 29% are currently separating recyclable goods locally, i.e. by separating plastics, metal scraps, bottles etc to sell to scavengers, but majority (80%) are willing to separate recyclable waste. Only 41% participate in the environmental sanitation that takes place every last Saturday of the month. This means that the KEPA sanitation monitoring system is not functioning properly as it should be. Two percent (27%) are currently separating compostable goods.

However, when the parameters were considered as a whole, it appears that the residents of the study area are aware to an extent the importance of proper waste management especially the health risks involved, but there is no functional structure for waste collection. If a good collection system is created waste management in Samaru will be greatly improved.

5.4 Functionality of the Existing Institutional Structures

In order to evaluate the functionality of the institutional structure of waste management in the study area, interviews were carried out among the KEPA staff and from the result of the interview it is seen that the existing structure of waste management lacks proper funding and the final disposal method is open dumping which a World Health Organisation (WHO) expert committee (1967) condemned and described as a most unsanitary method that creates public health hazards, a nuisance and severe pollution of the environment**.**

The Kaduna State Environmental Protection Agency is primarily in charge of setting up guidelines for solid waste management in Kaduna State, environmental quality standards (with related penalties and fines) and ensuring compliance for pollution control. They are also in charge of municipal waste disposal sites, prohibition of littering, and ensuring residents clean in front, and around their properties up to the sidewalk. Thus the community, individuals and the agency etc are also responsible for sanitation activities including the cleaning, collection and disposal of generated solid waste**.** This activity occurs in the whole of Kaduna state every last Saturday of the month, which is referred to as sanitation day. The KEPA in Zaria send out some of their officials to monitor and ensure that residents and shop owners clean up their environment, and failure to do that attracts a fine. The sanitation day is not effective because it is not well monitored; on the Environmental Sanitation day every landlord or occupier of a house is expected to clear drains, gutters, clear the street of all rubbish or refuse any sort, and movement is prohibited but during this period in Samaru people still move around and open their shops instead of cleaning up their environment. The structure of the waste collection from the

illegal dumpsites by KEPA is normally twice in a year and it takes place when the state government approves it and money is disbursed and these wastes is finally dumped on an open landfill along Dogarawa road or Bomo road where it will be sorted by scavengers and farmers that farm around that area and used as manure while the rest is incinerated.

The structure of the agency in charge of solid waste management is not functioning properly and this could be closely linked with the lack of equipment, trained and skilled man power, coupled with poor funding of the agency. The system of KEPA presently involves the following:

- Funding the various KEPA zonal offices and providing them with equipments such as trucks for waste evacuation from dumpsites.
- Providing buses for monitoring the waste generators and stakeholders to ensure that the sanitation day logistics is carried out properly.
- Ensuring that waste generators keep to the sanitation laws, and lawbreakers are adequately dealt with.

At the moment self-collection and disposal methods prevails in Samaru. The result also indicates that, the residents are willing to pay for improved solid waste management system.

The issue of lack of funds, manpower and equipments has been on since the inception of KEPA Zaria Zonal office in 1994, and the institution has not been able to come up with a proper collection system so they have therefore decided to welcome private sanitation agencies. The Private Environmental Caretaker (PECT) is a private sanitation agency. This agency in affiliation with KEPA in Zaria do the house-to-house collection every Saturday, by going round with their truck and collecting household

waste from the residents of Zango. Before PECT started their services in Zango, questionnaires was distributed and personal interviews were conducted and from the results the residents excitedly welcomed their services and it also showed that they disposed their waste indiscriminately; majorly by incineration and dumping in nearby self-created dumpsite. The residents agreed to pay a particular amount of money every month; and with this it is seen that Zango is cleaner than Samaru. Because of the effectiveness of this private sector, the residents are happy and impressed and the chief of Zango recommended them to the district head in Hanwa, where they just started functioning recently. When the waste is collected, they dispose it in the final disposal site in Bomo road where it is sorted by farmers and scavengers.

If KEPA will introduce the private sector services in Samaru, through the house-to-house collection system and also placing waste containers or incinerators at strategic points by dividing Samaru into wards, waste management system will be highly improved. Also an effective legislation for solid waste management should be established and enforced; this should be coordinated and monitored by the district/community heads, Landlords, Heads of schools etc. Any community or resident that fails to comply with this legislation should be heavily fined or taken to the KEPA court.

From the results obtained in this research the Samaru residents are willing to pay a token for waste collection and also welcome any waste management system the government is willing to setup. It was also observed that the residents of Samaru understand the importance of waste management to an extent but they lack knowledge and guidance on how to carry out proper waste management. Making the waste

management private sector driven will provide a good solution to the problem of waste disposal in Samaru.

Table 4.3.9: Waste Site Location in Samaru and Estimated Quantity Every Month

Locations	Quantity	Hazards
Lemu primary school	70 tippers	Untidy
By the rail in Hayin dogo	50 tippers	Untidy
Bomo road	40 tippers	Untidy
Amina primary school	56 tonnes	Pollution of source water, odours, epidemic in the neighbourhood.

Source: KEPA Zaria Zonal Office, 2010



Plate 1: Drainage in Danraka blocked by solid wastes



Plate 2: Illegal dumpsite in Hayin Dogo



Plate 3: A ditch in a residential area in Danraka, where the residents throw their waste.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This research work focused on assessing the functionality of the municipal solid waste management structures in Samaru. Through the use of questionnaires it was observed that the system of waste disposal is not effective and indiscriminate dumping is the order of the day in Samaru. These wastes dumped indiscriminately cause problems like environmental pollution, blockage of drainages, unpleasant odour, littering of the street, epidemic, ground water pollution.

Also the mode of final disposal is open dumping which gives rise to environmental, social, and public health problem. The waste is dumped in a low – lying (farm land) and it is sorted from time to time, composted and used as manure by the farmers. These final disposal sites cannot be called safe disposal sites according to the international standard because the sites are not well paved or well constructed. Therefore the main objective of the study was to investigate the current solid waste management structure problems in Samaru and their problems and suggest possible measures to deal with the problems. Thereby achieving effective and sustainable solid waste management in Samaru.

This study assessed of waste management in Samaru, Zaria towards proposing an institutional framework that could improve the waste management situation, and this was achieved through the use of questionnaires, personal observations and personal interviews. It was observed that 73% of the people in the study area collect their waste with dustbins; most of these dustbins are not covered and often overflow and litter their

surroundings. Majority, (48%) depend heavily on the indigent under-aged children also known as ‘Maishara’ to dispose of their waste. Also it was established that individual indiscriminate dumping at nearby dumpsites with the associated problems drainage blockage leads to flooding during the rainy season, and also unpleasant odours and litters.

Furthermore, the KEPA equipments and personnel for handling solid waste in the area are inadequate and the State government are not willing to help/fund waste management in the area.

5.2 Conclusion

This study concludes in this study that the present method of solid waste management in Samaru is not adequate.

Also, the final disposal method of waste practised by the KEPA is the use of open dumpsites and this is done without any regard for pollution. Perhaps it is necessary for the government to device more improved techniques for solid waste management. In conclusion, it is found that in Zaria, the activity of waste management needs more effort like:

a. Putting in more funds by the government;
b. Providing or making available more manpower;
c. And a call for public participation in waste management in Samaru.

5.3 Recommendations

Based on the findings of the study the following recommendations are suggested to help in achieve a satisfactory solid waste management in Samaru.

a. The author suggests that as a first step to solid waste management in Samaru, all stakeholders – communities, businesses, schools, local government, provincial government – be involved in the process;
b. Individual homes and shops should have a proper waste bin for proper collection of waste on a daily basis.
c. The public should be educated by the KEPA on solid waste and its related issues.
d. Stricter enforcement of bye-laws should be ensured by the KEPA where administrative penalties for minor violations should be taken with urgency.
e. The byelaws on sanitation should be made in such a way that every landlord is required to monitor and ensure that their house/houses are clean;
f. The Samaru community should adopt a self-help approach to solve the problem, by organising periodic clean up exercises (apart from the monthly sanitation exercise at the end of the month).
g. The chief and other opinion leaders should be given additional roles to play in ensuring environmental cleanliness by authorising the chief to take up the additional job of ensuring clean environmental practices; and
h. Opportunities for private sanitation agencies should be created and encouraged.

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QUESTIONNAIRE

Dear respondent,

This questionnaire is designed to evaluate the effectiveness of solid waste management in Samaru, Zaria. To enable an accurate assessment, it is important that all information requested in the questionnaire should be provided as completely and accurately as possible. Thanks. Please circle your answers.

1. Gender

a Male b Female

2. House address/area:.....

3. Age

a. Less than 17 **b**. more than 17years

4. Educational background

a. No formal education **B**. elementary/primary education **c**. junior secondary school

D. senior secondary school **e**. others

5. Whose responsibility do you think it is to clean your surroundings?

a. Individuals/you b. KEPA c. both

6. Do you think it is appropriate for you to clean your surroundings?

a. Yes b. no.

7. If yes, why do you think so?

a. a clean environment means good health b. I was brought up to always keep my environment clean. C. all of the above

8. Do you often clean your surroundings of your house/shop every morning?

a. Yes b. no

9. Why?

a. I like clean environments b .I see my neighbours clean so I follow suit c .I was thought to always clean my environment.

10. How do you dispose of your refuse?

a. Dumping in nearby dumpsites b. dumping in nearby drainage

C. use of private sanitation agencies d. use of maishara boys

11. How do you collect your waste?

a. Dustbin b. polybag c. refuse heap in your compound

12. Do you normally participate in the environmental sanitation that takes place every last Saturday of the month?

a. Yes b. no

13. How do you discard the waste that is no value to your household?

a. burn it

b. leave it on the street

c. bury it in the backyard
d. bring it to the dump site
e. leave it to be collected from the house
f. don't know

14. Is the solid waste collected from your house?

a. yes b. no

15. How many times per week is your solid waste collected from your house?

a. daily
b. twice a week
c. once a week
d. every now and then
e. there is no collection
f. don't know

16. What is your opinion about the current situation of the disposal of solid waste in your neighbourhood?

a. there will be problems in the end
b. nothing is wrong with what I'm doing now
c. no opinion/don't know

17. What do you consider the most urgent problem related to the disposal of solid waste in your neighbourhood?

a. personal health
b. pollution of living area and playgrounds for children
c. littering of solid waste in the neighbourhood
e. nothing is wrong
f. no opinion

18. What is your opinion about the present site where you dispose your waste?

a. everyone throws waste there
b. the site produces foul odours
c. nothing is wrong with the site
d. no opinion/don't know

19. What do you consider the most urgent problem related to the present site in your

Neighbourhood where you dump your waste?

a. public health risk
b. groundwater contamination
c. it becomes an eyesore with unpleasant odours
d. uncontrolled dumping at the area
e. nothing is wrong with the dump site

20. Are you currently separating recyclable goods?

a. yes

b. no

21. Would you be willing to separate recyclable goods?

a. yes

b. no

22. Are you currently separating compostable goods?

a. yes

b. no

23. Would you be willing to separate compostable goods?

a. yes

b. no

24. How would you be willing to contribute to effective waste disposal?

a. bringing my own garbage to the communal container as whatever the neighbourhood Identifies as container

b. bringing my own and my neighbour's garbage to the communal container as whatever the neighbourhood identifies as container

c. ensure my neighbourhood and i participate in the sanitation every last Saturday of the month.

d. paying for an amount agreed upon by the community for a solid waste collection system