

THE WASTE MANAGEMENT
SYSTEM IN LOW INCOME AREAS OF
JOS, NIGERIA: THE CHALLENGES
AND WASTE REDUCTION
OPPORTUNITIES

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ABSTRACT

An estimated 2 billion people do not have access to waste collection services, and 3 billion do not have access to controlled waste disposal. This lack of services and infrastructure has a detrimental impact on public health and the environment with waste being dumped or burnt in communities. With waste levels projected to double in Less Economically Developed Countries (LEDCs) by 2025 there are significant challenges facing municipalities who already lack the basic resources needed to manage waste. The United Nations acknowledged the problems of poor sanitation and waste management in the Sustainable Development Goals which sets targets to address these challenges, including the target by 2030 to substantially reduce waste generation through prevention, reduction, reuse and recycling.

Jos, the capital of Plateau state in Nigeria, shares the waste management challenges facing cities in LEDCs. The population of Jos is projected to increase from 1.3 million in 2007 to 2.7 million in 2025, with much of the population living in densely populated areas that lack basic sanitation and controlled disposal of waste.

This thesis presents the results of a detailed investigation into the current waste management system in Jos with a focus on low income areas. Through the adoption of mixed methods the thesis identifies how waste is currently being managed and establishes the challenges to sustainable waste management. The existing waste management system was found to be grossly inadequate with 64 communal collection containers being used to collect waste for the entire city, this equates to 20,313 citizens per container. The system leads to most residents disposing of their waste through open dumping in public space and water bodies, and open burning, with impacts to public health and the environment. Key challenges identified include the lack of suitable resources, political interference, poor governance, overlapping responsibilities of agencies, lack of waste awareness amongst the public, and poor infrastructure. 13 recommendations are presented to help develop an improved waste management system in the study area.

Despite reduction and reuse being the priorities of the waste hierarchy there is a paucity of research on the potential of waste prevention within LEDCs especially low income areas. With waste levels projected to increase, waste prevention interventions could play an important role. Following waste analysis and a review of waste prevention initiatives adopted globally, a shortlist of options suitable for the study area was developed. This shortlist was assessed using Ketso and SWOT analysis facilitated in focus groups representing the waste industry and the community. Community composting was identified as waste prevention intervention with the most potential due to 65.2% of the waste stream in the study area being biodegradable, and only 5.2% of the community currently composting. Benefits of this approach would be less pressure on the waste collection system, reductions in waste being indiscriminately dumped, increased awareness of waste issues, and compost production that could be utilised in the community.

7 recommendations are presented that in the long term could help to promote waste prevention in the study area including training of community volunteers, engagement with community leaders, and the development of holistic waste awareness campaigns.

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LIST OF ACRONYMS

AEPB	Abuja Environmental Protection Board
AFR	Africa
AIDS	Acquired Immune Deficiency Syndrome
ALCO	Abidjan Lagos Transport Corridor
APO	Asian Productivity Organization
ARFs	Advanced Recycling Fees
AYU	African Youth Union
BHCC	Brighton and Hove County Council
CBOs	Community Based Organizations
CDAs	Community Development Associations
C&D	Construction and Demolition waste
CDCP	Centre for Disease Control and Prevention
CDPH	California Department of Public Health
CECOD	Conservation Efforts for Community Development
CERAG	Chintan Environmental Research Action Group
CFR	Case Fertility Rate
C&I	Commercial and Industrial waste
CIA	Central Intelligence Agency
CIWEM	Chartered Institution of Water and Environmental Management
CIWM	Chartered Institution of Wastes Management
CISP	Chartered Institute of Purchasing and Supply
COPD	Chronic Obstructive Pulmonary Disease
CPE	Centre for People and Environment
CPHEEO	Central Public Health and Environmental Engineering Organisation

CSL	Cygnnet Services Limited
CUG	Clean up Ghana
DCSF	Department for Children, Schools and Families
DEFRA	Department for Environment, Food and Rural Affairs
DETR	Department of the Environment, Transport and the Regions
DIGs	Deputy Inspector General of police
DLA	Direct Labour Agency
DOE	Department of Energy
DOE	Department of Environment
EAP	East Asia and the Pacific
EC	European Commission
ECA	East and Central Asia
ECN	European Compost Network
ECWA	Evangelical Church Winning All
EEA	European Economic Agency
EEE	Electrical and Electronic Equipment
EFTA	European Free Trade Association
EFInA	Enhancing Financial Innovation and Access
EHOs	Environmental Health Officers
EIA	Environmental Impact Assessment
ELRI	Environmental Law Research Institute
EPA	Environmental Protection Agency
EPR	Extended Producer Responsibility
ERP	Environmental Resource Planning
ESDO	Environment and Social Development Organisation
EU	European Union
EWWR	European Week for Waste Reduction

FCT	Federal Capital Territory
FEC	Federal Executive Council
FEE	Foundation for Environmental Education
FEPA	Federal Environmental Protection Agency
FGN	Federal Government of Nigeria
FMCG	Fast Moving Consumer Goods
FME	Federal Ministry of Environment
FMH	Federal Ministry of Health
FRN	Federal Republic of Nigeria
GCOML	Grand Cereal and Oil Mill Limited
GDP	Gross Domestic Product
GHG	Green House Gases
GIS	Geographic Information System
GJMP	Greater Jos Master Plan
GM	General Manager
GNI	Gross National Income
GNP	Gross National Product
GRA	Government Reserve Area
HCV	Hepatitis C Virus
HDI	Human Development Index
HIV	Human Immunodeficiency Virus
HRM	Human Resources Management
IETC	International Environmental Technology Centre
IGP	Inspector General of Police
ILO	International Labour Organization
IOM	International Organization for Migration
IPCC	Intergovernmental Panel on Climate Change

ISR	Informal Sector Recycling
ISSWM	Integrated Sustainable Solid waste Management
JUSUN	Judicial Staff Union of Nigeria
JUTH	Jos University Teaching Hospital
KOEE	Kenya Organization for Environmental Education
JMDB	Jos Metropolitan Development Board
LAC	Latin America and the Caribbean
LAWMA	Lagos State Waste Management Authority
LEDC	Less Economically Developing Country
LGA	Local Government Area
MCC	Mennonite Central Committee
MDGs	Millennium Development Goals
MEDC	More Economically Developed Country
MENA	Middle East and North Africa
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NBS	National Bureau of Statistics
NA	Native Authority
NAFDAC	National Agency for Food and Drug Administration and Control
NASWDEN	National Association of Scrap and Waste Dealers Employers of Nigeria
NCC	Norfolk County Council
NDHS	Nigerian Demographic and Health Survey
NEP	National Environmental Protection
NESREA	National Environmental Standards & Regulations Enforcement Agency

NEST	Nigerian Environmental Study Action Team
NGO	Non-Governmental Organization
NHP	National Housing Policy
NIMBY	Not-In-My-Back-Yard
NIPSS	National Institute of Policy and Strategic Studies
NIUA	National Institute of Urban Affairs
NLWA	North London Waste Authority
NMC	Nigerian Mining Corporation
NOSDRA	National Oil Spill Detection and Response Agency
NP	Nigerian Police
NPC	National Population Commission
NSIWC	National Salaries, Income and Wages Commission
NYC	New York City
NYCCC	New York City Community Composting
NYCCP	New York Care Coordination Program
OCHA	Office of the Coordination of Humanitarian Affairs
OECD	Organisation for Economic Co-operation and Development
PAHs	Polycyclic Aromatic Hydrocarbons
PAHO	Pan American Health Organization
PBB	Polybrominated Biphenyls
PBDEs	Polybrominated Diphenyl Ethers
PCBs	Polychlorinated Biphenyls
PCDD	Polychlorinated dibenzo-para-dioxins
PCDF	Polychlorinated dibenzofurans
PEPSA	Plateau State Environmental Protection and Sanitation Agency
PGMs	Platinum Group Metals
PLHA	Plateau House of Assembly

PLSG	Plateau State Government
POPs	Persistent Organic Pollutants
PPP	Polluters Pays Principle
PPP	Public Private Partnership
PRS	Planning Research and Statistics
PSCDB	Plateau State Capital Development Board
PSIRS	Plateau State Internal Revenue Service
PSP	Private Sector Participation
PSWMA	Plateau State Waste Management Agency
PSSH	Plateau State Specialist Hospital
RCRA	Resource Conservation and Recovery Act
SEPA	Scottish Environmental Protection Agency
SEPA	State Environmental Protection Agency
SG	State Government
SES	Socio-Economic-Status
SNV	Stichting Nederlandse Vrijwilligers
SRI	Stanford Research Institute
SSA	Sub Saharan Africa
SWDS	Solid Waste Disposal Service
SWM	Solid Waste Management
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TAM	Team Action Management
UN	United Nations
UNAIDS	United Nations Programme on Aids
UNCHS	United Nations Centre for Human Settlements
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme

UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFPA	United Nations Population Fund
UN-HABITAT	United Nations Human Settlement Programme
UNICEF	United Nations International Children's Emergency Fund
UNIJOS	University of Jos
URP	Urban and Regional Planning
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
USGAO	United States Government Accountability Office
WB	World Bank
WEEE	Waste Electrical and Electronic Equipment
WESP	World Economic Situation and Prospects
WESSA	Wildlife and Environmental Society of South Africa
WFD	Waste Framework Directive
WFP	World Food Programme
WHO	World Health Organization
WRAP	Waste and Resources Action Programme
WREP	Waste and Resources Evidence Programme
WtE	Waste to Energy

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DEDICATION

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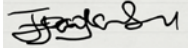
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DECLARATION

I declare that the research contained in this thesis, unless otherwise formally indicated within the text, is the original work of the author. The thesis has not been previously submitted to this or any other university for a degree, and does not incorporate any material already submitted for a degree.

Signed 

Dated 4th October 2017

1 INTRODUCTION

1.1 DEFINITION OF SOLID WASTE

Solid waste has many definitions, for instance, the European Union defined waste as *“Any substance or object which the holder discards or intends or is required to discard”* (Council Directive 2008/98/EC). In Nigeria, there is no formal government definition of waste however, several academics have proposed definitions from a Nigerian perspective. Oyedele (2009) defines solid waste as leftovers arising from human, animal or plant activities that are discarded as useless and not having any consumer value. Babayemi & Dauda (2009) define solid waste as any useless, unwanted, non-liquid, and non-gaseous material that results from human and animal activity. Festus & Omoboye (2015) state that wastes are materials or substances that are either spoiled, rejected or no longer required for their original purpose. This implies that any surplus unwanted material that is worn out, broken or contaminated is waste. However, the Nigerian Environmental Society (Undated) defines waste as *“any material that lacks utility or an object or substance that the owner or generator voluntarily or involuntarily relinquishes ownership”*. The researcher therefore adopts the definition by the Nigerian Environmental Society¹.

Given the level of scavenging on waste heaps in Nigeria for materials to be reused or sold, it can be argued if solid waste is indeed useless and unwanted material (Butu & Mshelia, 2014): waste is very much a resource (Sridhar & Hammed, 2014). In Nigeria, terms such as garbage, trash, refuse, and rubbish are commonly used to describe solid waste. Wastes are usually classified as gaseous, liquid, or solid-wastes, depending on their form. This research is concerned with solid waste.

Hoornweg & Bhada-Tata (2012) categorised the sources of solid waste as residential, industrial, commercial, institutional, construction and demolition (C&D), medical, agricultural and other wastes. Table 1 shows the sources of waste, the waste producers and the types of material within each category. Residential waste is waste generated from households, and as shown in Table 1 in its non-separated form, it encompasses a heterogeneous mix of materials including food waste, paper, cardboard, plastics, textiles, glass, metals, ash, household hazardous wastes and e-waste. It forms part of municipal solid waste which is defined by some Nigerian scholars as all waste collected by private or public authorities from households, industry (non-hazardous), commerce, and institutional establishments (including hospitals), and street sweepings (Igoni et al. 2007; Ogwueleka, 2009). In this research, materials from households which fall within the solid-waste category form the focal point of this study. It is important to note that in Nigeria waste from small

¹ The Nigerian Environmental Society (NES) is a professional, non-profit oriented, non-governmental body which is committed to advocacy and actions towards environmental protection, sustainable environmental development and promotion of environmental professionalism within Nigeria and in the global arena. It is recognized as the Premier Environmental Society and watchdog of the environment in Nigeria.

business or micro enterprises may end up in the waste stream alongside household waste.

Data is not published by the Nigerian government on the national levels and breakdown of waste arisings, however studies have been completed to understand local levels and sources of waste. For example, a review by Kayode & Omole (2011) equated levels for Ibadan, Nabegu (2013) for Kano, and Okey et al. (2013) for Uyo. Table 1 includes a breakdown of minimum and maximum levels for each waste stream based on a review of these studies. There is inconsistency in these studies with some overlap in waste streams and definitions. For Nigeria, data on agricultural waste and C&D in particular is limited.

Table 1 Sources, producers, and types of solid waste

Source	Typical producers	Types of material	% of waste in Nigeria	
			Min.	Max.
Residential	Single and multifamily dwellings	Food, paper, cardboard, plastics, textiles, leather, yard waste, wood, glass, metals, ash, bulky items, household hazardous wastes (e.g. gas tanks, waste containing mercury, motor oil), e-waste (e.g. computers, phones)	49.0	78.9
Industrial	Light/heavy manufacturing, fabrication, power/ chemical plants	Packaging, food wastes, hazardous wastes, ashes, special wastes	2.3	16.1
Commercial	Stores, hotels, restaurants, markets, office buildings	Paper, cardboard, plastics, wood, food wastes, glass, metals, hazardous wastes, e-wastes	14.4	28.3
Institutional	Schools, hospitals (non-medical waste), prisons, government buildings	Similar to commercial	5.8	
Construction and demolition (C&D waste)	New construction sites, road repairs, renovation sites, demolition	Wood, steel, concrete, dirt, bricks, tiles	Low awareness of C&D waste in Nigeria	
Medical waste	Hospitals, nursing homes, clinics	Infectious wastes (e.g. bandages, gloves, cultures, swabs, blood and body fluids), hazardous wastes (e.g. sharps, instruments, chemicals), radioactive waste from cancer therapies, pharmaceutical waste	In many parts of Nigeria still collected together with MSW	
Agricultural	Crops, orchards, vineyards, dairies, farms	Spoiled food waste, agricultural waste (e.g. rice husks, cotton stalks, coconut shells, coffee waste), hazardous wastes (e.g. pesticides)	Low awareness of agricultural waste in Nigeria	
Other wastes	Street cleaning, landscaping, parks, beaches, wastewater treatment plants	Wide range of materials depending on source	0.3	1.9

Source: Collated from Adewumi et al. (2005); Fakere et al. (2012); Hoornweg & Bhada-Tata (2012); Kayode & Omole (2011); Nabegu (2013); Obi et al. (2016); Okey et al. (2013); Ukoje, (2011); Wodele et al. (2016); Wokekoro (2007)

1.2 BACKGROUND AND CONTEXT OF THE RESEARCH

1.2.1 Waste management in LEDCs

Solid Waste Management (SWM) has been recognized as one of the biggest challenges facing municipal authorities across the world, as a result of population growth, urbanization, and poverty (Hoornweg & Bhada-Tata, 2012; Tacoli, 2012; United Nations (UN), 2013; UNDP (United Nations Development Programme), 2012a). Less Economically Developing Countries (LEDCs), in general, have a higher population-growth rate of 2.4% per year compared to 0.8% in More Economically Developing Countries (MEDCs) (UNDP, 2011). Since 2007 more than half of the world's population has been living in urban centres (Tacoli, 2012; UNDP, 2012) and the figure is expected to exceed 70% by 2050 (UN, 2013). The UNDP (2012) estimate that by 2050 urban dwellers will account for 86% of the population in the MEDCs, and 64% in LEDCs. The growth of population in urban areas of LEDCs is a result of rural-to-urban migration with people seeking employment opportunities and a higher standard of living. In addition, people seek better medical facilities which mean a lower infant mortality rate (UNDP, 2011).

The criterion typically used to categorise countries based on their economic status are Gross Domestic Product (GDP)², Gross National Product (GNP)³, Gross National Income (GNI)⁴, level of industrialization, Human Development Index (HDI)⁵, level of infrastructure and general standard of living (UN, 2014). The World Bank has classified countries as high-income, upper middle income, lower middle income and low-income based on GNI (see Table 2).

Table 2 World Bank classification of countries

Country income division	GNI per capita	Examples of countries in the income group
Low income countries	<US\$1,025 (£790) ⁶	Benin, Chad, Mali, Niger, Uganda, Zimbabwe
Lower middle income countries	US\$1,026 - US\$4,035 (£790- £3,109)	Cameroon, Ghana, India, Nigeria , Pakistan, Sudan,
Upper middle income countries	US\$4,036 - US\$12,475 (£3,110 - £9,614)	Brazil, China, Iraq, Libya, South Africa, Turkey
High income countries	>US\$12,476 (£9,615)	Australia, Canada, France, Japan, UK, USA

Source: World Bank (2016)

² GDP - the total value of goods and services produced by a country in a year.

³ GNP - the total economic output of a country, including earnings from foreign investments.

⁴ GNI - GDP plus net property income from abroad

⁵ HDI - is a composite statistic of life expectancy, education, and per capita income indicators, which are used to rank countries into four tiers of human development. It was developed by the United Nations as a metric to measure the social and economic development levels of countries.

⁶ Based on the exchange rate of \$1.00=£0.78 April 2017 derived from xe.com. This exchange rate is used throughout the thesis.

MEDCs, also referred to as developed or industrialized countries are sovereign states that have a highly developed economy and advanced technological infrastructure relative to other less industrialized nations. The World Bank (2016) defines MEDCs as countries with a GNI of over £9,615 per capita. Examples of MEDC are Canada, France, Germany, Italy, Japan United Kingdom and United States of America.

The World Bank (2010) classifies all low and lower middle-income countries as LEDCs but states that the use of the term is for convenience, it is not suggesting that all economies in the group are experiencing comparable development. Classification by income also does not necessarily reflect development status however, in general, LEDCs are relatively poor countries that have a higher birth rate, higher infant mortality rate, higher death rate, lower life expectancy and a lower literacy rate compared to MEDCs (Revision World, 2017). Sullivan & Sheffrin (2003) suggest that LEDCs are nations with an underdeveloped industrial base and a low Human Development Index relative to other countries.

This study is focused on a lower middle income country, Nigeria, and other examples of countries in this income group include Bangladesh, Cameroon, Ghana, India and Pakistan. Lower middle income countries have an average life expectancy of 67.3 years, GNI per capita of between US\$1,026 (£790) - US\$4,035 (£3,109), and a combined total population of 2.9 billion (World Bank, 2015).

Generally high economic development and high rates of urbanization result in larger amounts of waste being produced, as such MEDCs generate more waste than LEDCs. Table 3 displays the waste generation per capita by income level, indicating the average value and the lower and upper boundary for each income category. Hornweg & Bhada Tata (2012) observed that high-income countries produce 2.1 kg per capita per day compared to 0.79 kg in lower middle, and 0.60 kg in lower income countries.

Table 3 Waste generation rate per capita (kg/capita/day) by income level

Income level	kg/capita/day			Waste collection rates
	Lower boundary	Upper boundary	Average	
High	0.70	14.0	2.1	98%
Upper middle	0.11	5.5	1.2	85%
Lower middle	0.16	5.3	0.79	68%
Lower	0.09	4.3	0.60	43%

Source: Hornweg & Bhada Tata (2012)

Global municipal solid waste generation levels were an estimated 1.3 billion tonnes in 2012, and as the income level and rate of urbanization increases in LEDCs, global levels are expected to increase to approximately 2.2 billion tonnes by 2025 (Hornweg & Bhada Tata, 2012). The implication of this is that the cost of SWM will globally increase from £131.5 to £240.3 billion over this period. The projected increases in waste costs would be greater than five times for lower income countries, and four times for lower middle income countries like Nigeria.

Waste collection rates vary depending on the income of a country and also political will. As shown in Table 3 lower income countries have an estimated 43% of their waste collected compared to 98% in high income countries. Within LEDCs there is a variation in waste management systems, with the affluent areas receiving developed services while in the more deprived areas waste services can be non-existent. UN-HABITAT (2010) states that currently waste management in LEDCs is inadequate and that challenges will increase because of competing resource and economic demands and limited availability of disposal sites especially in the urban centres.

A number of studies have been undertaken in LEDCs highlighting the serious solid waste management (SWM) challenges being faced including the work of Aliu et al. (2014), Guerrero et al. (2013), Harir et al. (2015), Henry et al. (2006), Khatib (2011), Njoku et al. (2015), United Nations Environment Programme (UNEP) (2013), and Wilson et al. (2012). Identified challenges from literature include increasing waste generation, inadequate waste collection, improper waste disposal, lack of legislation, lack of finance, lack of organisational leadership, perception that the service should be provided for free, and unskilled workers. Other challenges include increasing population, rapid urbanization, industrialization, economic development and lack of involvement of householders.

These challenges have resulted in solid waste being managed poorly, leading to waste being dumped openly in streets, streams, and open burning, with consequent adverse health, social and environmental effects on society (Butu et al. 2013). UNEP & Office for the Coordination of Humanitarian Affairs (OCHA) (2011) has reported on the loss of lives, spread of diseases and flooding as a consequence of poor waste management. Hardoy et al. (1993: p.4) describe LEDC urban environments as *“among the most health and life threatening of all human environments”*. UNEP (2015) has warned that this global problem has to be handled properly otherwise it is a danger to public health and the environment. It emphasized that it is an issue related directly to the way society manufactures and consumes goods, and it concerns everyone.

Nigeria is the focus of this research and it shares in the chronic waste management problems being faced by other LEDCs. It has an estimated population of over 183 million people (World Bank, 2015), and with a growth rate of 2.8% per annum, the population will rise to 239.8 million by 2025. The current population of Nigeria is 49.9% urban and 50.1% rural, and by 2025 it is expected to rise to 52% urban and

48% rural at a growth rate of 3.5% per annum (United Nations Department of Economic & Social Affairs (UNDESA), 2014). Rafei & Tabary (2014) placed Nigeria as having the 9th largest urban population in the world, and also the highest urban population in Africa. This growth of urban population has led to the development of informal settlements (Kayode & Omole, 2011). UN Habitat (2013) define informal settlements as residential areas with no land security, and usually lack basic sanitation services and city infrastructure, with houses not complying with current planning and building regulations, and often situated in physically and environmentally unfavourable areas. The majority of residents are low income households, and henceforth in this thesis these settlements are referred to as low income areas. Jos is the case study for this research and almost half of the urban population in Jos live in low income areas (Ibrahim, 2015). Figure 1 shows a typical example of such an area in Jos.



Figure 1 A typical low income residential area in Jos, Nigeria

Source: Moore (2006)

The World Bank (2014) reported that Nigeria is in acute poverty, with the per capita national poverty rate placed at 33.1%. It ranked Nigeria 3rd on World Poverty Index after India and China respectively. Those who fall under the poverty line, as defined by the World Bank, earn less than \$1.25 (0.96 GBP) per day. The report also stated that 7% of 1.2 billion people living below the poverty line worldwide are Nigerians. The National Housing Policy (2006) estimated that approximately 80% of the population of Nigeria is classified as low income, and receive inadequate solid waste management services.

It is estimated that 0.49 kg of waste is generated per capita per day in Nigeria with households accounting for about 90% of the municipal solid waste generated (Solomon, 2009). The increasing population of low income areas coincides with subsequent increases in municipal solid waste generation (Hoornweg & Bhada Tata, 2012). The total municipal solid waste generated in urban areas in Nigeria was estimated to be 40,959 tonnes per day in 2012, and by 2025 it is estimated it will rise to 101,307 tonnes per day (Hoornweg & Bhada Tata, 2012). According to Aliyu & Amadu, (2017) Nigeria faces many challenges in meeting the needs of the growing urban population including provision of infrastructure, employment, as well as basic services such as health care and solid waste management. Less than 50% of solid waste is collected in Nigeria and only 5% is recycled (Ibrahim, 2015). Inadequate access to solid waste management contributes towards illnesses such as diarrhoea, dysentery and typhoid. Literature indicates that much attention has been given to waste management problems in Nigeria (Uwadiogwu & Chukwu 2013), but household waste management in low income areas is one of its greatest challenges.

Hoornweg & Bhada-Tata's (2012) prediction on the global waste increases by 2025 is concerning, and with the rising population, rapid urbanization, increasing waste levels, and already limited infrastructure, LEDCs like Nigeria face increasing challenges in managing their waste (Abila & Kantola, 2013). These challenges could be addressed through the introduction of sustainable waste management practices based on the waste hierarchy with greater emphasis on waste prevention.

1.2.2 The waste hierarchy and the importance of waste prevention

The waste hierarchy (see Figure 2) is used worldwide as the best option for managing waste based on the principles of sustainability (UNEP, 2011).

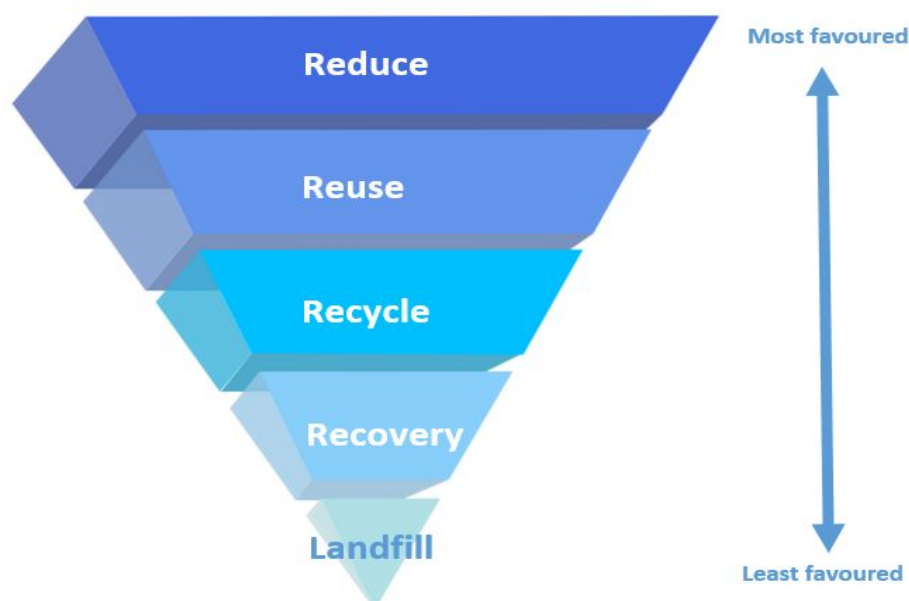


Figure 2 Waste Hierarchy

Source: Adapted from Council Directive 2008/98/EC 2008

UNEP (2013) suggest that the waste hierarchy is capable of identifying the most resource-efficient, long term move towards sustainable waste management.

Waste reduction is the priority of the waste hierarchy, and it means reducing the amount of waste being generated (CIPS, 2007). It involves governments, manufacturers, retailers and consumers working together to reduce waste at source, since waste that is not produced does not attract any management costs. For instance, government could introduce legislation to encourage the reuse of products such as a charge on single use plastic bags. Manufacturers could redesign their products thereby reducing the amount of packaging used, or longer lasting products that could be more easily repaired. Consumers could purchase products with the least amount of packaging and could be less wasteful by purchasing only items that they really need, or buying products that are more durable and repairable. All these could help in reducing the quantity of waste being generated, thereby conserving resources for future generations and contributing to a cleaner environment.

Re-use means using materials, products or items over and over again for the same or different function (New York City, NYC, 2017). For example, containers for food or drinks, such as glass jars and bottles, could be reused to store food. In LEDCs plastic drums or jerry cans are often reused to store water in homes for kitchen and laundry use. Other examples include giving unwanted clothes to those who need them, and using cloth nappies instead of disposable nappies.

Recycling implies the use of waste materials to produce new products (Waste Management Resources, WMR, 2009). This can include dry recyclables such as plastics, glass and metals and also processing organic waste to produce compost to be used on farms and gardens. Recovery refers to recovering energy from waste. This could be through biological processes such as anaerobic digestion, or thermal processes such as energy from waste plants. The least sustainable option is sending waste to landfill.

In the context of this research waste prevention encompasses reduction at source and reuse, the top two tiers of the waste hierarchy. It includes home and community composting since it reduces the amount of waste generated that needs to be collected by the municipality. Home composting as well as community composting according to Wilson (2005) would eventually be seen as a waste prevention strategy, it has historically been placed on the same tier as recycling.

In global terms, particularly in MEDCs, managing waste has traditionally focused on disposal rather than options higher up the hierarchy. However within the past few decades there has been increasing focus on recycling and now finally the importance of prevention is slowly being realised. Moving waste management up the waste hierarchy is an important way of maximising value from resources and generating more jobs, whilst lessening the burdens on the environment.

In the European Union (EU) the Waste Framework Directive (2008) required countries for the first time to establish a national waste prevention programme by December of 2013 consequently highlighting the important role that waste prevention through reduction and reuse can play.

UNEP (2015) emphasises the importance of waste prevention, stating that an ounce of prevention is worth a pound of cure, hence waste prevention is the most desirable option in the waste management hierarchy and an important goal and guiding principle of future waste strategies. The tenth meeting of the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal took place in Cartagena in October 2011. The resulting Cartagena Declaration (2011) called for the active promotion and implementation of more efficient strategies to achieve prevention and minimization of the generation of hazardous and other wastes. A preventive waste management approach offers the best chance for reversing the current trends in waste generation (Sitarz, 1994). Wilson et al. (2010: 192) believes that *“the question of how to bring waste growth under control is critical whatever the state of the waste management of any city or country, otherwise, attempts to improve standards of environmental control over waste disposal will likely end up as running hard simply to stand still as waste quantities increase”*.

UNEP (2015) argue that LEDCs need to develop and implement innovative and effective policies and practices to promote waste prevention in order to stem the relentless increase in waste per capita as economies grow.

1.2.3 An introduction to Jos, Plateau State

Figure 3 shows the location of Plateau State in the central part of Nigeria. It is one of the 36 states in Nigeria, and the city of Jos became the administrative capital of Plateau State in 1976. It is a colonial creation that was founded in 1902 by tin miners (Bingel, 1978; Morrison, 1976). The tin mining activities attracted migrants from all over the world to work in the mines and the related service industries (Freund, 1981; Plotnicov, 1967). The discovery of tin in Jos also led to the influx of tribes from other parts of Nigeria including the Hausa, Igbo, Urhobo, and Yoruba who now constitute more than half of the population of Jos. This melting pot of nationalities, ethnic groups and religions makes Jos an attractive place for other Nigerians, as such Plateau State is known in Nigeria as the 'home of peace and tourism'. There continues to be migration into Jos leading to increases in accommodation costs and land. The increases in population have partly been caused by the ongoing internal political instabilities in Nigeria.

In 1999 Sharia law was introduced in 12 northern states leading to riots mainly involving non-Muslim minorities within these states. One such riot killed over 100 people in Kano State in October 2001 (British Broadcasting Corporation (BBC), 2004; Voice of America, 2001). More recently the challenges caused by Boko Haram in north-eastern Nigeria have contributed in population increases in Jos since

it is one of the safest and closest places to relocate (Ajiji & Larab, 2016). Boko Haram is an Islamic militant group that believes politics in northern Nigeria has been seized by a group of corrupt, false Muslims. It wants to wage a war against them, and the Federal Republic of Nigeria generally, to create a pure Islamic state ruled by Sharia law.



Figure 3 Location of Jos, Plateau State in Nigeria

Source: Anekoson (2013)

There is limited reliable data on the population of Jos. In 2008 the National Population Commission (NPC) (2008) estimated the population was 1.3 million and growing at 2.8% per annum. Fola Consult (2009) projected that the population would reach 2.7 million by 2025. Currently 52% of the population live in urban areas and 48% in rural. Specifically the urban population has been increasing at a rate of 5.5% per annum, thus increasing the quantity of waste generated that needs to be managed (Ogwueleka, 2009; Peter et al. 2014). There has not been commensurate development in the rate at which social services and infrastructural amenities are provided especially in terms of solid waste management (Oyeleye, 2013). DungGwom et al. (2008) observed that over the last thirty years the city has been struggling with the challenge of handling its own waste. As a result of these challenges, the current waste management system is poor and sharing the same challenges faced by other Nigerian cities and LEDCs in general. The lack of services and infrastructure has often resulted in urban residents being confronted with waste dumped throughout the community in backyards, public spaces, drains, streets and

streams (Agunwamba, 1998; Daffi & Kassam, 2013). These actions have a negative impact on the environment and public health.

1.3 AIMS AND OBJECTIVES

To investigate the solid waste management problem (the lack of waste collection and controlled disposal services) this study has the following aim and objectives:

AIM:

The following research aims to develop an in-depth understanding of solid waste management practices in low income areas of Jos, in order to evaluate the management challenges and identify opportunities for waste prevention.

OBJECTIVES:

1. To investigate the existing systems for managing household waste in low income areas in Jos.
2. To identify the challenges (including future challenges) to achieving the sustainable management of solid waste in the study area, and to identify recommendations to improve current practice.
3. To understand the levels of waste generated and the composition of household waste in low income areas in Jos.
4. To review the existing waste prevention interventions currently being used in other parts of the world.
5. To evaluate the feasibility and impact of waste prevention opportunities in the study area.

In order to meet the aim and objectives of this research, the author adopted a mixed methods approach. A summary of the methods used for the investigation are shown in Table 4 along with the objective they helped to meet.

In order to understand the waste management system in Nigeria and low income areas of Jos, an initial comprehensive literature review was conducted. The review included consideration of how the waste management system has developed, the roles and responsibilities of different stakeholders, legislation, collection and disposal systems used and associated environmental and public health impacts.

The review was followed by direct observations, focus group discussions, and structured interviews with stakeholders in order to understand the waste management system in existence in Jos. Questionnaires with community members followed to help understand the behaviour of citizens in the study area.

The information collected helped to satisfy Objectives 1 and 2, with challenges to sustainable waste management being identified and recommendations to improve the current system proposed.

As covered in Chapter 1.2.2 waste prevention has been identified as an opportunity to address the waste management challenges in LEDCs. In order to develop an effective waste prevention strategy, it is imperative that the composition of the study area waste stream is understood. Key materials and associated interventions can then be implemented to address the identified priority materials. The author conducted waste composition analysis in order to establish the level of waste generation and composition from households, thereby helping to satisfy Objective 3.

In order to understand the waste prevention interventions being used in other parts of the world the author conducted a systematic literature review on existing waste prevention practices globally. From this a longlist of waste prevention initiatives was developed. These were assessed against five criteria in order to develop a shortlist of the most applicable interventions for the study area thereby meeting Objective 4.

In order to meet Objective 5 and evaluate the feasibility and impact of the shortlisted waste prevention opportunities in the study area, the author organised two focus groups with PEPSA⁷ officials and household members from the study area. These were conducted in order to gauge the views and opinions on the most applicable waste prevention opportunities using Ketso⁸ and SWOT⁹ analysis (see Chapter 4.3.8.1 for more detail on both methods). Recommendations are proposed to implement the identified waste prevention opportunities in Jos.

⁷ Plateau State Environmental Protection and Sanitation Agency (PEPSA). As covered in 3.2 PEPSA have the responsibility for managing waste in Jos Bukuru Metropolis.

⁸ Ketso is an approach used to help document the opinions of stakeholders during discussion with participants recording their views on different coloured paper.

⁹ SWOT analysis (strengths, weaknesses, opportunities and threats analysis) is a framework for identifying and analysing the internal and external factors that can have an impact on the viability of a project, product, place or person.

Table 4 Summary of methods used in this research to achieve set objectives

Method	Literature review on SWM was conducted	Direct observation of the study area by the researcher	4 focus group discussions held with 32 participants from the study area	5 interviews were conducted with different stakeholders of SWM in Jos	678 questionnaires were administered to householders from the study area	Literature review on national waste prevention initiatives was conducted	Waste composition analysis was carried out on 74 households from the study area	2 focus group discussions on waste prevention initiatives was conducted with 15 participants from the study area
Objective								
1. To investigate the existing systems for managing household waste in low income areas in Jos.	✓	✓	✓	✓	✓			
2. To identify the challenges to achieving the sustainable management of solid waste in the study area, and to identify recommendations to improve current practice.	✓	✓	✓	✓	✓			
3. To understand the levels of waste generated and the composition of household waste in low income areas in Jos.	✓	✓	✓	✓	✓		✓	
4. To review the existing waste reduction interventions currently being used in other parts of the world.						✓	✓	✓
5. To evaluate the feasibility and impact of waste reduction opportunities in the study area.						✓	✓	✓

1.4 CONTRIBUTION TO KNOWLEDGE

1.4.1 Existing research on SWM in Nigeria

Solid waste management has received attention in Nigeria with many publications looking at the effects of waste management on the environment and public health, for example work by Daffi & Kassam (2013), Egbere et al. (2001), Longe & Williams (2006), Momodu et al. (2011), Oyelola et al. (2009), and UNEP (2002). Research has also focused on waste generation and composition which is a vital aspect to enable its planning and management, for example the work of Ayotamuno & Gobo (2004), Babayemi & Dauda (2009), Ogwueleka (2009), Ogwueleka (2013), Sha'Ato et al. (2007). Similarly there has been published research on waste governance, regulation and legislation by Adama (2007), Ezeah & Roberts (2014), and Nzeadibe et al. (2010). More recently the role of the informal sector in waste management has been recognized as they utilize waste as a resource, and make invaluable contributions to society and often to the economy of a nation. Studies include Ezeah et al. (2013), Konya et al. (2013), Oumarou et al. (2012), and Zia et al. (2008). There are also publications on waste management and sustainability by Adewole (2013), Agbesola (2013), Batagarawa (2011), and Ezeah & Roberts (2012). E-waste management is another aspect that has been researched by many scholars for example Adediran & Abdulkarim (2012), Amachree (2013), Bates (2013), E-Terra Technologies (2016), Nigerian Custom (2011), Osuagwu & Ikerionwu (2010), and Umesi & Onyia (2008). The investigations by E-waste scholars have ranged from an appraisal of regulations and current practices, to disposal, and challenges facing the effective management of e-waste including the way forward for its management in Nigeria. These studies include identification of the key barriers to achieving sustainable solid waste management in Nigeria which include poverty, corruption, disposal habits of citizens, inadequate waste plants and equipment, high population and rapid urbanization.

1.4.2 Gaps and proposed contribution to knowledge

The author identified two main gaps in knowledge: waste management in low income areas and the potential role of waste prevention in LEDCs.

Waste management specifically in low income areas is a subject that has been under researched both in Nigeria and globally. Low income areas prevail in many cities in Nigeria including Jos with 80% of its population made of low income earners (The National Housing Policy, 2006). Sani (2003) established that the low income group, and by implication the low income areas, do not sufficiently benefit from government programmes or services. Solid waste management is an area of great concern to the general public, since lack of services has serious negative consequences on public health and the environment. Although literature exists highlighting some of the challenges to SWM management in Nigeria in general by Ezeah (2010), no studies have been done to identify the challenges that are specific

to the low income areas in general in Nigeria. Therefore, studying the low income areas fills the current gap in knowledge and could lead to improved SWM practice.

Research studies by Afun (2009) and Ajibade (2007) have recommended waste prevention to be used as a strategy for reducing waste generation in Nigeria. Ajibade (2007) believes that the approach which could reduce waste to the barest minimum is the most desirable for Nigeria, while Afun (2009) advised that the waste hierarchy should be a fundamental element of the national policy thrust for waste management. Even though studies have recommended waste prevention for Nigeria, no study has specifically looked at waste prevention in detail as a strategy. Waste prevention is still at an embryonic stage in Nigeria hence it has not been defined within any national strategies. In addition very little has been done on waste prevention in LEDCs *per se*, and even in MEDCs, Wilson et al. (2010) observed that it had taken over 30 years to focus more seriously on waste prevention, but now its importance is fully recognized and even considered a priority. Waste prevention is recognised as the priority of the waste hierarchy and it offers the best chance for reversing the current trends in waste generation in Nigeria and other LEDCs. Moreover, many waste prevention interventions are 'low-to-no-cost' thereby presenting cost-effective and viable solutions. They are also actions individuals can take thereby reducing over reliance upon government. The research contributes to increasing our knowledge of the role and opportunities of waste prevention in Nigeria with outputs applicable to other LEDCs with low income areas.

Even though waste management has been researched in Jos, studies have not focused on the waste management system and challenges in low income areas or identifying waste prevention opportunities. For example Peter & Ayuba (2014) presented a desktop review of the waste management system in Jos including information gleaned from diploma and undergraduate students; Ngwuluka et al. (2009) examined waste management in health care establishments, Ola Adisa et al. (2015) studied knowledge, attitudes/beliefs, and practice associated with medical waste management; Binbol et al. (2013) evaluated the waste management activities of PEPSA; Egbere et al. (2001) researched the health impacts associated with waste handling; Jatau (2013) and Ola-Adisa et al. (2015) researched attitudes and practices to waste; Peter et al. (2014) and Musa et al. (2008) looked at planning aspects of waste management in Jos.

This research contributes towards developing a better understanding of the waste management challenges being faced in low income areas with recommendations for improvement. The significance of the study is tied to the challenges of environmental protection, public health, as well as resources that can be gained from using a more efficient waste management system. The research contributes towards our knowledge on waste prevention opportunities in LEDCs, an area where there is little existing research. With the projected increases in waste and urban population growth, this makes the research very important and timely.

The research also contributes rich quantitative and qualitative data to better understand the waste management system and the behaviour of citizens.

1.5 AN OUTLINE OF THE THESIS STRUCTURE

This thesis is organized into the following structure as outlined below. Chapter 2 to 6 are Part A and focus more on the waste management system and challenges towards sustainable waste management. Chapters 7 and 8 make up Part B where the focus is on the role of waste prevention to address waste management challenges in the study area.

Part A

Chapter 1: Introduction

Chapter 1 is presented in five subsections. The first section provides the varied definitions of solid waste and goes on to explain the main categories of waste, the types of waste producers and the materials within each category. The second section presents the background and context of the research, starting with waste management in LEDCs, the waste hierarchy, and the importance of waste prevention. Also included in this section is a brief introduction to the study area, Jos in Nigeria. The third section sets out the aims and objectives of the study, highlighting the methods used in order to achieve the set objectives. The fourth section sets out the contribution to knowledge of this study. The final section presents an outline of the thesis structure.

Chapter 2: Literature review on municipal solid waste management in Nigeria.

Chapter 2 presents the literature review of municipal solid waste management in Nigeria. The chapter provides a holistic introduction to Nigeria, its geography, demographics, socioeconomic status and governance structure. The chapter moves on to present the municipal solid waste management system starting with the history of waste management, development of national policies, the waste management processes from generation to disposal, and the impact of improper waste management on the environment and public health. The challenges militating against sustainable solid waste management identified in past literature are presented.

Chapter 3: Literature review on municipal solid waste management in Jos

Chapter 3 focuses specifically on Jos, the focus of the research. The chapter starts by introducing Jos and provides information on its population and development. The chapter sets into context low income areas and their access to sanitation. The World Health Organisation (WHO) defines sanitation as the provision of facilities and services for the safe disposal of human urine and faeces. Inadequate sanitation is a major cause of disease world-wide and improving sanitation is known to have a significant beneficial impact on health both in households and across communities. Sanitation also refers to the maintenance of hygienic conditions, through services

such as waste collection and wastewater disposal. The chapter moves onto review existing waste management studies undertaken in Jos and presents information from waste generation through to waste disposal including its impact on public health and environment.

Chapter 4: Research methodology and design

Chapter 4 presents the methodology adopted in this study. The chapter starts by setting out the research problem and setting research questions in order to fulfil the aim and objectives. The chapter moves onto to reflect on research philosophy explains how this influenced the research design process. The study adopted a mixed method approach and each method is explained and justified with consideration of research skills literature. The chapter also considers reliability and validity of the data collected and ethical concerns/issues.

Chapter 5: Results

This chapter presents results from the fieldwork. It starts by presenting more detail on the nature and characteristics of the study area including housing, access to utilities, sanitation and demographics of residents. The subsequent section provides information on the solid waste management structure in Jos as well as the role and responsibilities of different stakeholders identified during the fieldwork. The chapter moves on to focus on the waste management system in the low income areas including waste storage, collection, disposal and impacts of the waste management system. Key challenges towards the sustainable management of waste in Jos are identified. The chapter also includes information on existing waste reduction, reuse and recycling activity.

Chapter 6: Discussion

Chapter 6 discusses the results from fieldwork. The chapter is structured around the challenges identified during fieldwork to achieving sustainable waste management in the study area. These challenges are discussed with reflection on past studies, and recommendations presented to overcome these issues. Limitations of the fieldwork conducted for Part A of this study are also considered.

Part B

Chapter 7: Waste Prevention

In Chapter 7 the research focuses on the second part of this research which is waste prevention. The chapter introduces the concept of waste prevention and goes on to present the waste composition analysis conducted to understand the waste generation levels and composition in the study area. The results are presented and discussed and identify the materials desirable to target for waste prevention.

Chapter 8: Waste Prevention Opportunities

Chapter 8 focuses specifically on evaluating the waste prevention opportunities for the study area. Following a literature review of existing waste prevention interventions, a longlist was developed and evaluated based on their suitability for the study area. After which a short list of waste prevention interventions was generated with more detailed information on the interventions presented. The short list of interventions was tested with stakeholders from the study area in order to assess their suitability. The chapter presents the results from each stage along with discussion and consideration of limitations from Part B of the research.

Chapter 9: Conclusions and recommendations

Chapter 9 concludes on the main outcomes of the research and also highlights the contribution to knowledge, and suggests areas for further investigation.

The appendices supporting this thesis are provided on the accompanying CD.

2 A REVIEW OF MUNICIPAL SOLID WASTE MANAGEMENT IN NIGERIA

2.1 BACKGROUND TO NIGERIA

2.1.1 Geography and demographics

Nigeria is officially known as the Federal Republic of Nigeria (FRN), Abuja became its capital on December 12th 1991. With 183 million people Nigeria is the most populous country in Africa and is the seventh most populous country in the world (World Bank, 2015).

Africa is depicted in Figure 4 with Sub Saharan Africa (SSA) shaded in green. Nigeria lies in west SSA on the Gulf of Guinea, and it shares a border with Benin to the west, Niger to the north, Chad and Cameroon to the east (CIA, 2011). It lies between latitudes 4° and 14°N, and longitudes 2° and 15°E. It covers 923,770 km² made up of 910,770 km² land and 13,000 km² water.



Figure 4 Map of Africa showing Sub Saharan Africa (SSA) and Nigeria
Source: CIA (2013) and UN (2013)

Nigeria emerged as the largest economy in Africa with a GDP of US\$510 billion in 2014 (The Economist, 2014; The Guardian, 2014). Despite the latest GDP figures dropping to US\$481 billion, Nigeria's GDP is still higher than South Africa (US\$ 312 billion) and Angola (US\$ 102 billion).

Oil had been the dominant source of government revenue, energy and foreign exchange (Odularu undated), since the 1970s and Nigeria is now the twelfth-largest producer of petroleum in the world. Regulatory constraints and security risks have restricted new investment in oil and natural gas, and Nigeria's oil production has dropped from 2012 to date. However, the Nigerian economy has continued to grow at a rapid rate of 6-8% per annum, with services contributing 57% of the GDP, manufacturing and agriculture contributing 9% and 21% respectively, with the remainder through oil. The economy is thus diversifying and is becoming more service-oriented, in particular through retail and wholesale trade, real estate, and communications (African Economic Outlook, 2015). In order to sustain the annual growth rate, the Nigerian Government is privatizing important sectors of the economy, promoting public-private partnerships, and encouraging strategic alliances with foreign firms, especially for infrastructure development and technology acquisition in critical sectors such as security, power generation, agriculture, transport, and healthcare.

Table 5 compares the characteristics of Nigeria with other countries within SSA. The author's rationale for choosing these specific countries was to ensure a fair geographic representation of SSA and they are presented in alphabetical order.

The population is distributed 52% urban and 48% rural and Nigeria has the highest population density in Africa with 200 people per km² (World Bank, 2015). The global literacy rate for people aged 15 and above is 86.3%. Specifically for SSA the literacy rate is 64.0% with women representing almost two-thirds of the illiterate adults (CIA, 2015; UNESCO 2015). Nigeria's literacy level is 66.2% and it trails other countries in SSA including Ghana, Kenya, South Africa, Tanzania, Uganda, and Zimbabwe where literacy levels exceed 80%. According to the latest WHO data published in 2015, life expectancy in Nigeria is 54.5 years which gives Nigeria a World Life Expectancy ranking of 171 out of 193 countries (WHO, 2016).

The Human Development Index (HDI) is published by the United Nations Development Programme (UNDP) and is an indicator for assessing long-term progress in three dimensions of human development: a long and healthy life, access to knowledge, and a decent standard of living. A country scores a higher HDI when they are performing well, for example life expectancy, education levels and GDP are high. The UNDP classifies each country into one of three development groups:

- Low human development for HDI scores between 0.0 and 0.5.
- Medium human development for HDI scores between 0.5 and 0.8.
- High human development for HDI scores between 0.8 and 1.0.

In terms of HDI, Nigeria was placed 152nd out of 188 countries and territories in 2015 with a score of 0.527, meaning that Nigeria is considered to have a medium level of human development (UNDP, 2016). The comparative value for SSA in 2015 was 0.523, and for Europe and Central Asia both 0.756, and the world average 0.717. The 2015 HDI value for Nigeria was however an improvement on the country's previous HDI values of 0.500 (2010), 0.514 (2012), 0.521 (2013) and 0.525 (2014).

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Table 5 A comparison of Nigeria's characteristics with other SSA countries

Country	Population (millions)	Area (km²)	Population density (persons per km²)	Literacy rate (%)	GDP (Billion US\$ in 2015)	Life expectancy (years)	Human Development Index (HDI)
Angola	26	1,246,700	20.4	72.2	102.64	51.7	0.53
Benin	11	112,622	97.9	45.5	8.48	59.2	0.48
Cameroon	24	475,442	49.7	79.4	29.2	54.9	0.51
Central African Republic	5	622,984	7.9	36.8	1.5	49.5	0.35
Chad	15	1,284,000	11.1	46.2	10.89	51.1	0.39
Ghana	28	238,540	116.3	83.7	37.86	60.0	0.58
Kenya	48	580,370	80.4	82.0	63.4	60.6	0.55
Nigeria	183	923,770	199.9	66.2	481	54.5	0.51
South Africa	55	1,221,037	44.9	96.7	312.8	57.1	0.67
Tanzania	56	947,300	57.3	80.4	44.9	64.1	0.52
Uganda	41	241,040	164.5	80.5	26.37	53.2	0.48
Zimbabwe	16	390,760	40.3	89.1	13.89	54.8	0.51

Source: Adapted from UNESCO (2016), UNDESA (2015), UN (2016), World Bank (2016), and UNDP (2015)

2.1.2 Socio-economic status

Despite having the largest economy in Africa, Nigeria is considered a poor country because of the high number of people living in poverty (Dauda, 2016). It is an acute problem in Nigeria with the World Bank (2014) stating that 33.1% of Nigeria's population is living under the international poverty line which is defined as the minimum level of income deemed adequate in a particular country. The common international poverty line was originally set to roughly \$1 a day (Sachs, 2005) but it has now been updated to \$1.90 a day due to inflation (World Bank, 2015). Most scholars agree that \$1.90 a day is a better reflection on the current situation, and particularly the new price levels in LEDCs (Lingnau, 2016). The World Bank (2014) ranked Nigeria 3rd in the World Poverty Index after India and China respectively. The World Bank (2014) also stated that 7% of 1.2 billion people globally living below the poverty line are Nigerians, and Ferreira et al. (2015) believe that over 85% of extremely poor people could be from SSA.

Dauda (2016) stated that Nigeria's poverty rate has continued to increase despite being home to abundant resources such as crude oil, minerals and rich fertile soil. Ofoche (2012) assumed that this poverty has been caused by the overwhelming socio-economic problems facing Nigeria in particular population increase. Egunjobi (2002) and Oyesiku (2002) stated that Nigeria's uncontrolled growth in population and urban development has resulted in a decline in the country's national wealth. With an annual growth rate of 2.8%, Nigeria's current population of over 183 million is expected to be 200 million in 2019 and over 440 million in 2050, taking it into the top five most populous countries in the world (UN, 2015). The poor economic climate and low industrial development are additional reasons for the levels of poverty and high unemployment rate¹⁰ (Chete et al. 2016).

Other issues such as lack of funds, lack of visionary leadership, corruption, and undue political interference has made it difficult for the Nigerian government to plan and provide effective social services to the people in terms of water supply and sanitation, housing provision, and job opportunities particularly for the urban poor (Bakare, 2012; Boris, 2015; DungGwom et al. 2008; Lawal & Oluwatoyin, 2011; Mathews 2002;). As a result, urban economic development is not proportionate with measures required to alleviate poverty and create economic opportunities to improve the standard of living and quality of life of the people (Oyesiku 2002; UN Habitat, 2004).

The socio-economic and environmental effects of these failures fall greatly on the poor, who are left out from the benefits of urban prosperity, leaving them with low income. The Daily Independent (2014) observed that less than 10% of the country's population amasses and controls over 90% of the country's wealth and resources. A consequence of which is the high rate of crime, corruption, violence and insecurity in

¹⁰ The World Bank (2012) has put the unemployment rate in Nigeria at 22%, and the youth unemployment rate at 38%.

the country as documented by AllAfrica.com (2011), Chikezie & Ikemitan (2011), Lawal (2010), Okeshola (2007), Okeshola (2014), and Onwuka et al. (2015). Many reasons have been given by these scholars regarding the spate of insecurity including the unemployment of youths, political and electioneering conflicts, socio-economic agitations, ethno-religious crises, ethnic militias, boundary disputes, cultism, god-fatherism¹¹ and poverty. These problems individually and collectively constitute threats to the peace, security and development of the country.

To address the levels of poverty the Nigerian government has an established minimum wage of which all employers (including small, medium and large establishments) are required to pay their workers. Fapohonda et al. (2012) describes the minimum wage not only as the smallest hourly wage that an employee is paid as mandated by federal law, but also as a social protection which requires the effort, commitment and collaboration of all stakeholders. This corresponds with the International Labour Organisation (ILO) Convention 131 of 1970: 9, which stipulates *“that the minimum wage is the sum payable to a worker for work performed or services rendered within a given period, whether calculated on basis of time or output, which may not be reduced either by individual or collective agreement, which is guaranteed by law and which may be fixed in such a way as to cover the minimum need of the worker and his/her family in the light of economic and social condition”*. In Nigeria this wage is fixed by the government with inputs from different commissions, and revised every 5 years. The government’s involvement in setting a minimum wage dates back to the colonial period with the Hunt Commission of 1934 (Ekwoaba & Olusanya, 2011).

In 2011, the Minimum Wage (Amendment) Act, which replaced the Minimum Wage Act of 2004, was signed by former President Goodluck Ebele Jonathan revising the national minimum wage upward from NGN7,500 (£18.43)¹² to NGN18,000 (£44.22) per month. Currently the national minimum wage is NGN18,900 (£46.43) per month and both the public and private sectors are required to abide by it and those who can afford to pay more can do so, but no employer is allowed to go below it (Ahiuma-Young, 2013). However, there is a general lack of implementation and enforcement, resulting to a high percentage of people being paid below the minimum wage including part time workers, single parents, the retired and students.

Until recently unemployed youth were not given any stipend or allowance, and had been left on their own to struggle for daily survival. However, in 2016 the government announced that unemployed youth would receive of NGN5, 000 (£12.28) every month to support them (Nwabughogu 2015; Tukur 2015). Anecdotal

¹¹ God-fatherism is a form of political corruption in which an influential member of a party or a person in power or of financial capability puts another person in a leadership position and influences their decision making in order to get an advantage/wield power.

¹² Based on the exchange rate of NGN1.00=£0.002 April 2017 derived from xe.com. This exchange rate is used throughout the thesis – however due to the volatility of the Nigerian economy the exchange rate can significantly fluctuate.

evidence shows that whilst some payments have been made there are logistical and political problems impacting its roll out.

Low-income households are defined by National Salaries, Income and Wages Commission (NSIWC) (2012) as households whose income falls below NGN43, 164 (£106.05) per month. Enhancing Financial Innovation and Access (EFInA) (2011), a top international consulting company, used a slightly higher threshold of NGN50, 000 (£135.50). EFInA (2011) stated that the average monthly individual income across Nigeria ranges from NGN5, 000 to NGN40, 000 which is equivalent to £12.28 to £98.27. In reality, most employees who work outside the public sector or outside the organized private sector, as well as many self-employed Nigerians, earn well below the national minimum wage. This, by implication indicates that about seventy percent (70%) of Nigerians earn less than NGN500, 000 (£1,228.4) per annum and fall into the low income category. Studies by The National Housing Policy (NHP) (2006), and Aluko & Amidu (2006) broadly agree and state that about 80% of the population of Nigeria is classified as low income.

EFInA carried out a year survey in order to understand the characteristics of the low income population in Nigeria. The survey revealed that low income earners work in both the formal and informal sectors, many of whom are married householders engaged in small businesses on a subsistence basis (EFInA, 2011). Okpoko & Oluwatayo (2014) found that home-based enterprises play an important role in contributing to household income, and providing some level of social protection. EFInA (2011) adds that most of the low income earners engage in menial jobs like farming, truck pushers¹³, okada riders (taxis), barbers, tailors, artisans and entrepreneurs. Under these arrangements the minimum wage does not apply, and they would still be classified as unemployed as they are not in formal employment through government or private companies.

Income in the informal settlements of Nigeria is low, intermittent and uncertain. The continuing growth of informal settlements can be attributed to the decline in both formal and informal sector employment. The unemployment rate in Nigeria has been rising from 6.4% in January 2015 to 10.4% in January 2016 to the current 14.2% in January 2017 (Trading Economics 2017). This conflicts with data from the World Bank (2012) which put level of unemployment in Nigeria at 22%, and the youth unemployment rate at 38% in 2012.

Nigeria's economy slipped into recession in early 2016 and since then many people have lost their jobs with banks, companies and other organisations, and this has contributed to the rise in unemployment rate. Moreover, there has been an embargo on employment by government because of financial limitations. Though the informal sector has always been part of the urban economy in Africa in general and Nigeria in particular, many urban residents are involved in multiple livelihood strategies, as

¹³ Truck pushers are also known as wheel barrow pushers or cart pushers.

people are compelled to employ diversified means of income generation through the acquisition of additional jobs (Trading Economics, 2017).

2.1.3 Governance structure in Nigeria – waste management

Nigeria has a three tier system of governance made up of the national government, 36 state governments which are divided into 774 Local Government Areas (LGAs). Each tier has a distinct function as stipulated by the constitution and independent of each other (Afon, 2007). Table 6 shows the different tiers of government with their varying functions. Note that whilst there are 6 regions in Nigeria there is no regional government in place.

The national government is made up of the Legislature, Federal Executive Council (FEC), and the Judiciary (see Table 6 for an explanation). This governance structure is also replicated at state level. The local government tier however only has two arms of government, made up of the Legislature, who are councillors representing different wards in the council, and the Local Government Executive.

In terms of environmental issues, the Federal Ministry of Environment at national level is divided into four sections comprising of the technical and service departments, the parastatals and units. The Ministry's main functions revolve around policy, enforcement and intervention. Its mission is to ensure environmental protection, natural resource conservation and sustainable development, with one of the Ministry's main thrust being effective waste management which is the focus of this research.

In terms of solid waste management, Figure 5 provides an overview of the tiers of government and their responsibilities. The Federal Ministry of Environment at national level coordinates the formulation of waste management policies and legislation. It supports the implementation of these policies through the allocation of funds to state and local government. In addition, the Federal Ministry of Environment administers and enforces environmental laws in Nigeria through the National Environmental Standards and Regulations Enforcement Agency (NESREA).

Based on the constitution of Nigeria, local governments are primarily responsible for providing frontline waste services including collection and disposal (Afun, 2009), however in practice this is not always the case as often they are not able to provide effective and efficient solid waste services due to costs (Isa, 2015). As a result the state government steps in to supplement the efforts of local government, particularly in those cities that are state or regional capitals (Afun, 2009). This is the situation in Jos where Plateau Environmental Protection and Sanitation Agency (PEPSA) fulfil the role of the local government and collect and dispose of waste. In the context of this study, the Plateau State Government manages waste through the state Ministry of Environment, and PEPSA, an agency of the Ministry of Environment, are directly responsible for waste management.

Table 6 Tiers of Government and their Functions

Tier	System	Functions
Federal Government of Nigeria (FGN)	<p>Nigeria runs a presidential system of government consisting of three arms:</p> <p>Legislative: National Assembly of 109 Senators and 360 Representatives. The National Assembly has the responsibility for making laws for governance. The Legislative is made up of specialised committees who focus on different aspects of national life.</p> <p>Federal Executive Council: President plus Ministers and Heads of Parastatals. The Federal Executive Council implements laws made by the National Assembly.</p> <p>Judiciary: A wide range of courts including the Federal High Court, Court of Appeal, Supreme Court. The Judiciary is responsible for the interpretation of the laws in accordance with the provisions of the Constitution.</p>	<p>The FGN renders services to its citizens through 26 federal ministries, 15 agencies and 19 councils and commissions. These have a wide range of responsibilities. Among them is the Federal Ministry of Environment which is responsible for solid waste management issues. It develops the national policy and legislation that governs SWM.</p>
State Government (SG)	<p>Nigeria has 36 States plus FCT Abuja. Similar to the Federal Government, each State has three arms of government as follows:</p> <p>Legislature: Members of House of Assembly. It comprises of representatives from all the local government areas within the State. It exercises identical functions at the State level with those of the National Assembly at national level. They make laws for the state, and act as a check and balance on the powers and actions of the Governor.</p> <p>State Executive Council: Governor plus Deputy Governor, Commissioners, and Heads of Parastatals.</p> <p>Judiciary: As per the Judiciary at national level.</p>	<p>Plateau State (where this research is based) is one of the 36 states of Nigeria. The state serves its populace through 17 state ministries, 10 departments, 12 agencies, 12 boards, 8 commissions and 5 others. There is the State Ministry of Environment and Mineral Development, and Plateau State Environmental Protection and Sanitation Agency which are responsible for SWM in Plateau State.</p>
Local Government (LG)	<p>Nigeria has 774 Local Government Areas (LGAs). Each local government area is administered by a Local Government Executive Council consisting of a chairman who is the Chief Executive of the LGA, and Legislatures who are elected members from the different wards in the council and referred to as Councilors.</p>	<p>Local government serve the public through different departments, including waste collection and disposal. Mandatory functions include planning, monitoring, service delivery, law making and enforcement, policy development and advocacy. Some of these functions are performed exclusively by the local government like the maintenance of cemeteries, markets and motor parks. Being the tier of government closest to the people, it is considered an important facilitator of economic and social development at the grassroots.</p>

Source: Afon (2007) and Nigerian Constitution (1999).

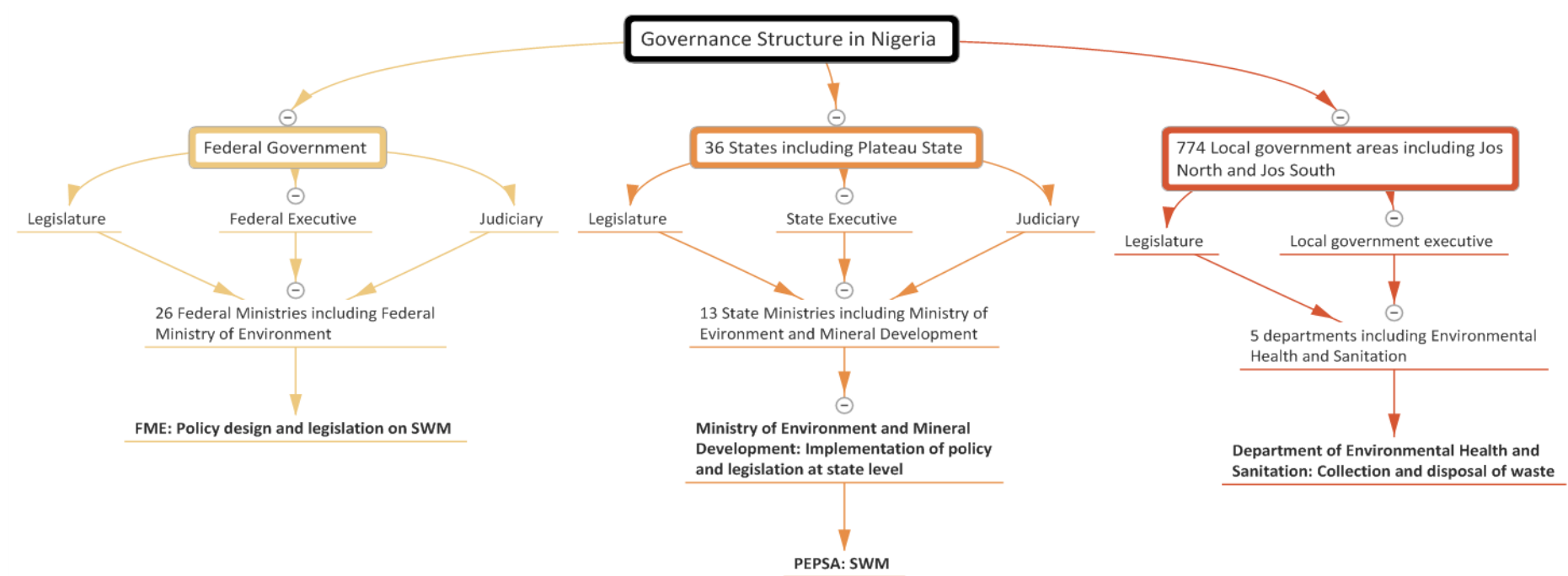


Figure 5 The governance structure of Nigeria and roles in waste management

Key

FME = Federal Ministry of Environment

PEPSA= Plateau State Environmental and Protection Agency

2.2 MUNICIPAL SOLID WASTE MANAGEMENT IN NIGERIA

2.2.1 History of waste management in Nigeria

Onibokun (1989) stated that the history of urban management, including waste, in Nigeria is tied to that of local government which has gone through four evolutionary stages. Before colonialism areas with substantial urban population in the north, west and south of Nigeria were controlled by a hierarchy of local chiefs¹⁴ with defined areas of jurisdiction and administration. The inhabitants of those communities lived by a system of well-defined rules and functional differentiations, such that public places were swept in rotation by groups of women. According to Onibokun (1989) household and other waste from public spaces was discarded in the surrounding bushes where it was left to decompose.

Following colonialism, the British masters adopted a policy of indirect rule. From the beginning of the proper period of colonial British rule in 1800, the colonial economic development policies and plans had little or no rules, to conserve the natural environment, and it was not clear which agency was responsible for the regulation and management of waste (Walling et al. 2004). Adelegan (2004) documented the development of environmental legislation and management since the early 1900s and his opinion is that the formative years of Nigerian environmental policy was characterised by a lack of established aims and objectives.

Subsequently the colonial masters introduced ordinances to strengthen administration with the first ordinance being the Public Health Act of 1909 which laid the foundation for improved sanitation. Sanitary inspectors were introduced and they went from house to house to make sure that houses and surroundings were clean. If they were not, those found guilty were sanctioned through the payment of stipulated fines.

The Township Ordinance No. 29 of 1917 classified urban settlements into three categories of cities, and the Town and Country Planning Ordinance of 1947 recognised the need for a separate administration to complement the local government councils to handle town and country town planning functions (Udoh, 2014). However neither considered waste, and a major short coming of the colonial era as identified by Onibokun (1989) was that the British colonial masters treated Nigeria as a rural country, therefore they made no effort to solve the emerging urban problem especially that of sanitation.

The third stage marked the immediate pre and post-independence period with the introduction of the Local Government ordinances of 1950 and 1954 which were subsequently amended. These ordinances introduced the three tier system of government as set out in Table 6. In addition to the three tiers, the ordinances

¹⁴ Including emirs, obas, and igwes.

recognised the special needs of metropolitan areas¹⁵ and urban centres, and created specific local government types such as municipal councils for the big cities like Lagos and Abuja, and urban councils for the smaller towns (Onibokun, 1989).

The last stage was the introduction of the Local Government edict of 1976 which established a unified and common local government system. 301 local government councils were created and the number has since increased to 774, with each expected to function as an effective third tier of government and empowered to exercise substantial control over local government affairs (Onibokun, 1989).

2.2.2 Development of national waste policy

Ikhariale (1989) stated that before 1988 Nigeria had no defined and clearly articulated national policy on the environment so it responded to most environmental issues on an ad hoc basis. Nwufu (2010) explained that the environment became an issue of concern to the world in 1970, and that led to the United Nations conference on the Human Environment in 1972. Although Nigeria was in attendance and a signatory to that conference, it did not develop an environmental policy or a strong legal framework for the protection of the environment until the toxic waste incidence of 1987 (Nwufu 2010). The discovery of toxic waste dumped at Koko in Warri Delta State by an Italian company made the national government to promulgate the Harmful Waste Decree 42 of 1988, which facilitated the establishment of the Federal Environmental Protection Agency (FEPA).

In 1989 the government formally launched the National Policy on Environment with the aim to define a framework for environmental governance in Nigeria. Both FEPA and the National Policy on Environment emphasized sanitation and waste management as part of an integrated holistic and systematic view of environmental issues (FEPA, 1990). The government has subsequently taken positive measures to improve the management of the environment by introducing acts and establishing many governmental authorities and agencies to ensure efficient and effective means of managing waste in the country. Table 7 sets out the key acts since 1988 relating to the management of solid waste in Nigeria.

¹⁵ Metropolitan areas are made up of more than one local government areas

Table 7 Statutory regulations guiding solid waste management in Nigeria

Act	Explanation
The Federal Environmental Protection Agency Act of 1988 (FEPA Act), Decree No.58 of 1988 and No.59 of 1992 as amended.	Established the Federal Environmental Protection Agency. The Agency administers and enforces environmental laws, ensuring that waste management is carried out within laid out standards and procedures. It is responsible for the protection and development of the environment in general, including initiation of policy in relation to environmental research and technology.
The Harmful Waste (Special Criminal Provisions), Decree 42 Act of 1988.	The Decree provides a legal framework for the management of hazardous waste. It prohibits the carrying, depositing and dumping of harmful waste on any land, territorial waters, contagious zone, exclusive economic zone of Nigeria or its inland water ways and prescribes the penalties for any person found guilty of any crime.
The National Guidelines and Standards for Environmental Pollution Control in Nigeria, 1991.	Sets out the protocol for monitoring and controlling industrial and urban pollution.
The National Effluents Limitations Regulations S.1.8 of 1991.	Makes it mandatory that industrial facilities install equipment to tackle pollution, make provision for effluent treatment, prescribes maximum limits of effluent parameters allowed for discharge, and sets out penalties for violation.
The National Environmental Protection (NEP) (Pollution Abatement in industries and Facilities Generating Wastes) Regulations S.1.9 of 1991.	Imposes restrictions on the release of toxic substances and stipulates monitoring of pollution to ensure permissible limits are not exceeded. It also covers incidents of unusual and accidental discharges, development of contingency plans, generator's liabilities, strategies for waste reduction, and safety of workers. In terms of waste reduction it emphasized that any industry or a facility shall adopt in-plant waste reduction and pollution prevention strategies.
Environmental Impact Assessment (EIA) Act, Decree No.86 of 1992.	This law states that before undertaking any project which is likely to have a substantial impact on the environment, an Environmental Impact Assessment must be done in order to establish what these impacts will be and how best to cope with them.
The Management of Solid Hazardous Wastes Regulations (Guidance on hazardous Chemical Management 2001).	This regulates the collection, treatment and disposal of solid and hazardous wastes from municipal and industrial sources, and provides a comprehensive list of chemicals and chemical wastes by toxicity categories.
The National Environmental Standards and Regulations Enforcement Agency (NESREA ACT), Act 2007 (repealed FEPA Act of 1988).	After repealing FEPA Act of 1988, the act became the major statutory regulation instrument guiding environmental matters in Nigeria. It specially makes provision for solid waste management and its administration and prescribes sanction for offences or acts which run contrary to proper and adequate waste disposal procedures and practices
National Environmental Regulations (Sanitation and Waste Control) S. I. No. 27 of 2009	This regulation provides the legal framework for the adoption of sustainable and environment friendly practices in environmental sanitation and waste management to minimise pollution.

Source: ELRI (2009)

The national government created the Federal Ministry of Environment (FME) in 1999, and as a result FEPA's functions were absorbed by the FME. With these institutional reforms, the National Environmental Standards and Regulations Enforcement Agency (NESREA) were established and is Nigeria's lead environmental protection agency (Federal Ministry of Environment, 2015). NESREA is responsible for the protection and development of the environment, biodiversity, conservation and sustainable development of Nigeria's natural resources in general. It is also responsible for liaison with relevant stakeholders within, and outside, Nigeria on matters of developing and enforcing environmental standards, regulations, rules, laws, policies and guidelines.

Most state governments in Nigeria, in line with national government, have established State Environmental Protection Agencies (SEPA) in order to further address environmental issues in their jurisdiction (Ogwueleka, 2009). At local government level, all environmental regulation and management functions are left with their environmental health service departments. The Fourth Schedule of the 1999 Constitution of the Federal Republic of Nigeria (Amended 2010) states that the issue of refuse collection and disposal should remain the responsibility of the local government agencies (LGAs).

The general perception that there is no regulation, or legislation on waste in Nigeria is untrue (Ezeah & Roberts, 2012), however it is poorly enforced (Afun, 2009; Agunwamba, 1998; Ikhariale, 1989; Walling et al. 2004). Ijaiya & Joseph (2014) state that the Nigerian Police is empowered to ensure, monitor and enforce the laws on environmental activities in Nigeria. To enforce regulations they can conduct a warrantless search on any building, land, or vehicle which they have reasons to believe is related to crime. The Nigerian police cooperate with the National Environmental Standards and Regulations Enforcement Agency (NESREA) to carry out its mandate to enforce environmental laws. Although NESREA is responsible for enforcing environmental laws, it has been problematic and with limited success. Therefore, the police often step in to assist in ensuring that laws and regulations concerning SWM are enforced.

Adewole (2009) believes that for effective sustainable waste management there needs to be the enforcement of environmental laws and regulations by the police and other agencies in the state. Afun (2009) stressed that legislation, or regulations, if not strictly enforced do not succeed, and Nigeria could solve their waste management problems through more robust and strict enforcement of the relevant legislation both at the national and state level. Sustainable development will be slow to achieve without rules, regulations and strict enforcement.

2.2.3 Solid waste generation

In Nigeria solid waste is generated at a rate beyond the capacity of authorities to handle in order to maintain a sustainable environment (Adejobi & Olorunnimbe 2012; Amuda et al. 2014). This has resulted in a poor solid waste management

system impacting on the environment and public health in most Nigerian towns and cities (Afon & Afolabi, 2007). Although it is generally reported that large quantities of solid waste are generated daily in Nigeria, the exact figure is difficult to determine as proper records and data on waste generation or disposal are not kept. Michael-Aguike & Ekpette (2012) and Nnaji (2015) decried the lack of data on this subject.

Afon & Okewale (2007) reported on a number of studies conducted in the 1980s to estimate the quantity of waste generated from residential areas in Nigerian cities, but each had a number of flaws. Examples of such studies include those by Adedibu (1983, 1988), Filani & Abumere (1982, 1986) and the results were criticised because of some methodological errors, such as the criteria used to choose participants, not taking a representative population, or being poorly structured.

Analysis of more recent studies have estimated that the levels of solid waste generation in Nigeria have been increasing from 9 million tonnes in 1993 (Uchegbu, 1998), to 13 million tonnes in 1995 (Chikwendu, 1997), to 17.9 million tonnes in 2006 (US EPA, 2010), while Ogwueleka (2009) reported an annual generation of 25 million tonnes in 2009. More recently Bakare (2016) estimated 32 million tonnes of solid waste was generated in 2016.

Atta et al. (2016) projected estimations of waste generation up to 2020. The estimates were based on using a baseline population of 158 million in 2011 from the 2006 census, a population growth rate of 2.5% based on World Bank (2011), and baseline waste generation rate of 0.5 kg/person/day. Two scenarios were calculated based on low (0.8%) and high (1.2%) economic growth rates. Table 8 shows the result of their estimates with annual waste arisings ranging between 35.08 to 35.92 million tonnes in 2017 with the quantity of waste generated by 2020 between 38.69 to 40.09 million tonnes.

Table 8 Estimates of future waste generation figures

Year	Projected population (million)	Rate of waste generation (kg/person/day)		Overall quantity of waste generated (million tonnes/annum)	
		Low (0.8%)	High (1.2%)	Low (0.8%)	High (1.2%)
2011	158	0.50	0.50	28.84	28.84
2012	162	0.50	0.51	29.79	29.91
2013	166	0.51	0.51	30.78	31.03
2014	170	0.51	0.52	31.80	32.18
2015	174	0.52	0.52	32.86	33.38
2016	179	0.52	0.53	33.95	34.63
2017	183	0.52	0.54	35.08	35.92
2018	188	0.53	0.54	36.24	37.26
2019	193	0.53	0.55	37.45	38.65
2020	197	0.54	0.56	38.69	40.09

Source: Atta et al. (2016)

Research has been carried out to estimate waste generation per capita in Nigeria. Ogwueleka (2009) reported a variation in the generation rate of between 0.44-0.66 kg/capita/day for rural and urban areas respectively (see Table 9). A number of other studies have put the average national figure between 0.45-0.55 kg/capita/day (Centre for People and Environment (CPE), 2010; Ogwueleka, 2009; Ossai, 2006; Solomon 2009). Solomon, (2009) estimated 0.49 kg/person/day with households accounting for 90% of the municipal waste generated.

Table 9 Waste generation in urban centres in Nigeria

City	Population	Tonnes per month	Waste Density (kg/m ³)	kg/capita/day
Lagos	8,029,200	255,556	294	0.63
Kano	3,348,700	156,676	290	0.56
Ibadan	307,840	135,391	330	0.51
Kaduna	1,458,900	114,443	320	0.58
Port Harcourt	1,053,900	117,825	300	0.60
Makurdi	249,000	24,242	340	0.48
Onitsha	509,500	84,137	310	0.53
Nsukka	100,700	12,000	370	0.44
Abuja	159,900	14,785	280	0.66

Source: Ogwueleka (2009)

The quantity and rate of solid waste generation in the different states of Nigeria depends on the population, level of industrialization and urbanization, socio-economic status of the citizens, and the kinds of commercial activities being undertaken (Babayemi & Dauda 2009; Ojo et al. 2015). Family size, level of education and monthly income also influences the rate of waste generation (Sujauddin et al. 2008). Kadafa et al. (2013) has shown a high correlation between income level and the quantity of waste generated.

2.2.4 Municipal solid waste composition in Nigeria

Whilst no specific waste composition studies have been undertaken in low income areas in Nigeria, a number of studies have investigated the municipal solid waste composition in Nigeria. Figure 6 shows a comparative analysis of waste composition from these studies, including a city from each of the 6 regions in Nigeria and the capital Abuja. It is important to note that all the publications used for this comparison focused on municipal solid waste only, which implies that it included residual and in some cases recycling waste if householders did not separate it out for collection. Across the studies the major constituent of the waste stream was putrescible¹⁶ varying from 26% in Maiduguri to 56% in Nsukka. Some other studies have suggested levels of putrescible waste could be as high as 78%-90% (Cointreau, 1982; Ogwueleka, 2009; Otti, 2011). Paper varied from 6.0% in Akure to 25% in Abuja, plastics between 7.7% in Akure and 18.1% in Maiduguri, metal 3.1% in

¹⁶ Putrescible is solid waste that contains organic matter capable of being decomposed – typically food waste and garden waste. This is sometimes referred to as organic waste or biowaste.

Abuja to 17.2% in Portharcourt, glass 2.5% in Nsukka and 13.5% in Portharcourt, and textile 2.5% in Makurdi and 7.6% in Port Harcourt. The remaining was made up of other wastes like ash, dust, ceramics, rubber, soil, bones, e-waste, scrap tyres, nappies and sanitary waste.

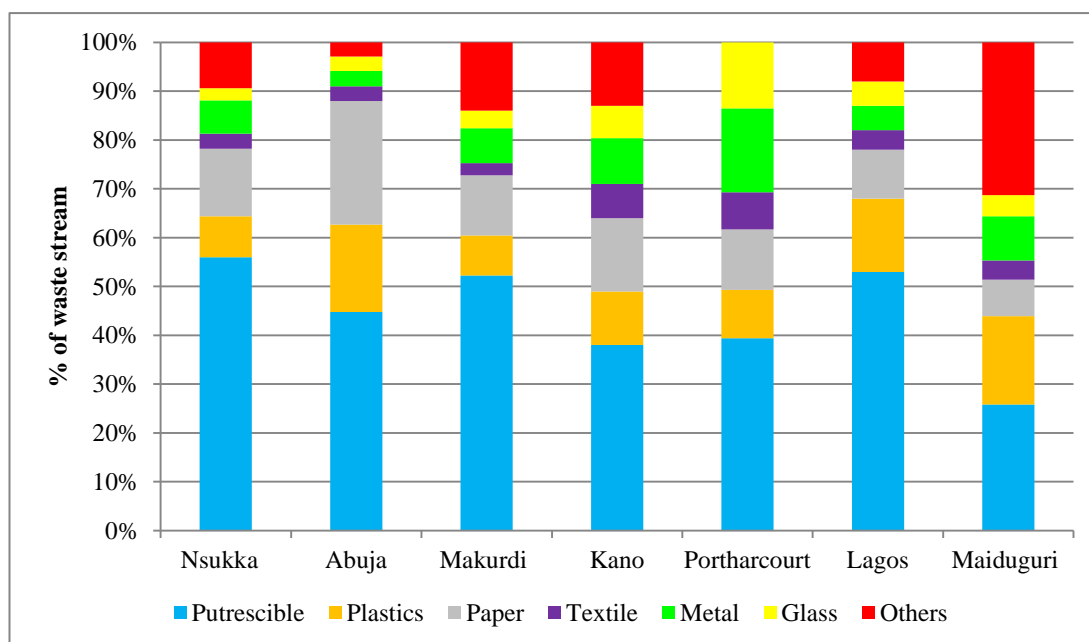


Figure 6 Waste stream composition from different cities in Nigeria by weight

Source: Collated from Abuja Environmental Protection Board (AEPB) (2012), Dauda & Osita (2003), Igoni et al. (2007), Kofoworola (2007), Nabegu (2010), Ogwueleka (2003)

2.2.5 Municipal solid waste collection

Household waste in most Nigerian states is generally not collected directly from households, but residents take waste and deposit it in communal public waste containers prior to collection by the municipal waste collectors. The exception is a few states including Lagos, Calabar and Abuja, who engage the services of the private sector, and they collect waste directly from households. However in these states the system is not universal, rural and low income areas rarely receive such services (Iriruaga, 2012).

An assorted range of vehicles are used for solid waste collection and transfer to disposal sites including trucks, side loaders, rear loaders, mini trucks, tippers, skip trucks and open back trucks (Abur et al. 2014; Ogwueleka, 2009). Figure 7 shows examples of some of the waste collection vehicles used for waste collection and transportation in Nigeria. Vehicles are often in-short supply or out of service due to frequent breakdown as a result of overuse (Agunwamba, 2003). For example Ogwueleka (2009) observed that 60% percent of trucks available for waste collection in Nigeria are in a state of disrepair or out of service at any one time. This has partially led to inadequate service coverage in most urban areas and non-collection in

rural areas resulting in improper waste disposal. For that reason many scholars have varied waste collection rates across Nigeria. For instance Ogwueleka (2003) suggested 60% of waste is collected, Iiriuaga (2012) mentioned 50%, Agboje et al. (2014) stated 20-80% while Bakare (2016) said 20-30%.



Figure 7 Waste collection vehicles being used in most Nigerian states
Source: New Agency of Nigeria (NAN, 2017); Uwaegbulam (2017)

2.2.6 Municipal solid waste management options

There are two ways of managing municipal solid waste, controlled or uncontrolled. Figure 8 shows the controlled and uncontrolled pathways of managing waste.

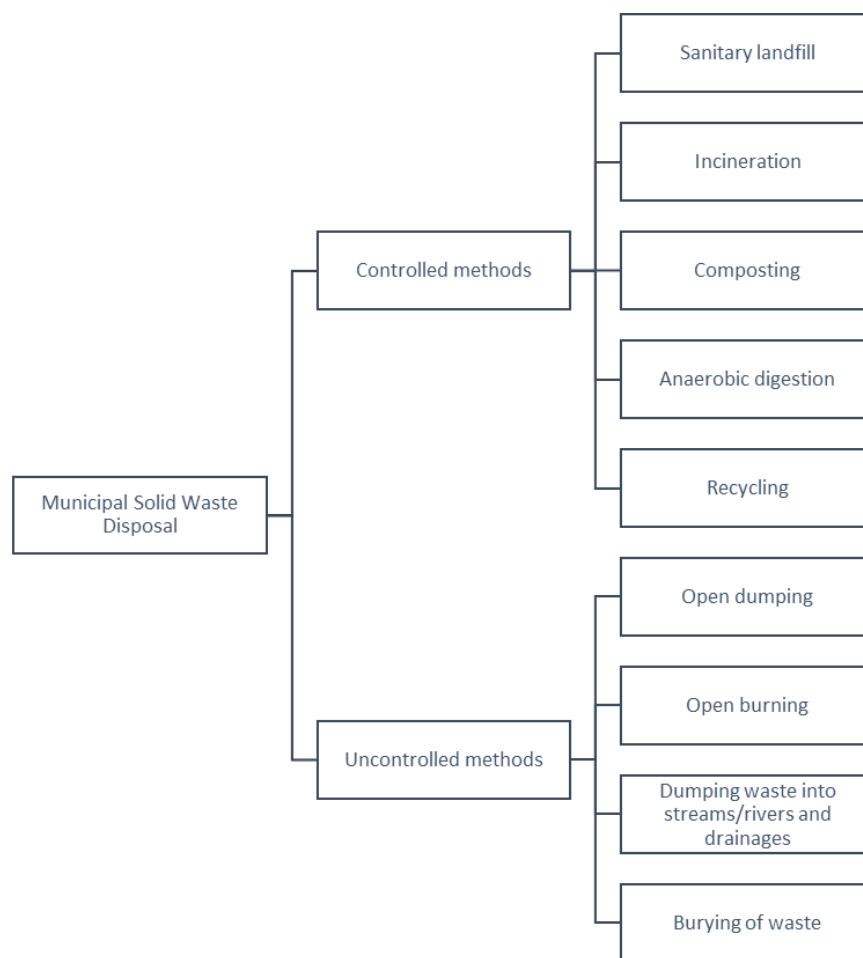


Figure 8 Controlled and uncontrolled management methods

The most common controlled ways of disposing of waste are sanitary landfill, incineration, composting, anaerobic digestion, and recycling (Alhassan & Mohammed, 2013; Nwachuckwu et al. 2010). The main uncontrolled methods are open dumping or burning either centrally or in communities, and disposal in streams, rivers and drains (Akpoghiran, 2016; Butu et al. 2013; Igoni et al. 2007; Obasioha, 2015; Uchendu, 2016). The majority of waste in Nigeria is managed through uncontrolled methods. This approach is considered naive, illegal and dangerous, as it impacts on the environment, society and public health (Ayuba et al. 2013; Ojewole, 2014). Evidence exists to show the dangers linked with improper solid waste disposal in Nigerian cities (Butu et al. 2013; Modebe, 2009; Momodu et al. 2011) – this is covered in more detail in Chapter 2.2.7.

2.2.6.1 Controlled approaches and consideration of initiatives in Nigeria

2.2.6.1.1 Sanitary landfill

Historically landfills have been the most common method of organized waste disposal and remain so in many places around the world. Sanitary landfills involve burying and managing waste within a controlled environment. Ogwueleka (2009) explains that a sanitary landfill has controls in place to collect gases generated, leachate management systems and other mitigations in place to control the impact on

the environment and society. Sanitary landfills are an environmentally accepted method of waste disposal but are capital intensive at roughly 3-8 times more expensive than open dumping (Ogwueleka, 2009; Sridhar & Hammed, 2014).

In Nigeria there are no sanitary landfills (Agunwamba, 2003; CPE, 2010; Imam et al. 2008; Nkwocha & Emeribe 2004) although some sites such as Mpape in Abuja have controls in place such as covering waste with soil (CPE, 2010). Sanitary landfills were introduced in Lagos and Onitsha two decades ago, but currently the landfills are not operating (Ogwueleka, 2009; Nwosu et al. 2016) because they require much greater initial investment and hence higher operating costs than uncontrolled or open dumps.

In response to the state of poor waste management, the Senate Committee Chairman of the National Assembly in Abuja in August 2010 called for the establishment of sanitary landfills and controlled waste management sites in Abuja. The call was made when the senator took a tour of the various dumpsites scattered along the suburbs of the city, and decried the poor management of dumpsites which were mostly located within settlements. However action is yet to be taken in response to this call as Abuja continues to use the Gosa and Ajata open dumps, while Nwosu et al. (2016) emphasized that there is no organized sanitary landfill site.

2.2.6.1.2 Incineration

Incineration is the combustion of waste at high temperatures which converts waste into ash, flue gas, and heat (Ogwueleka, 2009). Knox (2005) emphasized that flue gases must be cleaned of gaseous and particulate pollutants before they are dispersed into the atmosphere. In some cases, particularly in MEDCs, the heat generated by incineration can be used to generate electricity and are therefore referred to as Energy from Waste plants or Energy Recovery Facilities.

Two of the primary advantages of incineration are that waste volumes are reduced by an estimated 80-95% and the need for landfill space is greatly reduced (Greentumble, 2015). For urban areas, this can be especially important, as urban land is often at a premium.

In Nigeria incineration is not widely practiced (Afun, 2009; Obasioha, 2015; Ogwueleka, 2009) except in hospitals where medical waste is sometimes incinerated at a small scale but without energy recovery. Main (1993) and Phillips (1999) reported that 3 modern incinerators were built in Lagos with a European Economic grant at a cost of \$30 million (£23 million) but they were never used. In 1989, a decade after they were built, the government decided to dismantle two of these plants and convert the third one into a civic centre (NEST, 1991).

Sridhar and Hammed (2014) stated that incineration is a capital and energy intensive option which is about 5-10 times more costly than sanitary landfill. Though expensive, WHO (2004) and ALCO & World Bank (2007) believe that it is still the

best choice for the disposal of health care wastes which contain infectious or hazardous components.

2.2.6.1.3 Composting

Composting is a process in which waste materials are subjected to natural decomposition, facilitated by microbial activities under aerobic or anaerobic conditions (Adekunle, 2009). A number of studies such as Adekunle (2009), Adeoye et al. (1994), Gbolagade (2006), Iwegbue et al. (2007), and Sridhar & Bammeke (1986) show that composting has not been fully developed in Nigeria. Publications by Awomeso et al. (2010), Hoornweg et al. (1999), Olarenwaju (2009), and Sridhar & Hammed (2014) have highlighted the levels of biowaste in LEDCs including Nigeria. These wastes contain valuable resources in the form of nitrogen, phosphorus, and potassium (Hammed et al. 2011). Microorganisms play an important role in biogeochemical cycles and convert these valuable resources into useful compost.

Odon & Guobadia (2011) and Taiwo (2011) stated that composting should be encouraged by government authorities because of its benefits to the country and the public at large. Some of the benefits of composting include being cheaper than other options, large fractions of waste are turned into a useful product to enable increased food production, reducing the quantity of waste for disposal by as much as 65% leading to lower operational cost (Adekunle et al. 2011; Harir et al. 2015; Khadafa et al. 2013). Composting minimises air pollution, reduces water pollution, and reduces greenhouse gases by as much as 82% compared to a landfill (Farrell & Jones, 2009; Harir et al. 2015; Nabegu, 2011). Akinbile (2012) stated composting is the most viable waste management option for LEDCs because it is sustainable and environmentally friendly, and it uses limited land compared to landfilling. Odon & Guobadia (2011) added that government should encourage and support individuals, communities and private organisations to initiate home or community composting. They observed that the success of this project would require source segregation of organic waste in order to make composting easier.

There is limited record of composting in Africa, including Nigeria (Taiwo 2011), though Sridhar et al. (2013) posits that composting has been practiced in Nigeria on a limited basis for over 50 years. The practice is still largely neglected. Composting can be undertaken at centralised facilities or at home or community level.

As the name implies, home composting is carried out in homes on a small scale. In MEDCs households often buy pre-moulded plastic composting units in order to compost at home, however in Nigeria home composting is still at an elementary stage where households either dig holes or select spots at their backyards to dispose waste, and allow it to decompose before collecting it for onward application to their gardens and farmlands. Olowomeye (1991) reported that traditional Nigerian households made effective use of composting as a management strategy for solid waste generated within their surroundings and that waste from households like yam

peels, banana leaves, maize cobs, and egg shells were deposited in the backyard, where they were allowed to decay before subsequent utilization as compost during the planting season.

Composting at community levels is also referred to as decentralized composting, where small neighbourhood sites are used to compost the material close to where it was generated (Coker, 2006). Simple community composting was reported by Lewcock (1995) in a study of farmers' use of urban waste in Kano. Waste was dumped at specific sites in the community and left to breakdown. Lewcock stated that farmers in Kano then collected and used this slightly composted urban solid waste to fertilize their farms. Mortimore (1972) in a road side survey in 1962 recorded 1,447 donkeys, and in 1969 1,137 donkeys carrying 'taki' (manure from household waste and street sweepings and ash) out of Kano city to farms located 10-15km away from the city centre. The 'taki' represented about 140-185 tonnes of waste per day, and it could fertilize a farm of 1.5 hectares. Lewcock observed in the mid-1990s that farmers continued to use urban waste on a large scale.

Despite this long-standing tradition of composting, many Nigerian communities still make limited or no use of composting as a waste management strategy. Lewcock (1995) reported that there was significant potential for compost production in Kano but has not been maximised as a result of government apathy in providing the required structures. Lewcock (1995) mentioned that all farmers interviewed stressed the importance of urban waste to their farms, and because it was in high demand the method of collection changed from using a donkey to using the Kano State waste management tipper lorries. Studies undertaken by Sridhar et al. (2013) at the University of Ibadan reveal that communities can be effective in initiating composting projects if properly mobilized. The role of home and community composting is considered in more detail later in this thesis (see Chapter 8.2.1.1 and 8.2.1.2).

2.2.6.1.4 Anaerobic digestion

Anaerobic digestion is one of the oldest technologies in the world (Ngumah et al. 2013), and was introduced in Africa between 1930 and 1940 (Deublein & Steinhauser, 2008). Anaerobic digestion is a collection of biological processes in which microorganisms break down biodegradable waste material in the absence of oxygen (Okoro-Shekwaga & Horan 2015). The process can be used for industrial or domestic purposes to manage waste or to produce fuels. Anaerobic digestion is usually used for the treatment of animal waste and sewage sludge resulting from wastewater treatment plants. It is the most environmentally friendly option for the treatment of food waste (Okoro-Shekwaga & Horan, 2015). The main outputs are biogas which can be harnessed locally for cooking or lighting or put onto the grid, and a bio-fertilizer.

In spite of its early start in Africa, biogas technology on the continent is still at an embryonic stage. Specifically in Nigeria, the status of biogas technology remains

very poor, with no record of any existing commercial size plants that could contribute electricity to the national grid. The earliest record of biogas technology in Nigeria was in the 1980s, when a simple biogas plant that could produce 425 litres of biogas per day was built at Usman Danfodiyo University, Sokoto (Akinbami et al. 2000; Dangogo & Fernando, 1986; Sambo 2010). Since then about 21 small scale pilot digesters with a capacity of between 10m³ to 20m³ have been set up in different parts of the country (Chima et al. 2013). Chima et al. (2013) reports that the national government through universities and research centres are carrying out more research on anaerobic digestion, with a view to fully embrace and establish this technology. However, to date, biogas technology in Nigeria has stagnated at the institutional research and pilot stages rather than being rolled out commercially. Okoro-Shekwaga & Horan (2015) cite a range of barriers including ignorance, lack of a coordinating framework, and lack of political will from government. Moreover research at universities is frequently considered as being too academic and as such is rarely implemented in real life. On the other hand biogas technology is spreading across other African countries with Kenya taking the lead and further examples in Ethiopia, Tanzania, Uganda, Rwanda and Burkina Faso (Stichting Nederlandse Vrijwilligers, (SNV)¹⁷ 2017).

Chima et al. (2013), Ngumah et al. (2013) and Okoro-Shekwaga & Horan (2015) have enumerated the benefits of anaerobic digestion including being a source of energy leading to less dependency on fossil fuels, it is carbon neutral and converts organic waste to a high quality fertilizer. The gas burns cleaner than wood-fuel, kerosene, and undigested biowaste. Furthermore it decreases deforestation by providing renewable alternative to wood-fuel and charcoal. It contributes towards an integrated waste management system which reduces the likelihood of soil and water pollution compared to the disposal of untreated biowastes. Economic benefits include provision of cheaper energy and fertilizer, creation of job opportunities, and decentralization of energy generation and environmental protection.

2.2.6.1.5 Recycling

Although recycling exists in Nigeria (Kofoworola 2007), it has not received the attention of government and the waste management authorities, either in the past or at present. Therefore whilst recycling is common in most Nigerian cities (Otitoju 2014) it is normally implemented by the informal sector (uncontrolled recycling¹⁸) rather than government agencies (controlled recycling). Recycling can bring a range of benefits including economic growth, litter control, prolonging the lifespan of landfill, and conserving resources and energy (Adebola 2006; Adekunle et al. 2010;

¹⁷ SNV is a non-profit, international development organisation, established in the Netherlands in 1965.

¹⁸ Uncontrolled recycling activities are known to generate and release heavy metals and POPs into the environment, which can then be re-distributed, bioaccumulated, and biomagnified, with potentially adverse human health effects, while controlled recycling minimises the impact of heavy metals on the environment.

Ezeah et al. 2013; Kofoworola, 2007; Konya et al. 2013; Nzeadibe, 2009; Oguntoyinbo, 2012; Oumarou et al. 2012; Wilson et al. 2006; Wilson et al. 2009).

In Nigeria whilst there is an emerging awareness of the need to recycle, as mentioned above the activity is driven by entrepreneurs who seem to be light-years ahead of government (Umaru, 2010). Recycling of solid waste in Nigeria is mainly uncontrolled and revolves around the activities of informal workers, while controlled recycling is rarely practiced since government is not involved, and there are no formal recycling collection schemes. In local parlance (particularly in northern and central Nigeria) they are referred to as ‘Yan Bola’ (Guardians of the garbage), ‘Yan Panteka’ (Motor scrap cannibals), ‘Yan Gwangwani’ (Metal scrap collectors), ‘Yan Makera’ (Metal fabricators/smiths) or ‘Yan Tinka’ (Tin boys). Informal workers recover items of value from household garbage bins, construction sites, garages, markets and factories (Kofoworola, 2007; Nzeadibe, 2009; Umaru, 2010). In addition many people survive in Nigeria by scavenging open dumpsites for materials that could be sold (Ogwueleka, 2009). The materials are separated either at source or at dumpsites sites (Figure 9 shows a heap of metals separated at a dumpsite in Nigeria), before subjecting it to some level of processing, such as washing and drying then sold to the market. The price varies depending on type, quality and fluctuation of supply and demand in the market. After analysing the activities of scavengers and recycling in Nigeria, Aguwamba (2003) noted that well planned recycling and composting activities could result in cost savings of 18.5% and 57.7% in waste management and landfill avoidance respectively.



Figure 9 Metals separated from waste at a dumpsite, Rukuba road Jos, Nigeria
Source: Image taken by the researcher during fieldwork 2014.

According to Nzeadibe (2009) the informal recycling system consists of scavengers/waste pickers, middlemen, artisans, and small-scale enterprises that recover, re-manufacture or reuse waste. Some actors in the informal recycling sector produce finished goods from secondary raw materials for direct use by consumers and others convert the recovered materials into intermediate products using various processing steps. For example plastic wares might be pelletized or cut into smaller units to enable easy packaging for transportation to Onitsha or Lagos where more specialised recyclers further process them for the re-manufacture of various products (Nzeadibe & Eziuzor, 2006; Nzeadibe & Iwuoha, 2008). Figure 10 shows a truck loaded with metal scraps at Owode Onirin in Ikorodu Lagos for onward transportation to the foundries for recycling. The vehicle body parts can be seen flattened out in order to save space in the truck. The ‘Yan Bola’ underground economy has created a new class of entrepreneurs in the country’s environment industry (Umaru 2010). These shows a strong indication that the ‘Yan Bola’ business can progressively be the vanguard of advancing entrepreneurial development in Nigeria.



Figure 10 A truck of metal scraps at Owode Onirin, Ikorodu Lagos

Source: Uthman (Undated).

The materials collected through controlled and uncontrolled recycling are sold onto large businesses of which many derive a significant income selling products onto the international market. For instance Agwu (2013) cited the case of a Nigerian recycling company, Sun and Sand Industries Ltd, which made over \$61 million (£49 million) from exporting metals. Over 95% of the raw materials they source are metallic wastes that are recycled for export to manufacture cars and ship parts. Since 2005, the company had been exporting metallic waste from Nigeria to Japan, Hong Kong, United Arab Emirates (UAE) and India. Agwu (2013) quoted the manager saying “*Recycling is an industry that adds value to the Gross Domestic Product of a country and is always welcomed by any country that wants to create wealth and*

generate employment (such as Nigeria). Waste recycling here in Nigeria, is an untapped business that if you decide to go into today you are sure of making your cool money. The fun of it is that you might even decide to start now without you having necessary capital at hand and still be making your money from the business”.

The first Material Recovery Facility (MRF) in Nigeria was located in Lagos (Adegboye, 2015). The facility was developed by the West Africa Energy Group in collaboration with the Lagos State Government to ensure environmental sustainability through recycling and the creation of small scale entrepreneurial schemes in the area. The MRF receives, separates, and prepares recyclable materials for the end users. The facility provides materials for plastic, paper and metal manufacturers and creates jobs. No other state in Nigeria, including the capital Abuja, has a MRF hence there is heavy reliance on the informal sector in these states. UN-Habitat (2010) speculates that informal sector recycling is fuelled and maintained by a failure of the government, while Wilson et al. (2006) believes that recycling helps society to move up the waste hierarchy by preventing waste and supplying secondary raw materials industry. In addition Ezeah et al. (2014) suggest that the informal sector should be recognized and integrated into the waste management system as important elements for achieving sustainable waste management in Nigeria and LEDCs in general.

2.2.6.2 Uncontrolled approaches

2.2.6.2.1 Open dumping and disposal of waste in streams, rivers and drains

Open dumping is the common alternative to sanitary landfill in most African countries (Remigios, 2010). Nigeria commonly practices open dumping where waste is dumped in uncontrolled landfills (dumpsites) by trucks conveying wastes from urban or city centres (Ogwueleka, 2009). These open dumping sites are often approved by government and could last for many years. Usually the dumps are without regulation or standards that provide environmental protection. Ojo (2014) added that open dumpsites do not usually have liners, fences, leachate control systems, compactors or soil cover. Open dumpsites are cheap to manage and operate, and are generally sited on vacant open plots of land, gully erosion sites or low-lying areas, so that they can be reclaimed for future development. For instance in Plateau State most open dumpsites are on lands devastated by tin mining activities, gully erosion sites or abandoned mine ponds.

Conversely when households receive limited waste collection services from waste management authorities waste might be dumped in the community itself (Nnaji 2015). As shown in Figures Figure 11 to Figure 13, wastes from households is illegally dumped in communities including in open spaces, alongside highways and backyards (Babayemi & Dauda; 2009; Ojo, 2014; Onwughara et al. 2010).



Figure 11 Waste dumped at Ariaria Market, Aba, Nigeria
Source: Uchendu (2016)



Figure 12 Waste disposed in a stream in Delta, Nigeria
Source: Obasioha (2015)



Figure 13 Waste disposed in drainage channels at Mararaba, Abuja, Nigeria
Source: Butu et al. (2013)

Households in low income areas in Nigeria often dump waste within their communities in a manner most convenient to them, and in the locations above because of non-provision of waste collection services. Solid waste is also commonly disposed of in streams, rivers and drains (WHO, 1991). Nigerians dispose of waste into these bodies of water to allow water to transport it out of their sight (Igoni, et al. 2007). Ojo (2014) stated that 87% of Nigerians use these unsanitary methods of solid waste disposal. This practice can cause health risks and reduce the aesthetic value of the surrounding environment, deteriorate the urban environment, as well as contaminate natural resources (Ogu, 2000). It is an eyesore, produces an unpleasant odour, and creates a breeding ground for pests and diseases. Other impacts of open dumping include being a health hazard to informal workers, pollution of ground water, and spread of infectious diseases (Momodu et al. 2011). The dumping of waste can eventually result in the blockage of drains, streams and culverts thus leading to flooding in urban areas (Kofoworola, 2007).

Solid waste disposal in Nigerian urban areas has presumed appalling magnitudes as refuse heaps welcome visitors to major cities and urban centres (Osuocha, 1999). Open dumping cannot be considered as a long-term method of disposal as it results in threats to the environment and public health (Agaji & Wajiga, 2012), unfortunately in Nigeria open dumping is the most common approach for managing waste.

2.2.6.2.2 *Open burning*

The open burning of waste is common practice. This could be through households burning their waste at home, waste contained in public waste container inadvertently or advertently being set on fire, or systematic burning of waste on dumpsites. Some households burn their waste in their backyards as they consider it a cheap and easy way of disposing of their wastes. This method according to Araba (2010) is mostly used by households in low income areas who do not receive waste collection services. When waste is burnt on dumpsites this is conducted to reduce the volume of the waste (Araba, 2010; Igoni et al. 2007). Adebayo et al. (2006), Olufayo & Omotosho, (2007), Nabegu (2010), and Ngwuluka et al. (2009) have testified that burning waste at open dumpsites pollutes the air. In addition open burning waste can lead to fires getting out of control leading to the loss of lives (Aderemi & Otitolaju (2012). Figures Figure 14Figure 15 provide examples of open burning causing environmental pollution and a public health risk.



Figure 14 Burning household wastes at a courtyard in Aba, Nigeria
Source: Uchendu (2016)



Figure 15 Open burning of waste at a dumpsite
Source: Bakare (2016)

2.2.6.2.3 *Burying of waste*

Another method that is being practiced to a lesser extent in some parts of Nigeria involves disposing of waste by digging holes in the ground or filling existing holes such as abandoned wells or pit latrines around houses or neighbourhood (Dauda & Osita, 2003; Efe, 2013; Igoni et al. 2007). Residents dig holes around their houses in order to get sand for filling foundations of their house during construction. When they move into the house they use the hole to bury their waste. The hole is covered when filled up with waste and another one is dug and the cycle continues. Though similar to landfill, this method is practiced locally at individual household level. Igbinomwanhia (2011) reported that burying of waste is wildly practiced in Benin metropolis. It has however not received much attention because it is the least practiced method of waste disposal.

2.2.7 Impacts of waste management

Literature indicates that waste management in Nigeria is poor, resulting from irregular waste collection and indiscriminate disposal of waste. Khadafa et al. (2013) observed that waste is one of the three major environmental problems affecting

Nigeria, the others being flooding and desertification. The way in which waste is managed can have a profound impact on the environment, public health and quality of life (Agbede & Ajagbe, 2004). The impacts of waste on public health and the environment are discussed in detail in the following sections.

2.2.7.1 Impact on public health

Studies have been undertaken across Nigeria investigating the impact of waste on public health including work by Butu et al. (2013), Egberet al. (2001), Longe & Williams (2006), Modebe et al. (2009), Momodu et al. (2011), Nwanta et al. (2010), Owaduge (2010), and Oyelola et al. (2009).

Poor domestic waste handling practices, and inadequate provision of solid waste management facilities in Nigeria, have resulted in many households and municipalities disposing waste indiscriminately thus posing a threat to the health of urban residents. This according to Simon (2008) and Modebe et al. (2009) is worrisome, as it encourages proliferation of houseflies, pests, mosquitoes, rats and other vermin that aid in the spread of infectious diseases. Table 10 presents the outcome of a review on diseases experienced in Nigeria that have been linked with poor waste management provision. It includes information on how the disease is spread and details of studies documenting the impact in Nigeria. Some of the studies have emphasized the negative effects of poor waste management on children (Kogers et al. 2005), and adults (Obirri et al. 2010) and loss of flora (Shagal et al. 2012).

Olukanni et al. (2014) observed that inappropriate medical waste management is a major concern in LEDCs including Nigeria. According to Longe & Williams (2006) most hospitals in Nigeria employ the services of state owned solid waste management companies for final collection and disposal of their medical waste at government official dumpsites. The implication of this is that medical waste is dumped alongside other waste streams. Many scholars (Abah & Ahimain, 2011; Adegbite et al. 2010; Coker et al. 2009; Nguluka et al. 2009; Oke, 2008; WHO, 1999; WHO 2002) highlight that the incorrect handling and disposal of medical waste is a health risk to medical staff and other members of the public. Those exposed to medical waste are at higher risk of diseases such as Meningitis, Tuberculosis, Lassa fever, Ebola, Hepatitis and HIV/AIDS.

The open burning of waste could cause air pollution and health risks to those directly exposed to the smoke (Babayemi & Dauda 2009; Igoni et al. 2007). Onwughara (2010) reports an abundant release of poisonous gas substances into the environment as a result of burning of polystyrene foam and obsolete e-wastes. Open burning especially affects people with sensitive respiratory systems. Njoku et al. (2015) posits that smoke released during the burning of waste has a significant impact on human respiratory systems. Kram et al. (2014) stated that some of the pollutants contained in the smoke include dioxins, furans, arsenic, mercury, polychlorinated biphenyls (PCBs), lead, carbon monoxide, nitrogen dioxide, sulphur dioxide, and

hydrochloric acid. Some of the pollutants can also be left behind in the ash. Kram et al. (2014) and Nwaogu (2014) observed that toxic gases such as nitrogen oxide and sulphur dioxide which are released into the atmosphere through burning of waste later accumulate and fall as acid rain. Several kinds of human cancer and birth defects have been reported to be associated with the burning of municipal solid waste (Onwughara, 2010). For example burning tyres are known to emit dioxins and benzene derivatives which have been linked with reproductive impairment and cancer in humans (Aderemi & Otitolaju, 2012). In addition Cointreau (2006) states that exposure to smoke can cause headache, nausea, and rashes and worsen respiratory issues.

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Table 10 Diseases in Nigeria linked with poor waste management practice

Disease	Causative Agent	Impact on public health in Nigeria and context with waste
Cholera	Transmitted through water or food contaminated with the bacterium <i>Vibrio cholera</i> , as a result of poor waste management	<p>The first recorded case of cholera in Nigeria was in a village near Lagos on December 26th 1970 (WHO, 2011a). This led to an epidemic of 22,931 cases and 2,945 deaths with a Case Fatality Rate of (CFR) of 12.8% in 1971. Since then intermittent outbreaks have been occurring, and is associated with poor waste management. The later part of 2010 was marked with severe outbreaks starting in northern Nigeria involving approximately 3,000 cases with 781 deaths (Adagbada et al. 2012). Another outbreak started in May 2013 and continued up until 12 October 2014, with a total of 40,608 cases with 898 deaths, giving a CFR of 1.95% (Interhealth Worldwide, 2014). More than 34,000 suspected cases and 664 deaths were reported from January 2014 to 12 October 2014. Suspected cholera cases have been recorded in 19 out of 37 states (51%) including Bauchi, Borno, Adamawa, Katsina, Kebbi, Kaduna, Kano, Plateau and Zamfara.</p> <p>Many studies have been undertaken in order to understand the disease and find ways of treating it (Ariba, 2015; Dalhat et al. 2014; Interhealth Worldwide, 2014; Marin et al. 2013; and WHO 2014). Cholera is a threat, particularly, in overcrowded areas with poor sanitary conditions, where good quality drinking water and effective sewage and SWM systems are not available to the public.</p>
Diarrheal diseases	Diarrhea can be caused by many types of bacteria, viruses and parasites, (mainly rotaviruses) and are associated with poor hygiene due to improper solid waste management.	Joshua (2013) reported that diarrheal diseases kill an estimated 2.5 million people each year, with 60-70% of them being children under 5 years (Cesar et al. 2000; Ruxin, 1994). It is a widely recognized cause of childhood deaths in LEDCs, especially in SSA (Yilgwan & Okolo, 2012) where about 25% of under-five mortalities are directly attributed to diarrhoea (Cesar et al. 2000; Gutierrez et al. 1996; Ruxin, 1994). Literature links diarrhea to lack of safe water, basic sanitation, and hygiene (Oloruntoba et al. 2014), as a result of poor waste management. Other factors include lack of washing hand with soap and water after defecation and before food preparation, and poor sanitation including inadequate SWM leading to clogged drains and stagnant water presenting breeding grounds for flies/insects.
Hepatitis	Liver disorder contracted from contaminated blood and hypodermic needles disposed of carelessly, due	Hepatitis is a major cause of liver disease morbidity and mortality worldwide (Musa et al. 2015). It is caused through unsafe injections, and also very poor management of medical waste. Worldwide, injections cause an estimated 8 – 16 million cases of Hepatitis B virus (HBV) infection, 2.4 – 4.5 million cases of Hepatitis C (HCV) virus infection. The WHO

Disease	Causative Agent	Impact on public health in Nigeria and context with waste
	to poor management of medical waste.	estimates that about 20 million Nigerians are infected, with about 5 million dying of the consequences (WHO, 1999). Medical waste in Nigeria is often disposed together with other waste and this increases the risk of contracting hepatitis. The problem of Hepatitis in Nigeria has been documented by Onyekwere et al. (2002); Forbi et al. (2008); Adoga et al. (2009), and Adoga et al. (2010).
HIV/AIDS	Multiple sexual partners, delivery in unhealthy facilities, female genital mutilations, use of unsterile blood, traditional markings and tattoos, and exposure to medical waste which is poorly managed.	HIV remains a public health issue in Nigeria (Awofala & Ogundele, 2016). Globally 9% of the people living with HIV are Nigerians (UNAIDS, 2014). Awofala & Ogundele recently estimated that about 3.2 million people live with HIV in Nigeria and about 220,393 new HIV infections occurred in 2013 with 210,031 deaths from AIDS related cases. Nigeria now has the second largest HIV disease burden in the world behind South Africa which has 6.8 million cases (Federal Ministry of Health, 2013; Nigeria National Agency for the Control of AIDS, 2014; United States Agency International Development, 2013). Poor management of medical wastes contributes to the spread of HIV. In Nigeria medical waste is often disposed together with other waste in unsanitary conditions.
Lassa Fever	Transmitted to humans from contact with food or items contaminated with rodent excreta. Rats live and multiply more in dirty areas where food waste is poorly managed.	Lassa fever is a haemorrhagic fever common in four African countries including Nigeria. In 2012 more than 2,900 cases were reported in widespread outbreaks that occurred across many states in Nigeria (WHO, 2012). It breaks out annually during the dry season in Nigeria (WHO, 2015). WHO reported a high Case Fatality Rate of about 37.9%, affecting Bauchi, Edo, FCT, Kano, Nasarawa, Niger Oyo, Plateau, Rivers and Taraba. Choon (2016) estimates that there are 300,000 cases yearly with 5,000 deaths. Lassa fever is mainly transmitted by rodents, and rodents are associated with solid waste and dirty environments. However Choon (2016) stated that lassa fever could also be transmitted through human-to-human contact.
Malaria	Mosquitoes are responsible for the transmission of malaria through their bites. Dirty environments with waste blocking drains are breeding sites for mosquitoes.	Malaria is a major public health problem in SSA including Nigeria where it accounts for more cases and deaths than any other country in the world (Aribodor et al. 2016). In 2013, there were 2 million reported cases of malaria killing an estimated 584,000 people, 70% of whom were children under five with over (UNICEF, 2016; WHO 2014). Nigeria accounts for 25 percent of the world's malaria burden (WHO, 2012). Poor waste management can lead to stagnant water which is a breeding ground for mosquitoes.
Typhoid Fever	Caused by the bacteria <i>Salmonella</i> Typhi or	There is an estimated 12-33 million cases leading to 216,000-600,000 deaths annually. The disease is common where there is a general warm humid climate, poor sanitary practice as a

Disease	Causative Agent	Impact on public health in Nigeria and context with waste
	Paratyphi. It spreads through contaminated food and water supplies in areas with poor sanitation resulting from poor waste management.	result of poor waste management, poverty and ignorance. It is a disease that is prevalent in LEDCs due to poor waste management (sanitation and hygiene) (Okore et al. 2015). WHO (2008) stated that it is spread by eating food or drinking water contaminated with faeces of an infected person. In addition the Centre for Disease Control and Prevention (CDCP) (2007) observed that it can be transmitted by flies such as <i>Musca domestica</i> .
Yellow Fever	Transmitted through the bites of infected mosquitoes, as in the case of malaria above	The WHO estimates that yellow fever causes 200,000 infections and 30,000 deaths every year, with almost 90% of these occurring in Africa (Tolle, 2009). Yellow fever is transmitted by mosquitoes belonging to the aedes and haemogogus species, when they come in contact with non-immunized humans. The different mosquito species live in different habitats, some breed around domestic houses others in jungles (WHO, 2017). Densely populated cities are particularly vulnerable, as stagnant water, which could be caused by poor waste management, provides good condition for mosquito larvae to thrive.
Non Infectious Respiratory Disease also known as Chronic Obstructive Pulmonary Disease (COPD)	Results from direct inhalation of airborne dust particles and smoke contaminated with pollutants resulting from the burning of waste.	The impact of non-infectious respiratory disease in Nigeria is still unknown because limited research has been carried out, as such no national data on the prevalence of COPD exists (Akanbi et al. 2009). However, the burden of infectious and non-infectious respiratory disease appears to be on the increase. Wood is an important cooking fuel in many homes in Nigeria, and COPD resulting from such exposures has been reported by Erhabor & Kolawole (2002). In addition behavioural factors such as smoking and the burning of waste also contribute to the increase of respiratory diseases in Nigeria.

Dioxins are environmental pollutants belonging to the so-called “dirty dozen” - a group of dangerous chemicals known as persistent organic pollutants (POPs), which adversely affect human health and the environment (Zhang et al. 2011). Polychlorinated dibenzo-para-dioxins and dibenzofurans (PCDD/PCDF) constitute POPs. Fiedler (2007) and Zhang et al. (2011) have identified open burning of waste as the largest source of unintentionally generated POPs in LEDCs. Gullett et al. (2007) and Tang et al. (2010) state significant amounts of POPs could also be generated through the process of burning e-waste to recover metals. E-waste contains valuable metals including copper (Cu), platinum group metals (PGMs) as well as potential environmental pollutants, especially lead (Pb), antimony (Sb), mercury (Hg), cadmium (Cd), nickel (Ni), polybrominated diphenyl ethers (PBDEs), and polychlorinated biphenyls (PCBs). Burning e-waste generates dioxins, furans, polycyclic aromatic hydrocarbons (PAHs), polyhalogenated aromatic hydrocarbons (PHAHs), and hydrogen chloride chemicals which contaminate the environment (Robinson, 2009).

Exposure to dioxins and furans has been associated with certain types of cancer, liver problems, and impairment of the immune system, endocrine system, heart attacks and reproductive functions.

Dioxins and furans produced from the open burning of waste can be deposited on plants, which may be eaten by animals, and they can stay in the food chain until it ends up in the meat and dairy products consumed by humans. Over 90% of human intake of dioxins and furans is from food mainly meat and dairy products, fish and shellfish. Robinson (2009) specified that e-waste workers suffer negative health effects through skin contact and inhalation, while the wider public are exposed to the contaminants through smoke, dust, drinking water and food.

Oyelola et al. (2009) has recorded cases of diseases resulting from the burning of solid wastes and gaseous emission from dumpsites. Similarly Owaduge (2010) has established an association between waste burning and the incidence of respiratory diseases among adults and children in Nigeria. Smoke from the burning of waste has harmful health effects on city residents through breathing in of particulates in the air containing carbon monoxide, nitrogen dioxide, and sulphur dioxide, and it is worst amongst households that burn their own waste. Akanbi et al. (2009) specifies that biomass smoke is an important risk factor for Chronic Obstructive Pulmonary Disease (COPD). Wood is an important cooking fuel in Nigeria, and COPD resulting from such exposure has been reported by Erhabor & Kolawole (2002).

2.2.7.2 Impact on the environment

Alabi et al. (2012) and Modebe et al. (2009) observed that improper handling, storage and disposal of wastes is a major cause of pollution of air, soil, groundwater and surface water sources.

Globally the most serious environmental problem in terms of solid waste is the emission of greenhouse gases (Longe & Williams, 2006; Osinowo, 2001; Ngwuluka et al. 2009; Walling et al. 2004). Greenhouse gases and their effect on the environment has gained the attention of researchers and environmentalists in recent times due to its overwhelming impact in terms of global warming (Achike and Onoja, 2014; Aderogba, 2011; Anomohanran, 2012). The open dumping of organic waste releases methane which is a potent greenhouse gas.

Soil contamination results from waste being dumped in open spaces or dumpsites. According to Omonfonmwan & Esa-Edoh (2008) the growth and development of urban centres, coupled with improper waste management have worsened the aspect of soil pollution in Nigeria. Waste dumps lead to the contamination of soil with heavy metals and elements. Yusuf (1983) observed that chemical elements released from waste dumps into soil profiles in Kano metropolis contributed to the pollution of soil in that locality and the same was reported by Butu et al. (2013) in Karu. The contamination of soil by heavy metal can cause adverse effects on human health, animals and soil productivity (Smith et al. 1996). Waste contains a variety of metals which get transferred to plants through water within the soil or seep into underground water (Voutsas et al. 1996). Elements such as Cd, Cu, Ni, Pb and Zn can change the soil chemistry and impact on the animals and plants that depend on that soil for their nourishment (Ali et al. 2014).

Dumpsites pollute surface and ground water (UNEP, 2015) and they discharge unwanted biological, chemical, and physical waste materials into bodies of water causing water pollution (Adelegan, 2004). Studies have shown impairments of groundwater quality as a result of leachate generated from dumpsites (Longe & Kehinde, 2005; Longe & Enekwechi, 2007).

Enekwechi (2007) described leachates outflow and infiltration as the most critical source of groundwater contamination from the existing solid waste management practices in Lagos, thus constituting potential public and environmental problems. Onwughara et al. (2010) believes that water contamination by leachate can transmit bacteria and diseases such as typhoid fever which is a common problem for people from LEDCs who cannot afford to dig wells deep enough to reach fresh water aquifers. Longe and Balogun (2010) stated that some Nigerians still depend on shallow wells for their water supply and a great percentage get their domestic and drinking water from ponds and streams. Hence water pollution is a major concern that places the health of about 40 million Nigerians at risk of diseases such as

cholera, dysentery, diarrhoea, and typhoid fever (Adelegan, 2004; Orubu, 2006; WHO 2017). The incidence of these diseases can put additional burden on the inadequate health services available in Nigeria, consequently leading to severe economic burdens on both the country's struggling health system, and the populace majority of whom are extremely poor (Okonkwo et al. 2014). Daffi and Kassam (2013) notes the National Environmental Sanitation Policy, developed by the Federal Ministry of Environment in 2005, was to ensure sound environmental sanitation practices that will promote sustainable development, public health, and good quality of life however environmental sanitation remains very poor in many neighbourhoods.

Butu et al. (2013) observed that waste blocking gutters contain decomposable waste which generates an unpleasant smell and attracts flies and also contain harmful bacteria which are pathogenic to humans. Studies have also shown that waste in gutters and waterways contribute to flooding (Kofoworola 2007, Toyobo et al. 2013). Folorunsho & Awosika (2001) have related the flooding in Lagos to clogging of drainage channels by dumped solid waste, and this is replicated in most cities. Toyobo et al. (2013) observed that pure water sachets disposed in gutters caused the blockage of drains which flood during heavy rain. The current state of plastic bag waste pollution in Nigeria is alarming. Other impacts from plastic bags reported by Ogwo et al. (2013) include choking of animals, and water and soil contamination from plastics breaking down in the environment.

2.2.7.3 National Environmental Sanitation Day

In order to address the impacts of waste on communities, the National Environmental Sanitation Day has been in operation since March 1984. The initiative sets aside 7am -10am on the last Saturday of the month for cleaning the environment. During this time movement is restricted and all residents are expected to remain at home and clean their houses and surroundings including clearing gutters, cutting grass, tending to overgrown vegetation or tidying up premises in general. This practice has been ongoing since March 1984 (Omonisa, 2015). More information on this initiative in the context of Jos is covered in Chapter 5.4.8.

2.2.8 Challenges to sustainable waste management in Nigeria

Some of the challenges to the sustainable management of solid waste in Nigeria have been identified and discussed by Abila & Kantola (2013), Abur et al. (2014), Adelegan (2004), Agunwamba (1998, 2003), Agwu (2012), Babalola et al. (2010), Ezeah et al. (2009), Ezeah (2010), Ezeah & Roberts (2012), Iriyuga (2012), Olowomeye (1991), and Walling et al. (2004). The challenges identified are grouped under the following sections: societal, institutional/regulatory, political, operational, economic, and cultural challenges. Table 11 sets out the challenges identified.

Table 11 Identified sustainable solid waste management challenges in Nigeria

Category	Examples
Societal	Unplanned nature of municipalities Increasing waste generation due to growth in population and urbanization Size of country making dumping of waste accessible
Institutional or regulatory	Insufficient policies for good practice Weak regulatory framework Lack of environmental reforms No clear plans, strategies and actions Non-involvement of the public in SWM decisions
Political	Political appointment and interferences
Operational	Unqualified staff in managerial positions Low/no training opportunities Inadequate staffing and poorly paid staff Operations limited to collect and dumping of waste Inadequate or obsolete equipment
Economic	Inadequate funding High risk/low return on SWM investment
Cultural	Poor public attitude towards solid waste Non recognition of informal sector or scavengers Lack of public education and awareness

Source: Abila & Kantola (2013), Abur et al. (2014), Adelegan (2004), Agunwamba (1998), 2003, Agwu (2012), Babalola et al. (2010), Ezeah et al. (2009), Ezeah 2010, Ezeah & Roberts (2012), Iriugba (2012), Olowomeye (1991), and Walling et al. (2004)

2.2.8.1 Societal challenges

The challenges in this category are set out in Table 11 and range from the unplanned nature of municipalities, increasing waste generation due to population increases, and rapid urbanization. Rapid urbanization has completely overwhelmed African cities (Ogbazi, 2013). Rapid population growth and urbanisation have been closely linked with unplanned development and informal settlements. The unplanned nature of municipalities is one of the greatest challenges facing solid waste management in Nigeria. Nwaka (2005) criticised the role of government in the rapid expansion of spontaneous settlements and argued that the procedure for obtaining and developing land became excessively bureaucratized, obstructive, and riddled with corruption. For example, restrictions on the availability of land, especially for the poor, encouraged the growth and expansion of more irregular settlements on the fringes of towns or on vacant public lands.

Nwaka (2005) added that the increase in informal settlements is mainly due to the the private sector being at the forefront of urban housing. Even though there is a law on urban and regional planning, no efforts have been made to put the laws into action

by government, and for that reason only 20-40% of developments have followed the urban and regional planning laws, hence most developments are unplanned (Nwaka, 2005).

The limitation of government planning controls, plus the indiscriminate developments associated with the informal sector have produced uncontrollable and unhealthy urban environments. Ogbazi (2013) stated that the lack of urban planning has failed to address waste management in Nigeria. Agunwamba (1998) and Oyeniyi (2011) observed that the unplanned nature of many cities in Nigeria makes it difficult for proper collection and disposal of waste, since most houses are built without adherence to set standards, with narrow and unsurfaced streets making waste collection difficult. For example, Nwaka (2005) revealed that government's lack of concern for the proper planning of cities has led to random developments observed in Kano where residential areas are not accessible to waste management agencies. A survey in Kano (Nabegu, 2010) found that 69% of respondents believe that only a small fraction of the state has access to waste collection service due to inaccessibility of most parts of the city. Similarly, Ayotamuno & Gobo (2004) pointed out that as the villages around Port Harcourt began to develop, there was little or no government approval and planning. Ogbazi (2013) stated that most government agencies responsible for urban planning have approached planning development arbitrarily.

A further challenge presented by Imam et al. (2008) is congestion in cities which hamper collection efforts, this problem is escalated by poor planning (Agunwamba, 1998). In Abuja the waste management agency tried night time collections to overcome this problem, however it was found to be problematic due to security concerns.

Nwaka (2005) observes that, in Nigeria, the drainage systems have open drains in the form of a trenches with little width and depth. As these drains are not covered, coupled with poor waste collection services, they are usually blocked with waste materials. Nwaka noted that environmental awareness is still at the elementary level especially among the informal settlements.

Rapid urbanization also presents challenges in the development of appropriate disposal infrastructure. Sangodoyin (1993) stated that rapid urbanization increased the difficulty of getting lands needed for the siting of landfills to accommodate the increasing waste arisings. Afon & Okewole (2007) pointed out that as the growth in population continues more land will be needed to cater for the extra waste that will be generated. They argue that Oyo Townships in Oyo state will need an additional 1.3 acres of land annually to accommodate the projected annual waste growth rate of 3%. They noted that 39.5 acres of land was acquired to cater for the waste arisings of the 394,632 inhabitants of the town in 2005. Based on their projection they estimated

in the next 20-30 years an additional 26.9-48.7 acres (the equivalent of 13.5-24.4 football pitches) will be needed for the dumping of waste in the town.

Conversely the abundance of land available for waste disposal in Nigeria is also an encouragement for the indiscriminate disposal of waste, and a hindrance to the expensive but sustainable disposal options such as sanitary landfilling and incineration. For instance MyLifeElsewhere (2017) observed that Nigeria's landmass of 923,768 km² is about 4 times the size of UK (243,610 km²).

2.2.8.2 Institutional or regulatory challenges

Institutional and regulatory challenges relate to governance and the rules and regulations controlling the management of waste.

Adelagan (2004) detected that right from the inception of British rule in the 1800s, colonial economic development policies and plans contained little or no requirements to conserve the natural environment. Thus the formative years of institutional environmental regulation in Nigeria were characterized by the absence of a clear sense of direction and commitment to waste and environmental management. Ezeah (2010) observed that municipal solid waste management in Nigeria is still at an emerging stage because of improper organisation and for that reason gross inefficiencies are common.

Adama (2007) and Imam et al. (2008) identified institutional and legal frameworks to be the pillar of SWM, yet it is the area where deficiencies are most glaring. Nabegu & Mustapha (2015) observed that the legal provisions for SWM show a clear gap leading to lack of coordination and conflict between the federal, state and local governments. An overlap of regulatory functions across these three tiers of government has been a major setback as it creates a climate for unhealthy competition with little progress which could have been achieved if the roles of each institution were more specific or complimentary.

Ikpeze (2014) adds that lack of environmental reforms with respect to waste management is the main reason why municipal waste authorities have failed to execute their mandate to the citizens, thus making Nigeria one of the dirtiest nations in the world.

Historically the public sector has provided solid waste management services in urban cities in LEDCs including Nigeria (Akaateba & Yakubu, 2013). However there have been major lapses resulting from managerial, operational, financial, and technical incompetence (Olukanni et al. 2016). This has given rise to the more recent involvement of the private sector in solid waste management. The private sector has been identified by Ibrahim (2014), Ibrahim et al. (2014), and Okpoko & Oluwatayo (2016) to have a stake in urban solid waste management in Nigeria. Lagos was the first state to adopt the public private partnership (PPP) model in 1997 (Lasisi, 2007).

In this model both the government (public) and the private sectors share the risks and benefits of waste management (Aliu et al. 2014; Nwachukwu, 2009). Ogu (2000) suggests that using the private sector in SWM could enhance service delivery.

Similarly according to Imam et al. (2008) the non-involvement of public members in SWM issues and governance is detrimental to developing an efficient management of waste.

2.2.8.3 Political challenges

Political challenges relate to the way power is achieved and used in the country or society. Ezeah & Roberts (2012) observed that the political class regularly interfere with solid waste management in Abuja, particularly in the area of appointments of managers to waste management agencies. Similarly Agunwamba (1998) observed that the belief that officials tasked with enforcing environmental laws can be bribed, prevent people from taking environmental laws seriously. Agunwamba (1998) also noted that politics rather than environmental considerations influence the location of waste management facilities and argues that this system often leads to illogical and wasteful decisions. Adewole (2009) also argued that the inability of the previous Lagos State Waste Management Authority to deliver a sustainable waste management service could have been due to corruption. Adewale stated that waste management officials were known to demand money before collecting waste from markets, while in some cases, the informal waste operators (truck pushers) have been asked for bribes before they can dispose of their waste on the dump sites thus leading to illegal dumping. Agunwamba (1998) also opines that personal interests have often led to delays or stoppage of environmental policies in the country.

2.2.8.4 Operational challenges

Operational challenges relate to the functioning or working of SWM infrastructure. From literature it is clear that in Nigeria local conditions are not taken into consideration before the adoption of a waste management strategy.

Ogwueleka (2009) revealed that irrespective of the local conditions most cities in Nigeria adopt open dumping or uncontrolled landfills as their disposal route. This may be attributed to the fact that in most cases state environmental bodies are headed by politicians and their associates who have very little or no training on solid waste management. A good example of this was illustrated by Leton & Omotosho (2004) who found that although landfilling is widely used in most Nigerian cities, the geologic assessment they conducted revealed that open dumps and landfilling are not suitable for some states in the Niger Delta. This is particularly true in Bayelsa State due to the fact that the area is overwhelmed with water and highly waterlogged all year round. The same study suggested that Yenagoa and Bayelsa State as a whole should adopt alternative disposal or treatment method rather than landfill.

The composition and density of waste in Nigeria also presents challenges. Waste from Nigeria is heterogeneous, dense and high in moisture content (Ezeahl 2010; Ogwueleka, 2009). As a result waste management solutions from MEDCs may not be transferrable to Nigeria, and LEDCs per se. Imam et al. (2008) argues that since the waste composition in Abuja is high in organics, compaction trucks may not be appropriate yet half of the collection vehicles owned by the state solid waste management agency are compaction trucks. Furthermore Nabegu, (2010) reveals that the compaction trucks used in MEDC achieve a low compaction rate in Nigeria, due to the high density of solid waste. Ezeah & Roberts (2012) observed that some of the old solid waste collection vehicles brought into the country from developed countries are quickly abandoned due to unavailability of spare parts. Agunwamba (1998) concluded that equipment that cannot be serviced or maintained locally will amount to a waste of resources in the long term.

Main (1993) and Nigerian Environmental Study Action Team (NEST) (1991) earlier observed that the incineration plants in Lagos were never operational due to technical issues. Solomon (2009) added that incineration of waste will achieve a better result in countries with less than 20% water content in their waste. Solomon observed that the water content of solid waste in Lagos was about 30-40% hence these incinerators were never used. Some of them were decommissioned while one was converted to a recreational facility. Hence, it is fairly obvious that incineration plants for Nigerian cities with the heavy moisture contents in the waste will make combustion difficult (Ogwueleka, 2009).

A further challenge is the frontline resources available to undertake collection. Ezeah & Roberts (2012) mentioned instances where basic resources used by waste collection crews such as bin bags, sacks and plastic receptacles were not available. Babalola et al. (2010) and Bakare (2016) lamented the inadequate and unreliable collection services for solid waste management in most Nigerian cities. Ogwueleka (2009) observed that 60% of collection trucks are out of service at any one time, and many frequently break down due to overuse (Agunwamba et al. 2003).

Agunwamba (1998) identified limited human capacity and waste management knowledge as a challenge to solid waste management in Nigeria. Most staff of the environmental protection agencies and government ministries lack adequate training, hence they are not up to date in their knowledge of SWM good practices. In addition staff salaries are poor and often irregularly paid which leads to low morale and affects staff performance. Ogwueleka (2009) suggested that the low morale among waste management agencies personnel resulting from poor remuneration, affects solid waste management performance. The consequence of this is that waste management responsibilities in Nigeria are handled by less experienced staff, who have not reached managerial levels in their respective agencies. As a result the heads

of agencies or ministries who are political office holders decide on waste management issues based mostly on political convenience rather than good solid waste management practice.

2.2.8.5 Economic challenges

Inadequate funding has been identified by several researchers as one of the most predominant factors affecting SWM in Nigeria (Agunwamba, 2003; Ayotamuno & Gobo, 2004; Babalola et al. 2010, Ezeah & Roberts, 2012; Igbinomwanhia 2011, Ogu, 2000; Ogwueleka, 2009). It has been suggested that the financial strength of environmental agencies in the country has not been able to parallel the rate at which solid waste is generated and Ogwueleka (2009) argues that environmental agencies do not have the capacity to perform their duties effectively due to limited budgets. Afon & Okewole (2007) noted that solid waste management is not regarded as important or a priority by the three tiers of government in the country hence there are some long periods of financial neglect of the solid waste management agencies. Ezeah & Roberts (2012) argue that since waste management agencies are not involved in budgetary allocations waste management departments are overlooked and underfunded hence it is difficult for them to employ and retain experts in waste management. Ezeah & Roberts (2012) pointed out that as a result of a shortage of funds waste management agencies are unable to purchase equipment needed for efficient service delivery. Agunwamba (1998) noted that the low level of funding seriously hinders the operations of the waste management agencies and commented that collection operations are sometimes cancelled or delayed due to lack of fuel for collection vehicles. In addition Ezeah & Roberts (2012) criticised the poor funding of waste management bodies, stating that shortage of funds often leads the agencies to purchase old or used machineries from Europe which as covered previously may not be appropriate.

As a result of the inadequate funding, a number of authors have been arguing for the implementation of charges to citizens to help develop better services. In Port Harcourt for instance, like most states in the country, the state government is the sole financier of solid waste management (Ayotamuno & Gobo, 2004). Ayotamuno & Gobo argued that this system of funding is not sustainable. Hence, Imam et al. (2008) suggested that some form of user charge might help reduce the burden of funding on the government. Similarly Ogbonna et al. (2007) noted the findings of the Rivers State Ministry of Environment & Agip Oil Company Limited who estimated there was an increase of 25.4% in the volume of waste generated in Port Harcourt between 2000 and 2001. They concluded that solid waste management agencies should adopt an approach which charges residents according to the volume of waste they generate.

A study of waste management in Benin, Nigeria showed that waste management is capital intensive (Ogu, 2000). The study added that despite the financial implications

of waste management, there was no concrete plan being made for the recovery of some of the cost from residents. This was attributed to the fact that people are not used to paying for municipal waste management. Furthermore Omuta (1987) explains that as much as 30% of the locally generated revenue by the Benin local council is spent on solid waste management. Omuta suggested that nationally at least 5% of the country's revenue should be earmarked to improve the solid waste management system. In addition, he advised that a fee should be charged for the service however such fees should take the low level of income into consideration.

Agunwamba (1998) advised that in order to improve on solid waste management, adequate funding arrangements should be put in place and suggested that this should be done through private initiative and cooperation with the private sector. However since the private sector is profit driven, the present economic circumstances in Nigeria as a whole have tended to negatively influence the inflow of private capital for municipal solid waste management. In addition to this, he suggested that funding should also be provided for waste management research in Nigeria.

2.2.8.6 Cultural challenges

One of the most important factors in solid waste management is the cooperation of the public. Imam et al. (2008) pointed out that there is a wide spread lack of environmental awareness and concern on environmental issues. Adewole (2009) reported that the negative waste disposal habit of most people in Lagos is fuelled by ignorance and poverty. He added that the manner in which people discharge garbage into drains or highways seems to suggest that Nigerians are permanently accustomed to dirt. Agunwamba (1998) and Amasuomo et al. (2015) have reported a general careless attitude of the public and government towards waste management. Rahji & Oloruntoba (2009) argue that there is a need for government to engage in environmental campaigns in order to enlighten the public on best environmental practice and suggested that increasing the awareness of the people may have a positive impact on their attitude towards the environment.

Nabegu (2010) observed that in Kano waste was dumped indiscriminately on the streets and in public places and water bodies. His study showed that householders were only interested in their immediate vicinity. Only 11% of the people interviewed as part of the study express concern for environmentally sound and safe waste disposal.

Imam et al. (2008) concluded that the level of awareness and the attitude of the population can greatly affect solid waste management process. They observed that the level of awareness can impact on domestic waste storage, segregation, littering and fly tipping and recycling. Furthermore Nabegu (2010) pointed out that the level of environmental awareness will influence the effectiveness and sustainability of a municipal waste management system.

Omuta (1987) in his study of Benin explained that improvements can be observed if the public is carried along during the planning and implementation of solid waste management programmes. He suggests that community leaders should be engaged in the policy making process and that successful engagement with the community may improve cooperation.

Kofoworola (2007) suggested that government should use all media resources available to them to enlighten the people on the need to dispose their wastes at designated drop off points. Omuta (1987) added that educational programmes should be aimed at developing skills for the prevention of environmental degradation. He added that school curricula should also ensure proper environmental habits. Nabegu (2010) argues that it is not enough to enlighten the public; his view is that efforts to build awareness should be backed up by improvement in waste collection services. In addition, Agunwamba (2003) commented that enlightenment programmes should be sensitive to the particular needs and the socio economic needs of the people. He suggests that programmes should be geared towards encouraging a reuse and recycle and that the impact on the environment, economy and health of not engaging in these activities should be explained properly.

Abila & Kantola (2013) and Moruff (2012) synthesized the problems of waste management in Nigeria and categorically stated that cultural belief is a major barrier to efficient management of waste. Cultural beliefs are the norms, values, standards, and expectations a culture has generated for its members. Moruff (2012) suggested that the incessant urban environmental problems arising in Ibadan are as a result of cultural factors, such that the identified urban environmental issues are closely associated with the lifestyles of the people either as responses to urbanization or their spatial heritage.

Efforts of some waste management agencies in Nigeria to involve members of the public in waste management operations have not yielded a positive response from the public. For instance Amasuomo et al. (2015) observed that the waste management agency in Abuja adequately provided waste bins for waste storage at home and in public places to encourage residents to participate in sustainable waste management practices, nonetheless there was low public participation from residents. Amasuomo et al. (2015) revealed that the obstacles to public participation in waste management includes; lack of funding, inadequate government policies, environmental programmes, and behaviour of the public.

The informal sector is not recognized in SWM in Nigeria, for instance Salau et al. (2016) mentioned that in Lagos State there is no official recognition of the informal sector in waste management, although tens of thousands of cart pushers and scavengers exist on the streets and landfills collecting and recycling waste materials which constitute a viable component of the SWM. In order to promote a sustainable

SWM system and increase recycling rates, Imam et al. (2008) has called for co-operation between communities, the informal sector, the formal waste collectors and the government authorities. Mbah & Nzeadibe (2016) are soliciting that government should come up with a comprehensive policy to integrate the entire informal waste economy in municipal SWM.

2.3 SUMMARY OF CHAPTER

Overall the literature highlights the current poor state of waste management in Nigeria which is having a significant impact on public health and the environment. Many challenges exist which hamper the development of a sustainable waste management system including societal, institutional/regulatory, political, operational, economic and cultural.

The thesis now moves on to focus on the case study area for this research, Jos.

3 MUNICIPAL SOLID WASTE MANAGEMENT IN JOS

3.1 INTRODUCTION

As shown in Figure 16 Jos is the capital of Plateau State. It consists of 17 local government areas including Jos South and Jos North – these two areas make up the city of Jos, also referred to as the Jos Bukuru Metropolis, which is the focus of this research.

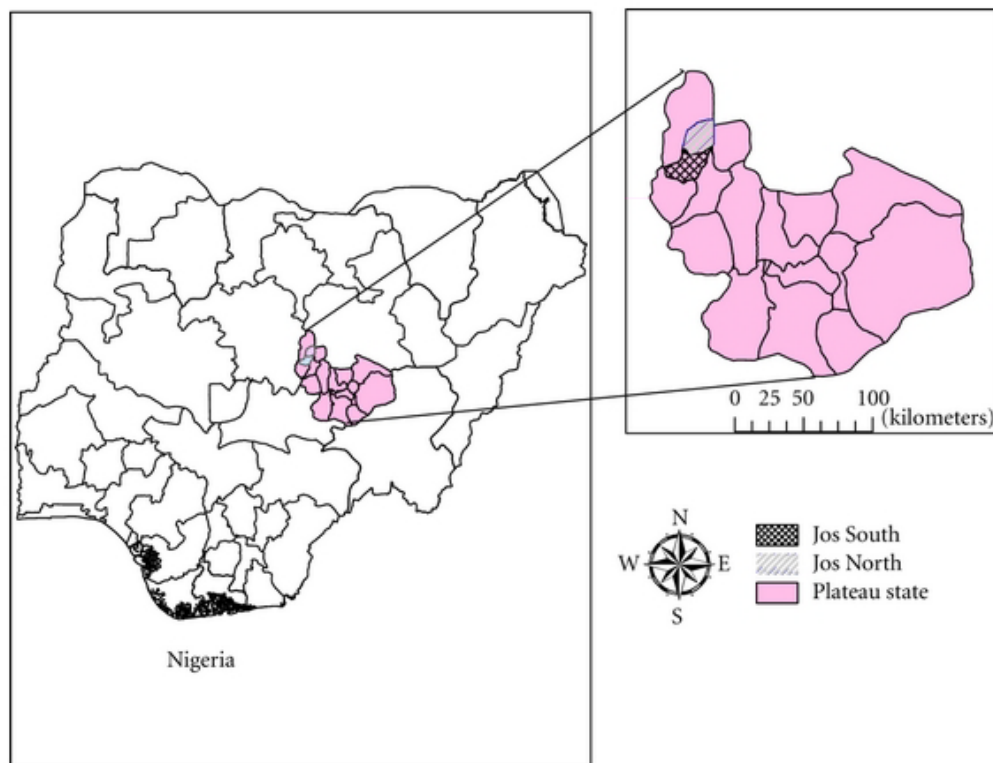


Figure 16 Map of Plateau State highlighting the study area (Jos North and Jos South)

Source: Meseko et al. (2012)

3.2 DEMOGRAPHICS OF JOS

3.2.1 Population growth

According to DungGwom et al. (2008), in the 1960s and early 1970s, was a small but well-managed town with the services running smoothly. This changed from the early 1980s due to its rapid growth and urbanization, coupled with the absence of planning and management due to administrative ineffectiveness, has led the city to become increasingly unsanitary. Figure 17 shows how the population of Jos has

changed from 1930 with estimates to 2025. The data used in Figure 17 was collated from publications based on estimates; as such the current population is likely to be much more than this considering the rate of population growth.

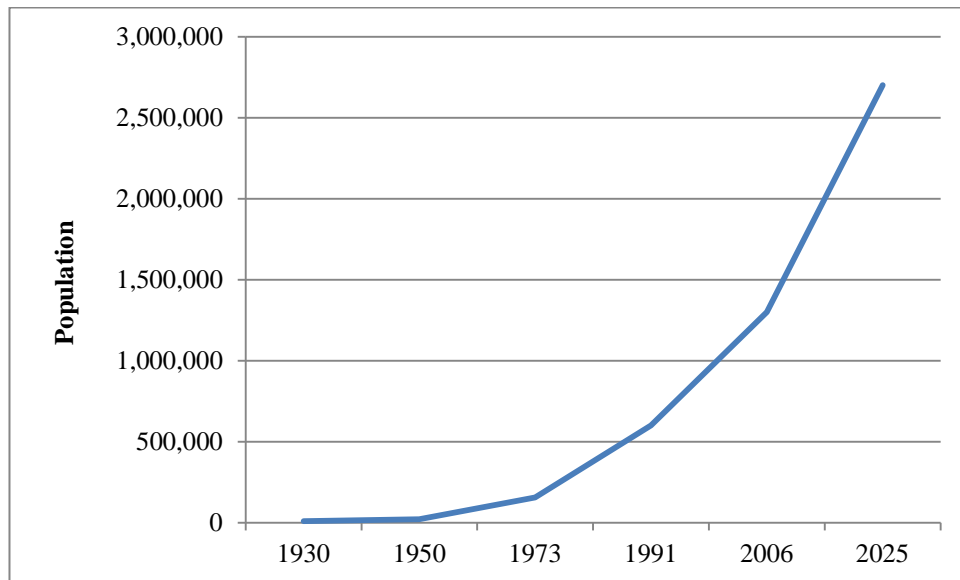


Figure 17 Population trends in Jos

Sources: DungGwom et al. (2008); Fola Consult (2009); NPC (2008)

While the country's population is increasing by 2.8% per annum, the rate of urban growth is as high as 5.5% per annum (NPC, 2008) which is the highest urbanization rate in the world (DungGwom et al., 2008). DungGwom et al. (2008) reported that the urban population in Nigeria in 1962/63 was 20%, increasing to 36% in 1991 and to 45% in 2006, and is projected to be 60% by 2020. This rate of urbanization and urban growth is thought to be replicated in Jos with the population increasing from 1.3 million in 2006 to 2.7 million in 2025.

Population growth in Jos has been exacerbated by its location. Ajiji & Larab (2016) noted that the wave of migration into Jos assumed an alarming rate from the 1980s as a result of religious violence witnessed in Kano, Bauchi, Jimeta, Jalingo, due to the Maitatsine riots. The Maitatsine riots were a series of violent uprisings originated by Islamist militants in northern Nigeria between 1980 and 1985. The riots prompted ethno-religious discord between Muslims and Christians. The reintroduction of the Sharia law system in some northern states in 1999 and the crises that followed, also lead to substantial influx of people into Jos from these areas (Ajiji & Larab, 2016; Okpanachi, 2012). The situation is now exacerbated with refugees fleeing the north eastern part of the country as a result of the ongoing Boko Haram attacks. Ajiji & Larab (2016) observed that people had to migrate to safer places on the basis of religion.

3.1.2 Growth in low income areas and infrastructure

Oladosu et al. (2015) stated there has been no effective administrative control over urban development in Jos and the 1973 Jos Master Plan had not been followed which set out the vision for developing the city in a controlled way. As such there has been a rapid increase in low income areas¹⁹ in the city. Figure 18 presents a map of low income areas in Jos including Tudun Wada and Jenta, which are the focal points of this research.

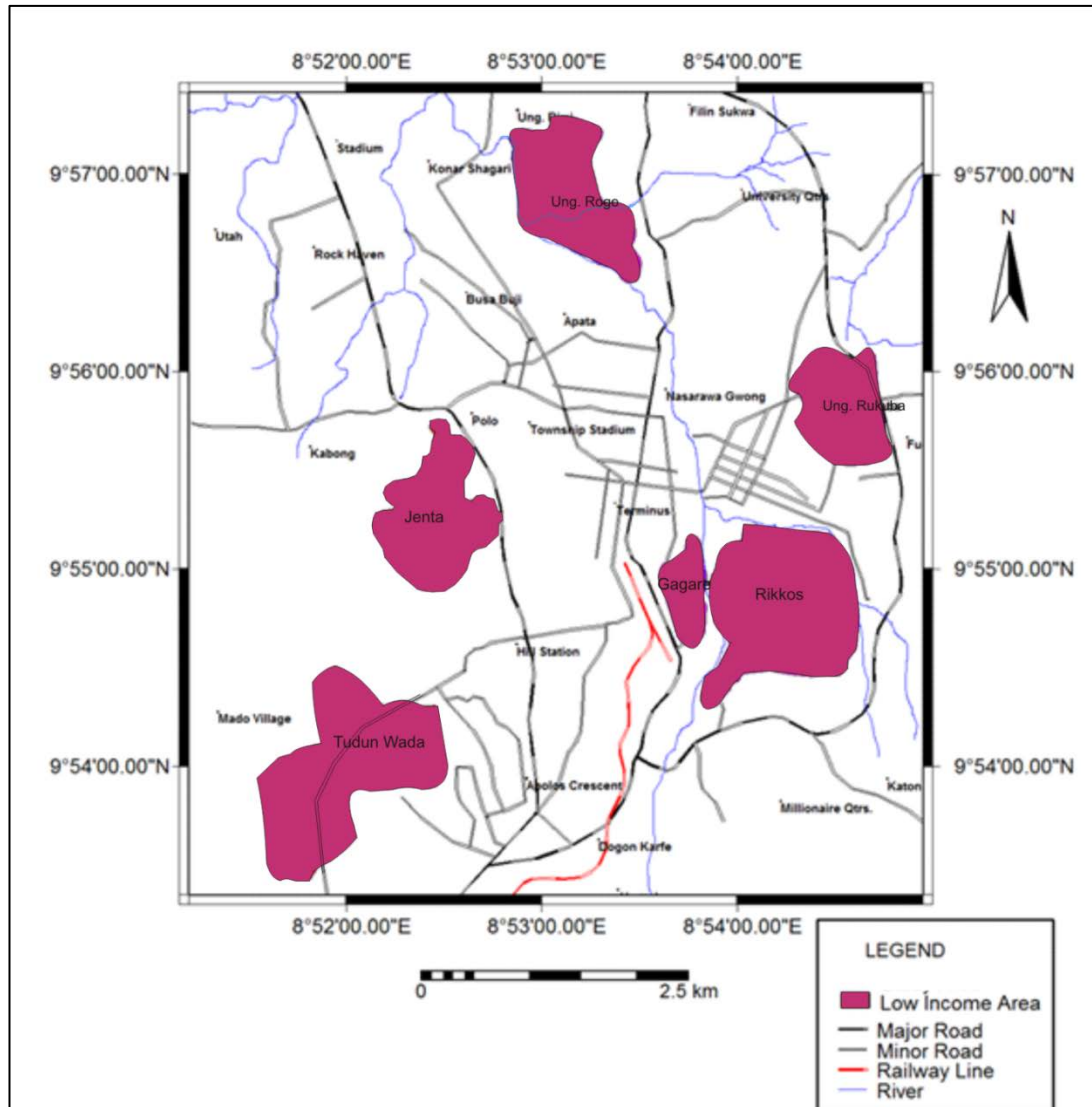


Figure 18 Map of low income areas and the study area in Jos

Source: Produced for this study based on data from observations and literature

Tudun Wada has approximately 2,445 households and Jenta 3,450 households. These areas have been impacted by the aforementioned ethno-religious problems that affected Nigeria. Enwerekwe (2011) reported that Mado Village which is part of

¹⁹ See Chapter 1.2.1 for definition of low income areas.

Tudun Wada area has witnessed a surge in population of low income families who relocated from more violent areas in the northern parts of Jos. In Jos currently Christians and Muslims find it difficult to live together, hence migrants and residents tend to settle in areas of dominance of their religion. Gyang & Ashano (2010) believe that most of the people who live in these low income areas cannot afford land in preferred areas of the city because of their low income status.

The population growth in Jos means housing in low income areas is built arbitrarily without proper planning (Ajiji & Larab, 2016). Even with a conservative growth rate of 5%, the population of Jos would have doubled within 18 years from 2007 to 2025. Bearing in mind the rate at which the population of Jos has been growing, and the trend of growth from 2006, if the present rate of expansion of the city is not curtailed then more congested low income areas without planning or the necessary infrastructure would develop within the city.

Some of the inhabitants of low income areas acquire land from landowners and construct houses on disadvantaged lands such as on rock or hill tops, because land on plains or flat areas is expensive (Gyang & Ashano, 2010). Figure 19 shows the kind of terrain and houses in Jenta. According to Vivan et al. (2015) most houses in these areas are old, built 11 to 15 years ago with cement blocks, and roofed with corrugated iron sheets. The walls and roofs of most of the buildings are in bad condition, and 86% of the houses are compounds with shared facilities such as toilets, bathrooms and kitchens. Due to the unplanned nature and clustering of houses, most compounds have poor ventilation, and most of the streets are unpaved with a poor drainage system. Based on the work of Oladosu et al. (2015) 45.5% of the population at Gangare and Angwan Rogo get power supply through the national grid, while the rest of the houses either illegally tap power, use kerosene lamps (17.5%), generators (16.9%) or use rechargeable lamps (20.2%).

The major source of water for household use and drinking is from hand dug wells (Daffi and Kassem, 2013; Dawang et al. 2015). Others sources include streams, which are highly polluted, rain water, taps, and buying from water vendors. Most of these water sources have a high nitrate value attributed to latrines, sewage and refuse dumps (Beka et al. 2009). Gyang & Ashano (2010) observed industrial effluents being discharged directly into streams by companies in Anglo Jos. This polluted water is directly used by farmers for irrigation along the stream channels.



Figure 19 Nature of houses in Jenta

Source: Image taken by the researcher during fieldwork 2014

3.1.3 Demographics of residents

Onwubiko (2013) stated that there is no accurate statistical data on the number of Nigerians that are unemployed, and no separate unemployment data exists for Jos. As covered in Chapter 2.1.2 there is much variation in estimated unemployment levels with the World Bank (2012) estimating the unemployment rate in Nigeria at 22%, and the youth unemployment rate at 38%. Uwa et al. (2016) suggests 60% of Nigerian youths are unemployed with secondary school-leavers²⁰, mostly found among the rural population, accounting for about half of this figure. Adesina (2013) observed that it is no longer about going to school and graduating or learning a trade, but about how to face the reality of graduating and joining the group of unemployed people with little hope of subsistence.

Research by Vivan et al. (2015) on the demographics of low income settlements in Jos indicate that there are more males than females in most areas, most inhabitants are married and fall within the age bracket of 40-49. About 70% of these inhabitants have lived in the area for over 30 years (Oladosu et al. 2015). Most of the residents are self-employed or entrepreneurs rather than being in formal employment because of lack of government or formal jobs in private companies. They are traders selling provisions in corner shops, firewood for fuel, roasted corn and ‘akara’ on road sides, artisans, farmers and labourers.

A large number of the people acquired vocational education because most cannot afford tertiary education. According to Education for All (EFA 2015) the education system in Nigeria consists of six years of primary schooling, three years of junior secondary, three years of senior secondary and four years of tertiary

²⁰ Typically aged between 16 and 20 years

education with both the public and private sector involved in delivery. Government education is supposed to be free in the majority of the state-owned institutions, but students are required to purchase books, uniforms and pay for resources costing them an average of NGN30,000 (£75.55) per child per year which presents a challenge. Oladosu et al. (2015) in their study on issues and challenges of urban renewal in Jos, discovered that 29.7% of the inhabitants of Angwan Rogo, Gangare and Dadin Kowa which are also low income areas did not acquire any formal education partly due to the cost.

3.2 WASTE MANAGEMENT IN JOS

Since the FEPA decree in 1988 (see Table 7) state governments are expected to establish a State Environmental Protection Agency and formulate their own policies in order to further address environmental issues within their jurisdiction. Specifically for Plateau State PEPSA was established in 2000 and they are responsible for the collection and disposal of waste. The Plateau State Environmental Sanitation Edict of 2007 is the most current strategy document which addresses waste management and pollution of the environment. Despite these arrangements and strategy, effective management of waste has been a challenge.

Peter et al. (2014) and Peter (2016) explained that the urban infrastructure is already strained significantly relative to the required waste management services and facilities. The low income areas already suffer from poor solid waste management services due to lack of access roads, inadequate storage of waste before collection, and lack of waste management facilities. Enwerekowe (2011) observed that SWM problems are most severe in informal settlements of Jos as a result of their population and urban density, hence waste management facilities are inadequate, insufficient and in most cases totally absent.

Gyang & Ashano (2010) and Peter et al. (2014) noted that both the local and national governments seemed ill prepared or equipped to provide the increasing population with basic and critically needed infrastructure such as for waste collection and disposal and water provision, as a result Jos now shares the same difficulties as other Nigerian cities in terms of solid waste management.

3.2.1 Levels of waste generation

There is limited reliable recent data on waste arisings in Jos. Figure 20 shows how the quantity of waste generated in Jos has increased from 1982 to 2010 based on data collated from studies by Efe (2013), Nigerian Environmental Study Team (NEST) (1991), and Oluwande (1984). Arisings have increased steadily with noticeable increases in 1990 and 2005. In 2010 an estimated 400,000 tonnes were generated with levels doubling within a 10-year period.

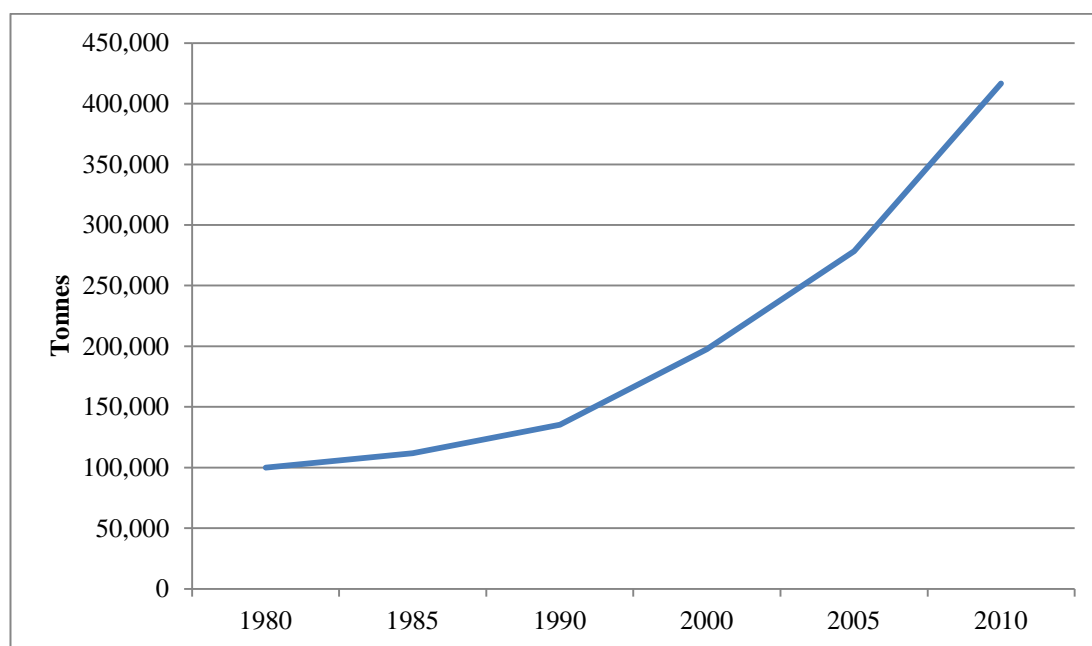


Figure 20 Estimated quantity of waste generated in Jos from 1982 to 2010

Sources: Collated from Efe (2013); Nigerian Environmental Study Team; NEST (1991); Oluwande (1984)

The data should be considered with some degree of caution because of inconsistencies either in the method of collecting data, estimates made without clear rationale, incomplete data, and non-representative data. Reliability of solid waste data from LEDCs could be compromised by seasonal variations, and lack of actual weight data. The most accurate way of determining the quantity of waste generated is through direct measurements at source however the generation rate is most often calculated using waste quantities that arrive at disposal sites. This method of measurement does not fully represent the waste stream, because waste could have been diverted before disposal with informal workers removing a large fraction of the recyclables. Furthermore due to the limited collection services large quantities of waste do not make it to the final disposal site.

Eche et al. (2015) state that in Jos 45% of waste generation comes from residential areas, and Plateau Environmental Protection and Sanitation Agency (PEPSA, 2013) has put the average waste generation rate at between 0.55-0.58 kg/capita/day. The levels of generation can be influenced by income, season, culture and the tradition of people. Peter (2016) made projections for waste arisings in Jos using an assumption of 0.5 kg/capita/day for waste generation (taken from NEST, 1991). Through projecting population increases, it was estimated 1.4 million tonnes of waste would be generated in 2025; three times the estimated levels for 2010.

3.2.2 Waste composition

The last waste composition analysis in Jos was conducted in 2008 with samples taken from high and low density areas (PEPSA, 2013). In Nigeria the upper and middle class often inhabit the low to medium density residential areas, while the high density areas are left for the poor or low income groups (Yunusa, 2005). This data was published by PEPSA (2013) and the work integrated into Peter et al. (2014). However, the author has concerns regarding the reliability and usefulness of the data as no information was provided on sample size of waste taken for analysis, and the results are published in an unclear way, for example the percentage values of the waste stream do not tally to 100%.

3.2.3 Municipal waste collection

In Jos waste collection is currently free for the 1.3 million inhabitants. As explained PEPSA is the waste management agency and their responsibilities include managing waste from households, offices, street, industries, hospitals, markets and institutions. This research is however only concerned with waste generated from households.

Households are not provided waste storage containers (Yawa, 1999), as a result they store their waste in varied containers such as plastic and metal buckets, baskets and plastic bags (Eche et al. 2015; Peter et al. 2014; Peter 2016; Yawa, 1999). The waste containers often used are old and without handles. Households take waste to public collection containers rather than PEPSA collecting directly from households. PEPSA is solely responsible for waste collection but due to inadequate resources it is estimated that only 50% of this waste is collected and often waste is left in communities (Efe, 2013). Both Eche et al. (2015) and Peter et al. (2014) have argued the need to improve municipal solid waste collection in Jos.

PEPSA is a public body and they undertake all collections, however public–private partnerships in solid waste management have been in practiced in Nigeria, and were adopted in Plateau State from 2005-2007 (Osesienemo, 2008). Under the system 24 private waste companies were registered with PEPSA and these companies were then contracted to deliver the collection service for 25 different zones (with one operator handling two zones). The role of the companies was to collect and transport all waste from zones under their responsibility, and to dump it at designated dumpsites approved by the Ministry of Environment, under the supervision of PEPSA. However this process led to problems including political office holders registering private waste companies just for the sake of collecting the money and never executing collections. This led to the termination of contracts with all private suppliers in 2007 and since then no private waste companies have been involved in municipal collections in Jos.

3.2.4 Waste disposal in Jos

There are no sanitary landfills in Jos for waste disposal, and as a result waste is disposed indiscriminately. Two types of open dumping exists in Jos, the first involves PEPSA collecting waste from public waste containers and dumping it at open dumpsites (Peter 2016). The second type reported by Daffi & Kassam (2013), Eziashi (1997), and Gyang & Ashano (2010) is where waste is indiscriminately disposed in communities be it on street corners, backyards, open spaces, and water bodies. Daffi & Kassam (2013), and Musa et al. (2008) have suggested reasons why waste is indiscriminately dumped in Jos, this include the inadequate number of public waste containers or non-collection of overflowing public bins so people have no option other than to dump the waste, non-availability of designated dumpsites, and the use of open trucks leading to waste being blown out. In addition children are often sent to dispose of waste, but because they cannot lift them into the community waste containers they dump it around the container or elsewhere (Daffi & Kassam, 2013).

3.2.5 The impacts on public health and the environment

The poor system results in impacts including flooding, air, water and land pollution, and also serves as agents of infections and diseases (Gyang & Ashano 2010). For example the flooding in Jos on July 23rd 2012 led to the loss of 107 lives, 320 houses destroyed, and 1,185 people being displaced (The Nation, 2012). The same paper reported the outbreak of cholera at the camp for flood victims, with 65 cases confirmed and referred to hospital. It is thought the cholera outbreak was a result of people drinking the flood water, and the flooding was attributed to the poor management system in Jos with waste blocking drains. Ahovi (2017) stated that in addition to causing flooding in Jos, waste dumped in communities, especially plastic bags, leads to stagnant water and the mosquitos therefore increasing the risk of malaria.

Water and land pollution can be seen in parts of Jos where people dig shallow wells with little or no concern for pollution. A survey of ground water quality in hand dug wells in Jos by Beka et al. (2009) observed nitrate values which exceeded the WHO threshold limit value²¹ of 3.0mg/l while some exceeded the WHO standard²² of 45mg/l. The high nitrate values were attributed to sewage, pit latrines and dumpsites. Daffi & Kassam (2013) recommended that residents should be made aware on the dangers of dumping solid waste into streams, and provision should be made of solid waste collection at such places.

²¹ The threshold limit value of a chemical substance is a level to which it is believed a worker can be exposed day after day for a working lifetime without adverse effects (Paustenbach 2011).

²² WHO has formed an authoritative basis for the setting of national regulations for drinking water quality and standards for water safety in support of public health (WHO, 2011b)

3.2.6 Resource recovery

Peter et al. (2014) found that most recycling in Jos is carried out by the informal sector who collect recyclable materials from households, public waste bins or dumpsites and sell them to the owners of recycling banks, who in turn sell these materials to processing and manufacturing industries in or outside Jos. Peter et al. cited examples where glass is collected, processed and recycled to cullet for use in the glass industry. In addition the bases of broken bottles are sold to small scale industries that cut and polish the glass to manufacture ash trays and candle holders. The Mennonite Central Committee (MCC) (2017) reported on their community project in Jos making accessories from scavenged resources such as seeds to make beads for jewellery, and plastic bags being woven into purses, bags and mats. They are rolling out a new project 'weave of hope', which pays displaced women to collect plastic water sachets which are cleaned, sewn and weaved into purses, wallets and other items for sale.

Jos is one of the most notable providers of waste materials to secondary markets (Sadiq 2017). Sadiq gave the example of a business man, nicknamed Baban Bola, who has dealt in scrap material in Jos since 1991. Baban Bola started as an itinerant waste picker moving from community to community in search of scraps and other waste materials, but he is now worth billions of naira and is regarded as one of Nigeria's most successful solid waste dealers. Baban Bola has branches of his waste material dealership throughout Nigeria with over 500 employees working for him. Scrap metal forms the bulk of materials seen leaving Jos for various parts of the country, especially Ogun, Lagos, Port Harcourt, Benin, Kano or Katsina, for reprocessing (Sadiq 2017).

Most members of the public in Jos, and Nigeria generally, are engaged in farming on a small or large scale. In Jos farmers are known to use urban waste as a fertilizer on their farms. Farmers sometimes pay to have waste dumped on their farmland, while land owners pay to have it and use it to reclaim their land. Lewcock (1994) and Lewcock (1995) indicated that urban waste was sought after by farmers, and the practice of using urban waste has been documented in Jos by Pasquini (2002), Pasquini (2006) and Pasquini & Harris (2004). The waste is not composted but burnt and applied directly as ash with other fertilisers (Alexander, 1986; Phillips-Howard & Kidd, 1991). Pasquini (2002) reported that during the late 1970s, farmers switched over from chemical fertilizer to using urban waste ash for farming in Jos.

In Jos farmers pay PEPSA to have the waste collected from the municipality delivered to their farms. The farmers then spread it to dry, and then burn it. The hard non-combustible waste such as glass bottles and metals are raked and removed for disposal while the ash from the waste is spread on the farm to fertilize it. Figure 21 shows heaps of ash from burnt waste on a farm in Jos waiting to be spread.



Figure 21 Heaps of ash waste on a farm in Jos

Source: Image taken by the researcher during fieldwork 2014

Pasquini & Harris (2004) concluded that the benefits of using ash are that it is a rich source of nutrients for crops, it raises the pH of the soil, and it also helps in alleviating waste disposal problems. Conversely Pasquini (2006) examined the health and environmental risks of using urban waste ash in urban vegetable production in Jos in terms of heavy metals accumulation in the food chain. Findings from the study suggest that the soil concentrations of the seven heavy metals analysed fall within 'typical' soil levels, and that there would not be any problems of either toxicities or deficiencies for plant growth. It is possible that with increasing development and consumerism on the part of the populace, waste is likely to include increasing sources of heavy metals. As such Pasquini & Harris (2004) encourage the pre-sorting of waste to enable biodegradable waste to be collected and safely used on farms.

3.2.8 Challenges to waste management in Jos

Binbol et al. (2013) observed that PEPSA was finding the management of waste in Jos very difficult, and attributed it to lack of trucks for waste collection, insufficient provision of public waste containers and non-provision of permanently designated waste dumpsites. Peter et al. (2014) and Peter (2016) also noted that PEPSA has limited containers available for distribution to residents to store their waste, hence residents mainly use old plastic or metal buckets to store their waste before disposal. Others challenges identified in literature are insufficient budgetary allocation, insufficient staffing, role conflict with other agencies, and non-enforcement of waste regulations. It has been documented that the waste collection resources available in Jos have been inadequate for decades. Pasquini (2002) observed 23 waste disposal trucks were commissioned in the 1980s for Jos, but by 2001 these were reduced to just four, due to vehicle breakdown and the non-maintenance culture of the municipality.

The activities of PEPSA were reported by Mallo & Anigbogu (2009) to have helped in clearing heaps of garbage indiscriminately disposed around the city, and also in regulating harmful environmental practices. However PEPSAs overall performance was rated at only 20% by householders of low income areas. Binbol et al. (2013) stated that the challenges PEPSA faced were the reasons for their poor rating. Hence Binbol et al. suggested that effort should be made to solve this problem through the intervention of government and other private organisations. In addition PEPSA should acquire more vehicles for waste collection, and provide residents with waste storage containers in order to reduce environmental pollution resulting from littering. With the projected increases in population and resulting waste generation, PEPSA face increasing challenges in delivering effective waste services in the Jos.

A further challenge identified by DungGwom et al. (2008) was historically the plethora of institutions in the state that performed overlapping functions, and worked at cross purposes rather than addressing different issues and problems. DungGwom et al. cited examples of agencies like the Jos Metropolitan Development Board (JMDB) based in local government, PEPSA, and the Direct Labour Agency, all crowding for the same functions. The situation has now changed however previously JMDB performed overlapping functions with PEPSA on waste collection and management, street and traffic management, control of illegal markets, management of motor parks and garages, and clearing of drains. The implication of this is that some of the functions were neglected when one agency expected the other to do it, while there was duplication on some other functions, especially where this involved income generation.

A further challenge identified in literature is the public's level of understanding about the importance and implications of SWM. Agunwamba (2003) observed that Nigerians inclusive of Jos have a poor attitude towards waste treatment and disposal because they know little about waste management hence they dispose of waste in their communities. Peter et al. (2014) noted that public awareness on waste management can create an impact on all stages of the municipal solid waste management process. Binbol et al. (2013) suggest that in order to tackle waste management problems for a healthy environment PEPSA should organize public awareness programmes. Jatau (2013) added that while promoting awareness on waste management, those with lower level of education should be the target group as studies has shown that they have the poorest attitudes towards waste management practices. This can be achieved through organizing workshops, seminars and conferences on waste management by government bodies.

3.3 SUMMARY OF CHAPTER

Jos has been experiencing increasing levels of waste generation with inadequate resources to manage this waste. However, the research has highlighted that the informal sector has an important role in managing waste and that waste ash has been utilised as a fertilizer.

Whilst some studies have been undertaken on waste management in Jos there remains a lack of reliable information especially in terms of data on waste generation levels and composition. Moreover, some of the studies cited have been based on desktop studies and utilise undergraduate research.

4 RESEARCH METHODOLOGY AND DESIGN

4.1 INTRODUCTION

Literature indicates that municipal solid waste management is a big challenge to Nigeria, due to the threat it poses to public health and the environment resulting from poor waste management practice (Abila & Kantola, 2013; Adediran & Abdulkarim, 2012; Adejobi & Olorunnimbe, 2012; Longe & Enekwechi, 2007; Modebe et al. 2009). Research shows that low income areas globally receive little or no attention from municipalities in respect to solid waste management (Adama, 2007; Mbah & Nzeadibe, 2016; Onu et al. 2012), with about 80% of the population in Nigeria not receiving waste collection services. This thesis investigates the challenges faced in implementing an effective waste management system in low income area of Jos, and evaluates the potential role of waste prevention. The study has asked the following research questions in order to gain full understanding of how waste is currently managed in low income areas and the potential role of waste prevention.

- What are the challenges associated with the sustainable management of solid waste in Jos?
- How could the management of solid waste in Jos be improved?
- What are the characteristics, and factors influencing the generation and composition of household waste in Jos, and how efficiently is waste currently being managed in low income areas?
- What are the current waste prevention opportunities that could be used to reduce waste? How viable are these waste prevention opportunities for Jos?
- What impact could these waste prevention opportunities have on waste arisings in Jos? What are the obstacles that could hinder their success?

To address these research questions the Research Onion methodological approach developed by Saunders et al. (2012) was used (see Figure 22). The Research Onion illustrates the stages that have to be covered while developing a research strategy, with each layer of the onion describing a more detailed stage of the research process. This chapter shall present the different stages of the Research Onion.

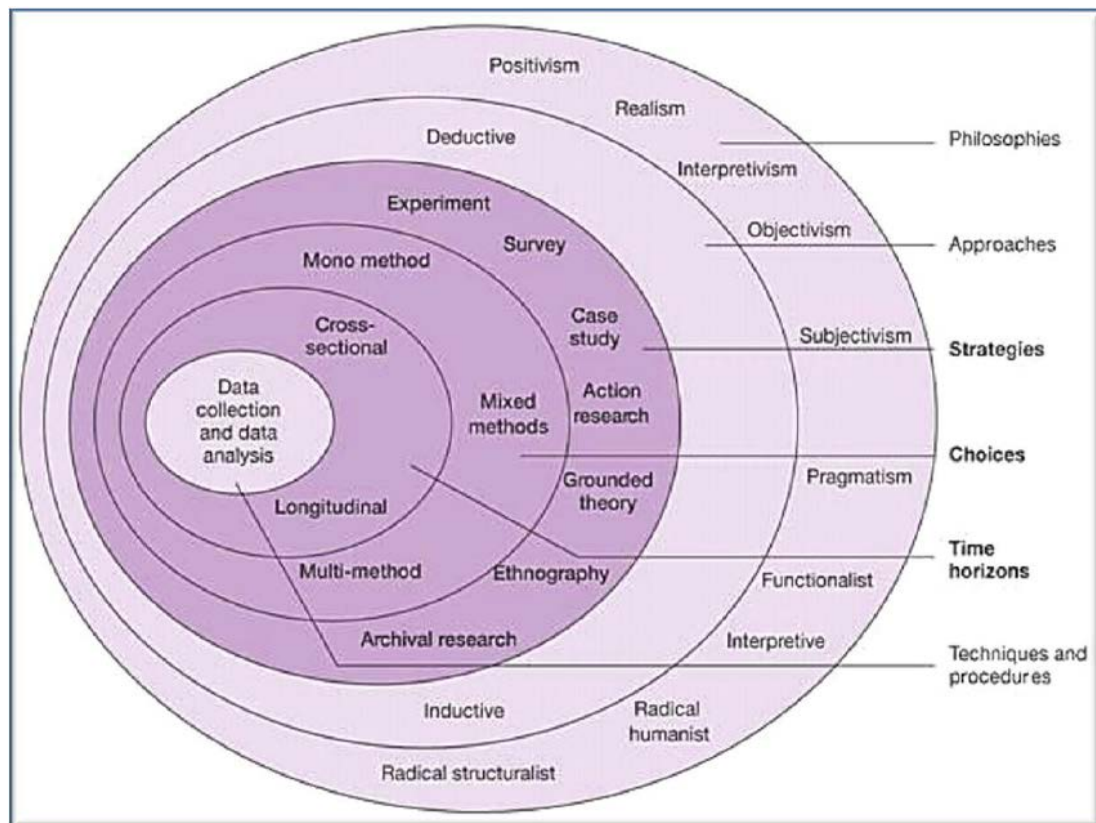


Figure 22 The Research Onion

Source: Saunders et al. (2012)

The data collection strategy used a mixed methods approach which combined qualitative and quantitative methods for undertaking the research. The methods used involved background fieldwork, direct observations, focus group discussions, interviews, questionnaires, waste composition analysis, screening and Strengths Weaknesses Opportunities and Threats (SWOT) analysis. Then follows information on secondary data used, data analysis including thematic and statistical analysis. Reliability and validity of the results are discussed, followed by ethical considerations. The researcher provides details on how any concerns were addressed and managed throughout the course of the study.

4.2 RESEARCH PROCESS

4.2.1 Nature of research

Research could be explanatory, descriptive or exploratory. Explanatory research tries to determine and report the association amongst variables in a research setting (Saunders et al. 2012) and tries to address the ‘why’ in the study of phenomena (Neuman, 2011). It tries to provide a justification to the reasons why things happen. Descriptive research identifies the constituents of phenomena and methodically records it giving specific details or a representation of the settings, situation, and

relationship of the phenomena (Fellows et al. 2008; Neuman, 2011). Neuman (2011) observed that the result of descriptive research is usually a detailed depiction of the research subject or an answer to the research question. Exploratory research is concerned with discovering and gaining insights about a particular research phenomenon (Saunders et al. 2012). Research is exploratory once it tries to acquire further knowledge in order to comprehend what is happening in a research setting before being able to identify the problem. Embracing an exploratory design helps the researcher to become familiar with the research phenomena and be able to advance a hypothesis, after gaining a perception (Babbie, 2007).

This study is therefore both exploratory and explanatory as it tries to acquire a deep understanding of current SWM practices in low income areas, and also seeks to identify the factors that could influence solid waste generation and composition. The study also provides an understanding of what happens in low income areas with regards to SWM, so as to be able to identify the challenges to sustainable SWM. It is important to have an understanding of the research phenomenon – waste prevention before supplementary data is collected so as to address the research problem – SWM practices in low income areas. This will give a better understanding of waste prevention and waste prevention initiatives that could help reduce waste arisings, and the new acquired knowledge could be used to transform SWM practices.

Exploratory research has the advantage of being flexible and adaptable, and is effective in laying the foundation for future studies (Dudovskiy, 2016). In adopting an exploratory and explanatory research design and method for this study, exploratory research will provide a better understanding of household SWM practices at low income households so as to inform on the practical ways of improving SWM practices at households.

4.2.2 Research Approach

Research is a careful search aimed at gathering information to produce or enhance knowledge (Pole & Lampard, 2002). Knowledge accumulation, according to Bryman (1988), follows two paradigms; quantitative or qualitative. The research approach is divided into deductive, inductive and abductive depending on the reasoning of the researcher (Dudovskiy, 2016). Deductive approach is concerned with evolving a hypothesis based on a theory that exist, and then planning a research strategy to collect data in order to test the hypothesis so as to disprove or confirm the theory (Wilson, 2010). Inductive approach is the opposite of deductive approach as it begins with observations and data collection which is later used to explore a phenomenon, and then tries to identify the themes and patterns and create a conceptual framework through theory generation and building on it (Babbie, 2010). Abductive approach combines both inductive and deductive approaches; it starts with data collection in

order to explore a phenomenon, then identifies themes and patterns and locates them in their conceptual frameworks, and later tests this through subsequent data collection. It involves theory generation or modification, incorporating existing theory where appropriate to build new theory or modify an existing one (Dudovskiy, 2016). According to Saunders et al. (2012) the major differences between deductive, inductive and abductive research approaches is in terms of logic, generalizability, use of data and theory.

This research is located within the inductive approach, as fieldwork was undertaken in order to collect data which was used to gain an in depth understanding of how households in low income areas managed their waste. Publications exist on household solid waste management, but no research has been undertaken on household waste prevention in low income areas particularly in the context of this research. This research shall provide new knowledge from the data collected.

4.2.3 Research Strategy

The research strategy addresses how the researcher plans to carry out the study so as to be able to answer the research questions in a systematic manner (Saunders et al. 2007). The strategy could consist of a variety of approaches including experiments, surveys, case study, grounded theory, action research and ethnography. In such cases the researcher has to look for the most appropriate methodology that can address both the research questions and objectives amongst other factors. The other factors that can influence the choice of a research strategy are the research philosophy, research approach, and time available, type of project and the research subject, type of information needed, access to participants, existing literature, and resources available for the research (Saunders et al. 2012).

Experimental research is a research strategy that examines the result of an experiment in conjunction with the expected results and the relationship between the factors compared and contrasted against expected outcomes (Saunders et al. 2007). Grounded theory uses a qualitative methodology hinged on the inductive approach where patterns originating from the data are a prerequisite for the study (May, 2011). For instance interviews can be conducted, transcribed and coded to pull together general issues connecting participants, which imply that outcomes of the investigation are resulting from the concluded study instead of probing records to ascertain if it fits preexisting frameworks (Flick, 2011). Bryman, (2012) observed this is a research strategy that is commonly used in the social sciences. Action research is any research initiated to resolve an urgent problem or a progressive problem, and it is usually led by persons working with others in teams or as part of a 'community of practice' to improve the way issues as well as problems are resolved. There are two types of action research, namely participatory action research and practical action research. Denscombe (2010) notes that the main rationale for using

action research is to solve a particular problem while producing a guideline for best practice. This type of research is practicable for the nursing and teaching professions (Wiles et al. 2011). Ethnography according to Bryman, (2012) means personally observing people in order to systematically study them and their culture. The researcher has to become part of the people being observed so as to see things from their perspective. This approach is commonly used in the biological, cultural and social sciences and communication studies, history - wherever people study ethnic groups.

Case study investigates a solitary unit for instance a person, a group, or a situation over time so that its main features can be established and generalizations drawn (Bryman, 2012). A case study is an empirical enquiry that investigates a contemporary phenomenon in depth and within its real life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin, 2014). For example if the study is about a group it can describe the behavior of the group in general, not the behavior of individuals in the group. Case study research may involve a distinct case or multiple case studies which might comprise quantitative data, relying on numerous sources of proof, and as a result benefits from the previous progression of theoretic suggestions to guide data collection and analysis (Yin, 2009). Hence case studies must not be confused with qualitative research, but is rather a combination of some quantitative and qualitative data. Yin (2014) specifies that case study is the best strategy to use in research when addressing the "how" or "why" questions, where in depth research is needed using a holistic lens, especially when the researcher has no control over the event. According to Mills et al. (2010) and Yin (2014) case study research has been used for years in many disciplines and professions in social sciences, education and administrative science. The difference between case study and other strategies like experiments and surveys is that the research subjects are studied within its context. Thomas, (2011) explains it as follows: *"Case study investigates one case or a number of small cases that occur naturally without controlling any variables or prioritizing data quantification. It uses a variety of methods and data sources with a large number of features of each, mainly looking at relationships and processes"*.

Creswell et al. (2003) has postulated that using mixed methods can offset the disadvantages that some of the methods have when used in isolation. Tashakorri & Teddie, (2003) observed that phenomena cannot be fully understood using either pure qualitative or pure quantitative techniques. A variety of data sources and analyses are needed in order to completely understand the multifaceted institutions and realities, which mixed methods provide. Johnson & Turner (2003) suggest that methods should be mixed in a way that has complementary strengths. A typical case in view is the use of case studies in combination with surveys, where one method gives greater depth, while the other gives greater breadth, and together they could

expectantly give accurate results (Tashakorri & Teddlie, 2003). Greene et al. (1989) gives additional support for the usefulness of mixed methods by proposing five functions for the method, which are triangulation, complementarity, development, initiation, and expansion. The first two functions (triangulation and complementarity) are related to the fact that mixed methods lead to multiple inferences that confirm or complement each other, while the other three (development, initiation, and expansion) are related to mixed methods studies in which inferences made at the end of one phase (qualitative) lead to questions and or design of the second phase (quantitative).

The design of a case study project is of great significance as it gets criticized for lacking sturdiness as a research tool (Zainal, 2007). Scholars adopt either the single case or multiple case designs dependent on the issue in question.

Research on household SWM has been undertaken by Araba (2010) and Solomon (2011) and they both have used the case study research strategy employing mixed research methods to collect their data. This research has similarly adopted the single case study research strategy using mixed methods to collect data from the study area. The use of these methods aided the researcher to reach research findings that are valuable, as quantitative research has wider coverage while qualitative research gives a deeper understanding.

Gerring & Cojocaru (2015) specify that a case study should focus on one or several cases that are explored in depth, integrate diverse styles of evidence, and potentially shed light on a broader population which it represents. Hence the case(s) have to be chosen logically for them to provide an in-depth understanding of the research phenomena (Denzin & Lincoln, 2005). Most often the study aim(s) and research question(s) are the key determinants in the selection of cases (Eriksson & Kovalainen; (2008). This is captured by Yin, (2014: p.28): *“You need sufficient access to the data for your potential case – whether to interview people, review documents or records, or make field observations...You should choose the cases that will most illuminate your research questions”*.

The case study for this research was selected based on the criteria suggested by Miles & Huberman (1994: p.34), which are as follows:

i. The relevance of the sample to the conceptual framework and research questions. The case selected for this study was relevant to the research questions set out for this study (see Chapter 4.1). The questions were set within the research context and demonstrate the problems being looked into by this study.

ii. The appearance of the phenomenon of concern of the study in the case. This is concerned with the possibility of available data on the phenomena of study, in this case SWM concerns within low income households. The selected case study has

been recognized to display the problem under investigation in Jos. For instance the study area formed the greatest concentration of poorly serviced unplanned low income settlements. These types of settlements are homes to the urban poor or low income group (UN Habitat, 2011), which are characterized by a lack of basic infrastructural services such as inadequate solid waste management resulting to negative impacts on public health and the environment.

iii. The ability of the sample to enhance ‘generalization’ of findings. The phrase ‘generalisation’ does not refer to statistical generalisation rather generalisation to theory where empirical findings supports or refutes existing theory (Eriksson & Kovalainen, 2008). Hillebrand et al. (2001) argues that a researcher can establish theoretical generalisation by demonstrating causal relationship on the basis of both structural similarity of cases and logical argumentation. Hillebrand et al. (2001: p.654) further sustains this argument by maintaining that causal relationships can be established by “*setting up a reasoning based on empirical facts, logical argumentation and formerly accepted theories which in turn are based on empirical facts, logic and even earlier accepted theories*”. In consideration of these, the selected case (Tudun Wada and Jenta) have structural similarity with a majority of informal settlements (low income areas) in sub Saharan Africa and LEDCs at large (Hove et al. 2013; Morakinyo et al. 2012). Hence the conclusions can allow for a theoretical generalisation only with reference to the crucial factors researched in this study.

iv. The sample should produce ‘believable’ descriptions and explanations true to real life. The case study for this study was selected based on the evidence of the existence of the research problem. Observations in the case study give a believable description of the SWM practices.

v. The feasibility of the sample place. This implies the resources available to the researcher to undertake the research; time, money, access to the people and the researcher’s work style (Miles & Huberman, 1994). It also includes the researcher’s expertise in terms of language and communication skills, ability to relate participants with their experience or the researcher/participant’s ability to cope with the circumstances under which data collection might be obtained (Curtis et al. 2000). In this study language and communication skills were an important feasibility factor of the choice of the case study. In Nigeria, apart from English and Pidgin English there are many regional languages, for example in the south-west Yoruba, south-east Igbo, south-south Ijaw, Itsekiri, Efik, Isoko, Urhobo, Ogoni. In northern Nigeria, where the study is located, the population mainly speak Hausa and English. The significance of language and communication skills was considered in the selection of the case study. The researcher being from the case study area was fluent in Hausa and this reduced problems that would have been encountered in communication if

undertaken in another community. In addition, the researcher being a member of staff at the University of Jos and being a resident of Jos, has background knowledge of the environment, the culture and the people. Hence the researcher was accepted by the research participants as one of them.

vi. The ‘ethicality’ of the sampling plan. This deals with the method of selection, whether or not it addresses ethical concerns such as informed consent, potential benefits and the risks associated with participation in the study, and the relationship between the researcher and the participants. Section 4.6 addresses ethics for this study.

4.2.4 Pilot testing of questionnaire

A pilot test is a preliminary study conducted to evaluate the feasibility and appropriateness of a research method. The pilot can help to understand the logistics needed, costs, adverse events, and sample size (statistical variability) to improve upon the study design prior to undertaking a full-scale research project (Hulley, 2007). It also provides an opportunity to validate the wording of the tasks, understand the time required and may supply additional data. Bryman (2012) specified that pilot testing research questions ensures that the methods adopted function well and help in fine tuning the approach leading to more reliable results (Schade, 2015). In this study questionnaires were initially tested with supervisors and some staff of the Department of Geology, University of Jos. The main reason for using staff of the University of Jos was because they were familiar with the setting and had knowledge of solid waste management, which helped in validating the content of the questions (Saunders et al. 2015). Another reason for testing the questions was to make sure that the aim for their formulation was achieved. The comments and critiques received enabled the researcher to address and clarify areas of concern. Thereafter the questions were tried in the field with a few household members from similar settings, and were found to be suitable for the study.

4.2.5 Sampling

Sampling refers to the process of choosing a representative sample from a target population and collecting data from that sample in order to understand the characteristics of the whole population (Martinez-Meza et al. 2016). Sample size is important in determining the accuracy and reliability of research (Zamoni, 2017). Morse (2000) recommended factors to guide researchers in determining sample sizes including the scope of the study, the nature of the topic, and the quality of data. These were carefully considered whilst deciding on the sampling strategy and size for this research.

Non probability sampling for specific purposes was suggested by Saunders et al. (2012) to be embraced for interviews. Non-probability sampling is a sampling technique where the samples are gathered in a process that does not give all the

individuals in the population equal chances of being selected. In this research purposive sampling was embraced in the selection of participants for both focus group discussions and interviews. Purposive sampling involves the identification and selection of participants that have knowledge of the subject, and could provide information that fits into the study criteria (Creswell & Plano Clark; 2011; Palinkas et al. 2015; Sekaran & Bougie, 2013). The stakeholders of SWM who participated in the focus group discussions and interviews were precise groups within the study area who could provide relevant information to answer the research questions.

A combination of random and convenience sampling was embraced for waste composition analysis and questionnaires. In random sampling everyone in the entire target population has an equal chance of being selected (Yates, 2008), and it is important to sample randomly to ensure a true representation of the population. Random sampling was used to recruit households whose waste samples were collected for waste quantification (completed for 74 households out of 80 that were recruited see Chapter 4.3.7 for more detail), while convenience sampling was utilized for 604 participants who completed questionnaires (see Chapter 4.3.6 for more details). Convenience sampling is a non-probability sampling technique where subjects are selected because of their convenient accessibility and proximity to the researcher. Convenience sampling became necessary as some households selected for participation declined to take part in the questionnaire survey. This necessitated the change of plan in administering the questionnaire, to involve those who were at home and willing to participate in the research.

4.3 DATA COLLECTION STRATEGY

4.3.1 Overview

This study was designed to take place in four phases (see Figure 23). The first phase marked the literature review period, formulation of the research questions and development of the methodology. A review of literature was undertaken and this was presented in Chapter 2 (on Nigeria) and Chapter 3 (on Jos). The review identified the gap in knowledge on waste management in low income areas and the potential role of waste prevention. Afun (2009), Ajibade (2007), and Ezeah (2010) recommended waste prevention to be used as a strategy for reducing waste generation in Nigeria.

The second phase describes the experimental period which involved the collection of primary and secondary data from the study area using mixed methods including observations, focus group discussions, interviews and questionnaires. The results are presented in Chapter 5. In the third phase the results are analysed to identify the challenges to sustainable waste management in low income areas in Chapter 6.

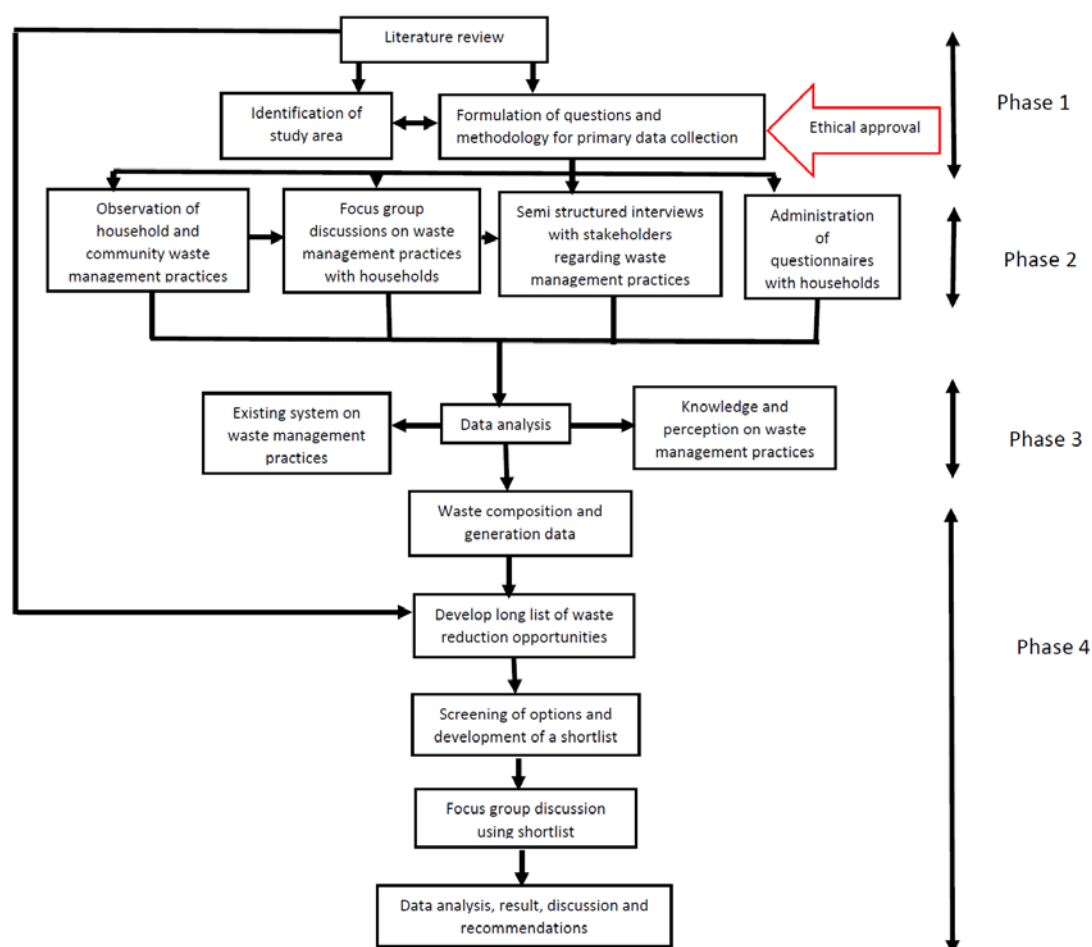


Figure 23 Design of research strategy and data collection

The final phase focused on waste prevention to identify intervention opportunities for the case study area. Waste composition analysis was undertaken to identify priority materials to focus on for prevention. The author conducted a comprehensive review of global waste prevention and produced a longlist of waste prevention opportunities. The list was assessed using five criteria which were: key materials in the waste stream, quick wins, economically viable, building on what already exists, and likelihood of the initiative working in Jos and Nigeria. Using the aforementioned criteria a short list of the 5 most applicable waste prevention opportunities was established. In order to further evaluate the appropriateness and impact of these activities two focus groups discussions were organised with PEPSA and household members of Tudun Wada and Jenta. The most applicable and viable options were selected and recommended for implementation in the study area.

Table 12 provides an overview of each of the methodologies applied and how they contributed towards meeting the stated objectives. Each method is discussed in more detail below including justification for the sampling size.

Table 12 Summary of methods used to collect data, and the objectives achieved

Phase	1	2				4		
Method	Literature review	Direct observation	4 x focus groups – 32 participants	5 x interviews	678 x questionnaires	Literature review – waste prevention	Waste analysis x 74 households	2 x focus groups on waste prevention - 15 participants
Objective								
1. To investigate the existing systems for managing household waste in low income areas in Jos.	✓	✓	✓	✓	✓			
2. To identify the challenges to achieving the sustainable management of solid waste in the study area, and to identify recommendations to improve current practice.	✓	✓	✓	✓	✓			
3. To understand the levels of waste generated and the composition of household waste in low income areas in Jos.	✓	✓	✓	✓	✓		✓	
4. To review the existing waste reduction interventions currently being used in other parts of the world.						✓	✓	✓
5. To evaluate the feasibility and impact of waste reduction opportunities in the study area.						✓	✓	✓

4.3.2 Background fieldwork

Background fieldwork was undertaken in Jos by the author for two weeks in July 2014. This fieldwork helped the author to identify the location of the study area and to establish contact with relevant officials and gatekeepers including pastors and ward leaders who could assist in the research.

The University of Jos was sought for collaboration and assistance in view of the fieldwork. An informal discussion with a lecturer who had been teaching waste management at the University helped to identify published and unpublished literature on SWM to provide information on previous research. A meeting with Plateau State Environmental Protection and Sanitation Agency (PEPSA) made it possible for the author to interact with officials from the agency.

To assist the author in data collection two research assistants from the Department of Geology, University of Jos (Ezekiel Y. Yenne & Sunday S. Daku) and one from Plateau State Polytechnic Barakin Ladi (Ayuba Y. Dabot) were recruited and trained, henceforth are referred to as the research team. Before the commencement of fieldwork the research team met on the 29th October 2014 where the author officially introduced the research project, and also explained their role as research assistants. The researcher trained the research assistants on how to handle and conduct focus group discussions, administer questionnaires and household waste analysis. Plans were agreed upon by the research team as to how and when the project was to start and end. Throughout the duration of primary data collection the author led the research assistants through the research process in order to give direction, clarification and explanation where necessary, so that the field-work could run smoothly.

4.3.3 Direct observations

Structured direct observation was used in this research because it is the most appropriate when consistent information needs to be collected. Observations can be made in real life situations, allowing the researcher access to the context and meaning surrounding what people say and do. Many researchers in waste management have used it as a method of study. For example Longe et al. (2009) used this approach on a study of people's perception on household SWM in Ojo local government, while Solomon (2011) used it when studying the role of households in SWM in East African capital cities. Solomon (2011) reported that direct observation at households is time consuming therefore in this study the researcher mostly monitored the community and the municipality rather than certain households.

Direct observation is also known as observational study (Holmes, 2013). This method of data collection involved the author going to the field to physically see and collect reliable data using a checklist of information. The checklist of information used for direct observation in the field included:

- Types of waste generated by households
- How waste is being stored
- Methods of waste collection
- Who collects it
- Who is responsible for handling waste at household level
- What do they do with the waste/Where does it go to
- What are the waste streams
- Any existing waste prevention activity

The checklist was used to directly observe the situation on the ground in Jos and to record information on the spot. The observation was intended to provide the author with a holistic understanding on how waste was being managed on the ground including: the types of waste generated, how it was stored, methods of collection and transfer, who provides the service, what householders do with the waste, and characteristics of households. The author also observed the process of flow of waste from generation by households through to disposal at dumpsites. As part of observation the author went out with PEPSA's waste collection crew to the different zones and recorded GPS coordinates of the public waste containers that were sighted in order to map them. Data collected was in form of pictures and field notes and the information gleaned helped to inform subsequent data collection. Direct observations lasted for a period of three months.

4.3.4 Focus group discussions

A focus group is a small group of people selected from a wider population and sampled for open discussion allowing participants to give their opinions on a particular subject or area (The American Heritage, 2017). Focus group discussion was used as a research method and it was chosen because it provides a rich understanding of people's experiences and perspectives, situated within the context of their particular circumstances and settings (Murphy et al. 1998). Morgan & Krueger (1997) posit that focus groups are a unique and independent form of data collection, which serve to improve the overall practice of qualitative research. In addition it is believed to complement other methods in research, especially for triangulation (Morgan, 1998) and for checking validity. Focus groups were used by Ezeah (2010) in a study on analysis of barriers and success factors affecting sustainable municipal solid waste management in Abuja, and Solomon (2011) on the role of households in solid waste management in East African capital cities.

In all six focus group discussions were conducted with four focus groups held during Phase 2, two each with household members from Tudun Wada and Jenta. The other two focus group discussions were held during Phase 4 of this research with PEPSA staff and household members from Tudun Wada and Jenta focusing on waste prevention options (see Chapters 4.3.8.1 and 8.2.2).

Table 13 Summary of focus group discussions conducted for phase 2 of this research

Place	T/Wada (FGDT1)	T/Wada (FGDT2)	Jenta (FGDJ1)	Jenta (FGDJ2)
Date	3/11/14	4/11/14	12/11/14	13/11/14
Venue	Residence	Wakili School of Business Studies	Residence	Bishop's court
Attendance (people)	8	11	6	7
Duration (minutes)	90	120	95	90
Language conducted	Hausa	Hausa	Hausa/English	English

The research team gained access to the study area and participants by using the gatekeepers. Saunders et al. (2012) defined gatekeepers as the person through whom researchers gain access and control to the study area and participants. Sadler et al. (2005) views gatekeepers as the ideal partners in helping the researcher gather a varied research sample. Sadler et al. (2012) believe that gatekeepers know the community better, and have a range of expert information dissemination skills and insights, and have well-established working relationships with members of their community.

Consultations were held with the Pastor of the 'Evangelical Church Winning All (ECWA) Good News' who was the gatekeeper for the recruitment of household members for focus group discussions in Tudun Wada. The Pastor introduced the author to his counterpart at ECWA Church Jenta Adamu to enable for the recruitment of focus group members in Jenta. He also introduced the author to the ward leaders in both areas. The pastors and ward leaders were used as the recruiting agents for both communities.

All participating members of the focus group discussions were selected based on guidance from the gatekeepers, and were community members who were open, and could provide information on solid waste management. To ensure that the focus groups were successful the participating members were contacted by the research team and informed about the objectives of the meeting and the intended topic of discussion.

The gatekeepers liaised with the participants and the research team, and dates, times and venues of the meeting were agreed upon before holding the meeting. The groups were constituted bearing in mind the homogeneity, gender and age, so that members could freely make contributions without holding back for any reason. Homogeneity is the quality of being similar or comparable in kind and nature. Homogeneity levels the playing field, and reduces inhibitions among people who may never see each

other again, and is important in maximizing disclosure amongst focus group participants. Krueger (1988) acknowledged that homogeneity in focus group discussion is important. Research by Kreuger (1988) and Kreuger (1994) provided the plan upon which the steps for conducting the focus group discussions were built. There are many advantages to interaction between participants and many see interaction as the key to the method (Kitzinger, 1994). The idea is that group processes can help people to explore and clarify their views and attitudes efficiently, and encourages participation from those who feel that they have little to say (Kitzinger, 1995). Kitzinger (1994) viewed interactive communication amongst participants as very important because it helped to clarify similarities and differences in expressed opinions and/or values. Members give answers and build on what others in the group have said.

The recommended number of participants in a focus group discussion can range from 6 to 12 and should be drawn from a study population of interest (Lewis, 2000; Morgan, 1992; Stewart & Shamdasani, 1990). In this research, focus group discussions involved 6 to 11 persons per group. This number of participants is small enough to allow everyone in the group to contribute (Krueger, 1994), yet large enough to share diverse opinions across the whole group rather than fragmenting into smaller parallel discussions. It was easy to moderate discussions as subgroups were not formed and everyone had enough time to express their view. Holding 4 focus group discussions in a single research study was in agreement with Glaser & Strauss (1967), and Patton (1990) who suggested having between 3-5 focus groups per project. Each group discussion took between 1 ½ to 2 hours within the guidelines of Stewart & Shamdasani (1990) that stated group discussion should generally last between 1-2 hours, or until the topic has been covered to satisfaction by the participants. The age of the participants ranged between 20 to 70 years old.

The first four focus group discussions in phase 2 were facilitated by one person (Sunday S. Daku), a field assistant who is a lecturer in the Department of Geology, University of Jos. The field assistant had experience of speaking in public being a lecturer, a former local government council member, a rapporteur at weddings and other public functions. The field assistant had also helped in conducting focus group discussions as a facilitator for a Professor at the Faculty of Education, University of Jos.

The role of the facilitator was to encourage group interaction, and ensuring that no individual participant dominated the discussion, and also lead the discussion through the range of topics from the beginning to the end. The facilitator was supported by a guide containing questions which directed the discussion (see Appendix 1). The guide was produced by the author in English and translated to Hausa for those groups who opted to use Hausa as the language of communication. The discussion guide was divided into four sections. The first section was mainly concerned with

self-introduction in order to make the participants comfortable. Thereafter an explanation was made for the purpose of the meeting after which the discussion procedure and ground rules were outlined, and consent of participants sought. They were also informed about their rights to leave whenever they felt uncomfortable in the group, or could ask further questions for clarification. The third section was on SWM practices at households. These questions were prepared during the literature review stage and were supplemented with direct observations from the field. Examples of topics discussed were participants' views on waste management in their community, the main problems of solid waste management, and solid waste management practices in their homes. The last section was to find out from the participants how they as individuals could contribute to improve the process of solid waste management from their households and community, and also if they had anything to say which they had not mentioned.

The author's role in focus group discussion was to listen and write down all the different views of participants, and also to clarify issues that the author felt the participants did not understand. The author recorded the focus group discussion with a Dictaphone in order not to miss out on anything said that was not written down in the notes. The different focus groups and members were coded in order to easily identify contributions when writing up the results. The documented views and opinions gathered from members in the group discussion could be explored further or verified when interviewing stakeholders. Appendix 2 includes copies of the consolidated transcripts for the two Jenta focus groups.

4.3.5 Semi structured Interviews

Interviews are the most common method of data collection used in qualitative research (Gill et al. 2008), and were an important method of study adopted in this research. Seidman (1998) acknowledges that interviewing is an efficient mode of enquiry and adds that recounting narratives of experience has been the major way throughout history that humans have made sense of their experiences. Silverman (2000) believes that interviews provide a 'deeper' understanding of social phenomena than would be obtained from purely quantitative methods, such as questionnaires. They are therefore appropriate where little is already known about the study phenomenon or where detailed insights are required from individual participants. They are also particularly appropriate for exploring sensitive topics, where participants may not want to talk in a group environment (Gill et al. 2008). Compared to structured interviews, semi-structured interviews are flexible and allow for the finding or clarification of information that may be significant to the participant but may not have been thought of as relevant by the researcher. Semi-structured interviews are made up of questions that assist in defining the subject to be explored, but also lets the researcher or interviewee deviate in order to pursue an idea or response in more detail (Britten, 1999). Interviews help to obtain detailed information about the personal feelings, perceptions, and opinions of the

interviewees. The interviews were conducted to complement the data collected through direct observation and focus group discussions. Likewise some of the information obtained during observations and focus groups discussions informed some of the questions asked. The main reason for using interviews was to extract in-depth information and insight from stakeholders, based on their knowledge and experience in the waste management industry. It was an opportunity for the author to meet personally with the stakeholders in a relaxed and quiet atmosphere to learn more about their experiences through structured interviews.

The researcher referred to Jacob & Furgerson (2012) for guidance on how to conduct the interviews. In preparing the list of topics to be discussed the author endorsed the recommendations made by Stewart & Shamdasani (1990) and Stewart et al. (2007).

A review of literature helped in establishing the list of stakeholders responsible for solid waste management in the study area and Plateau State in general. The following stakeholders were interviewed: one representative each from the State Ministry of Environment, PEPSA, academia, a private recycling entrepreneur, and manager of a private local recycling enterprise. These different stakeholders were interviewed due to their different roles in waste management in the state.

The semi structured interviews started with self-introduction, signing of a consent form (see Appendix 3), an explanation of the objectives of the research, and finally discussing issues of solid waste management in Jos and low income areas. Each interview was recorded using a Dictaphone for later transcription as well as writing down notes. The author sought more clarification on ambiguous answers and probed further depending on responses from the interviewee. Interviews were transcribed later and compared with written notes to verify unclear responses and matters requiring further clarifications were referred back to the respondents, after which results were coded and processed. The first three interviews were conducted in English while the last two were conducted in Hausa. Interviews lasted between 30-120 minutes depending on the organization represented and how much information was required from them. Yin (2003) specified that interviews could take a maximum of 60 minutes, but Jacob & Furgerson (2012) stated that interviews could take as long as 90 minutes, however they believed that it was more appropriate to range two to three shorter interviews than conducting one longer one. In this research the interview with PEPSA lasted for about 120 minutes because so much information was required from them. An overview of each interview is provided in the following sections.

4.3.5.1 Plateau State Ministry of Environment representative

The interview started with the representative²³ of Plateau State Ministry of Environment. The main objective was to gain an overview of the current way of

²³ For confidentiality the role of the representative is not disclosed in this research.

managing waste in Jos, and also to find out about more information waste responsibilities in the city. Other issues concerning waste management like institutional arrangements, bye-laws, policies, regulations were also discussed. Views were sought on how to improve solid waste management within Jos and low income areas. This interview was necessary because the Ministry of Environment is responsible for implementing government policies and directives and they also initiate and advise higher government on environmental matters.

The questions asked were based on information that the researcher needed to know so as to be able to address the research questions, and some questions were based on observations and discussions with focus group members.

4.3.5.2 PEPSA representative

The interview with the representative²⁴ of PEPSA helped the researcher to understand the current situation with waste management in Jos, especially in the low income areas. The role of PEPSA in waste management, the type of waste generated, the factors influencing waste generation, and challenges to the waste management system were topics covered. The interviewee also gave their opinion on how to improve the waste management system.

This interview was important since PEPSA was accountable for solid waste management in Jos. Questions were prepared prior to the interview and again informed by focus group discussions and observations. For example the focus group members in Tudun Wada accused PEPSA of not providing them with black plastic bags for waste collection as they had done in the past, and the author asked the PEPSA representative to explain the situation.

4.3.5.3 Academic

Interview was conducted with a Professor from one of the tertiary institutions in the State. The aim was to establish previous research conducted on solid waste management in Jos, and to understand what they consider to be the major causes of poor solid waste management especially among the low income areas. In addition the author sought to find out the impact of research on improving the solid waste situation in the city. This interview was necessary as it helped the author to acquire new information on research conducted that they were not aware of. The academic gave an insight into waste management research that had been undertaken at the University.

4.3.5.4 Private recycling entrepreneur

An interview was conducted with an entrepreneur who set up and now manages a private recycling business. The interview and site visit was conducted to obtain information on the kind of reusable and recyclable waste they deal with, where they obtain the materials from, who they sell to, how much they buy and sell, their

²⁴ For confidentiality the role of the representative is not disclosed in this research.

motivations, and the challenges they face. This interview helped the researcher understand the current reuse and recycling activity taking place in Jos.

4.3.5.5 Manager of a local recycling enterprise

Another interview was conducted with a manager of a local recycling enterprise manufacturing pots and other metal items from scrap metal. This was conducted to get information on how they source the recyclable materials, prices, and what they produce with the material. Again this information helped the researcher understand the current reuse and recycling activity taking place in Jos.

Full transcripts for all interviews are included in Appendix 4.

4.3.6 Questionnaire

A questionnaire is a structured technique for collecting primary data. It is generally a series of written questions for which the respondents has to provide the answers (Bell, 1999). Questionnaires are the most commonly used research method in social sciences. Mathers et al. (2007) state that it is a flexible research approach used to investigate a wide range of topics. Some of its advantages include practicality, ease of analysis and objectively, simple to administer, familiar format to most respondents, and a significant amount of data can be collected from a large number of people in a short period of time at relatively low cost. The disadvantages and limitations include reliability in responses, lack of conscientious responses, miscommunication, accessibility issues, and skipping of questions. Bulmer (2004) believes that the use of questionnaire is a practical and well-established tool within social sciences research to acquire information on social characteristics of participants. Questionnaires have been used by Zorpas & Lasaridi (2013) in their study on measuring waste prevention, and by Sujauddin et al. (2008) on household solid waste characteristics and management.

The questionnaire survey was designed by the author and embraced the steps listed by Mathers et al. (2009). The questionnaire was designed in such a way as to cover the research questions, aims and objectives, some of which include gathering data on waste management practices in the community, and how individual households managed their waste. It was also to determine the flow of waste from homes to disposal and to get their insights regarding the provision of waste management services in their communities to complement the other data already collected. As suggested by Krishnaswami & Ranganatham (2007) the questionnaire was pre-tested and revised, before administration by the author and three other research assistants. The pre-test exercise was carried out with five lecturers at the University of Jos, afterwards all suitable changes were made and the questionnaire finalised. The aim of the pre-test was to discover if households were at ease with the questionnaire, whether their answers provided the requisite information, if all words were understood, and to determine the time it took to administer a questionnaire.

The questionnaire is attached in Appendix 5 and took between 15-20 minutes to answer. Although it appeared long, most of the questions were closed and were easy to respond to, and had sub questions which not all respondents needed to complete. The survey covered background information of the participants, such as how long they have lived in the community, how old they were, educational level and profession. A section focused on variables that could influence the level of waste generation for example how many people lived in the household including the number of children, and the household monthly income. Another section focused on how waste was managed including who was responsible for managing waste, who collects it and frequency. If waste was not collected correspondents were asked how they disposed of their waste. Other questions covered the perceived environmental impacts in the community caused by the waste management system, if they paid for waste services and their opinions on the current waste management system in Jos and how could it be improved.

The remainder of the questionnaire focused on the top three tiers of the waste hierarchy with questions on waste reduction, reuse, and recycling. This included questions on if they were aware of what these activities are, and if they participated in them. In the context of prevention, questions were posed on composting, food waste prevention and the use of reusable nappies.

These questions were important to the author so as to provide a clear understanding on the demographics of residents and their waste management behaviour.

The questionnaire mainly adopted the use of close ended questions combined with a few open ended questions. Close-ended questions according to Mathers et al. (2009) are questions whose possible answers have been defined in advance and so the respondent is limited to one of those pre-coded responses, while the open ended questions are open to any response but allow the respondent to interpret the questions in their own way. The open-ended questions were incorporated into the questionnaire for the purpose of receiving the deep answers from the respondents. Polit & Becks (2008) mentioned the advantages of open ended questions include allowing respondents to give a richer and fuller perspective on the topic of interest, explaining that some of the richness may be lost when responses are classified. They also added that it gives freedom to the respondent, and therefore offers spontaneity and elaboration.

All respondents were asked the same questions in the same order, thus making it uniform and consistent (Reja et al. 2003). A few questions were asked that used the Likert scale. A Likert Scale is a type of rating scale used to measure attitudes or opinions (Bertram, 2016). Through this scale, respondents are asked to rate items based on their level of agreement, for example, strongly agree, agree, neutral, disagree, and strongly disagree.

In order to determine a suitable sample size, the author used a sample size calculator provided by Creative Research (2015) using a confidence level of 99% and confidence interval of 5% to calculate the sample size for the study area. The low-income study area had an estimated 5,895 households²⁵ and a sample size of 666 households was calculated in accordance with the procedure stipulated by Creative Research. The insistence on representativeness in statistical sampling is because it allows the researcher to make assumptions for the entire population.

In selecting the households that would participate in the study, the research team made an effort to recruit 750 households, more than the 666 household sample size. This was done as it was expected that some householders might not be cooperative or decide to opt out. On the first day of questionnaire administration 80 questionnaires were handed out to residents at their homes in the study area in person with an explanation on how to fill out the questionnaire for collection two days later. Upon collection the research team discovered that 42 questionnaires (52.5%) from the households responding were incomplete and instructions had not been followed and therefore withdrawn. 21 households (26.3%) filled the questionnaire accordingly, with the remaining 17 households (21.3%) not filling the questionnaire at all. As a result the author decided to change the method of administering the questionnaire in order to improve completion rate and generating more reliable data. The team agreed that the most appropriate method of administering the questionnaire was face-to-face with the research team working through the survey with residents, and moving from house to house engaging only with households willing to participate in the research. Baabeyir (2009) used this method in his research on social and environmental injustice in SWM in Accra, Ghana.

The research team made up of 4 people working in pairs administered the questionnaires on a face-to-face basis with household members from the study area for 6 weeks. The research team visited the study area on a daily basis from 8.00am to 6.00pm from Monday to Saturday and moved from one household to another introducing themselves and explaining the purpose of the survey. Household members were invited to partake in the research and were assured of their anonymity and confidentiality, and only those who consented were administered questionnaires.

At the end of this exercise a total of 678 questionnaires were available for use in the research, 42 were withdrawn because they were wrongly completed. This equates to 94.1% of the questionnaires being returned and used in the data analysis, while 5.9% of the questionnaires were incomplete and discarded. Face-to-face questionnaire administration was labour intensive, but remained the best way to achieve high quality data and high return rates (Mathers et al. 2007). This method enabled the research team to explain to the participant any questions that they did not understand. In addition Reja et al. (2003) observed that respondents feel more motivated to

²⁵ Based on data from the cartographer at the University of Jos.

complete a whole questionnaire without abandoning it while interacting with the interviewer. Probing was useful particularly for questions with multiple possible responses and for open ended questions. However face to face interviews can be intrusive and need to be handled with skill in order not to be biased, it can be a problem when more than one questionnaire administrator is involved since delivering consistent reactions can be difficult to manage. In addition, participants may have concerns about their privacy and anonymity when responding to questions on a face to face basis, and may not give honest answers to sensitive questions. There could also be a limit to the number of participants to be surveyed depending on the number of people administering the questionnaire (Alreck & Settle, 2004; Holbrook et al. 2003; Szolnoki & Hoffmann, 2013; and Wyse, 2014).

4.3.7 Waste composition analysis

Waste Composition Analysis (WCA) provides information on the types and amounts of materials that are in a given waste stream and usually involves obtaining samples of these waste streams and sorting them into pre-defined categories which are then weighed (Zero Waste Scotland, 2013). Waste composition according to Burnley (2007) is important because it provides information that can be used in designing municipal solid waste management strategies, and it also helps in establishing the basic character of municipal solid waste. Waste composition data was collected from households in the sample area as there was no data available specifically on waste generation levels and composition within the low income areas which was the focus of this research. As highlighted in Chapter 3.2.2 the last waste composition study had been completed in 2008 (PEPSA, 2013) but there was a lot of uncertainty in the rigour of the data. Moreover the data would be integrated into the criteria for identifying priority waste prevention interventions for the area by highlighting abundant materials being generated.

There are no existing guidelines in Nigeria for undertaking household waste composition and many different approaches have been adopted. Burnley (2007) reviewed a number of studies that had been undertaken on the composition of municipal solid waste in the UK and reported that they were not carried out in a systematic or consistent way, so limited information could be derived from comparisons of the results. Dahlén & Lagerkvist (2008) reviewed 20 different methods for conducting household waste composition studies and observed that there is no working international standard on how to conduct composition analysis, which methods ranged from sampling individual households, bulk samples, vehicle loads, civic amenity site waste, commercial waste, street litter, street sweepings, waste diaries and bulky waste.

The author chose to use guidance produced by Zero Waste Scotland (2013). The guidance was chosen because the methodology had been recently updated and the author believes it is a methodology that can be used internationally for household

waste composition analysis. The methodology guarantees a standard approach for the purpose of understanding the composition of waste within a particular area.

There are two main approaches to collecting samples. Bulk analysis involves collecting samples from a community to provide an overview of the composition from the given area. The alternative approach is collecting samples from individual households. Parfitt et al. (1997) reviewed both approaches and decided that if waste composition analysis was being conducted to obtain information on the recyclables, compostable, or packaging elements of the waste stream, then sampling waste from individual households was the superior option. Advantages of individual household sampling included identifying the discarded materials in the waste stream, tracking the results back to individual addresses, and knowing the total amount of waste generated from specific homes. Individual household waste analysis provides reliable data that is detailed, accurate and informative and can be combined with demographic information to identify factors that affect waste generation (Solomon, 2011). However Bandara et al. (2007) and Zero Waste Scotland, (2013) observed that individual household waste sampling was a more expensive approach than bulk household waste sampling.

The approach used in this research was to sample waste from individual households rather than bulk analysis. This approach would return more detailed data allowing analysis to the identify levels of waste per capita and variations in generation of individual materials across the households sampled. The gatekeepers played an important role in recruiting households in the analysis, and accompanied the author when approaching households to participate. Households were visited and the aim of the study was explained to them. They were also informed how the data was going to be used, after which their consent to participate in the research was sought. Only those who consented to participate in the research had their waste sampled.

The households recruited for this study were selected independently of other households. After recruiting the first household, every fifth household was considered for selection and this continued until the required sample size was achieved. Random selection was done in order to validate the study by eliminating bias. In designing the sampling technique the researcher followed the guidelines provided by Zero Waste Scotland (2013). Their report however considers that in practice the size of the sample is often limited by the resources available in terms of time and cost and the practicalities of how much waste a team can collect and sort in a day. The report recommends that the minimum number of households to be sampled within each stratum is 50 based on the natural variation in different categories of waste across households. A stratum for example could be an area with more affluent retired households, an area with low income households, or an area with households that have mostly young children and served by the same waste collection authority.

In this study the author considered the population of 5,895 households and a 361 sample size calculated based on 95% confidence level and 5% confidence interval (Creative Research, 2015). However waste composition analysis from 361 households would be difficult to achieve. The author decided to adopt Zero Waste Scotland (2013) recommendation of sampling not less than 50 households for this research, besides the households fall within the stratum of low income households. After considering other contingencies a total of 80 households were recruited for sampling in this study, but then 6 households were dropped because their data was incomplete at the end of the study. As a result 74 households participated in this study and their data forms part of the results. Results of the waste quantification analyses are presented and discussed in Chapter 7.

The procedure for waste composition analysis commenced with the research team providing households with plastic bags in which they were asked to put out all waste including materials that they might sell for recycling. The plastic bags were retrieved after 48 hours, and households were provided a fresh set of plastic bags. The research team returned in total three times throughout the week to collect, weigh, and sort each sample collected from households. This was planned by the research team bearing in mind that unlike in the UK where residual waste is collected fortnightly, in Jos waste is not collected so household might dispose the waste every day.

The solid waste was taken away on each collection day to the government designated dumpsite at Zaria Road. The contents were emptied and spread onto a plastic sheet and sorted into 13 pre-determined categories (see Table 14). The author adopted the primary level categories for waste analysis as used by Bichi & Amatobi (2013), Ejaro & Jiya (2013), Gawaikar & Deshpande (2006) and Okeniyi & Anwan (2012). All weights were recorded into the data sheet, after which the waste was bagged for disposal at the dumpsite.

The households sampled also participated in answering the same questionnaire as set out in 4.3.6. Therefore the author was able to interrogate data from the questionnaire and composition for each individual household and calculate the per capita waste generated per day and look for other trends in the data.

Table 14 Categories used for waste composition based on Bichi & Amatobi (2013)

S/N	Primary category	Examples of materials included in this category
1	Food waste	Left over food, bread, peels, vegetables, bones
2	Paper	Newspaper, magazines, cardboard and other paper
3	Glass	Glass, bottles and jars
4	Metals	Drink cans, tins, nails, and other types of metals
5	Plastic films/bags	Plastic bags, plastic films, water sachets
6	Dense plastics	Plastic bottles, packaging, other rigid plastic
7	Textiles	Clothing, textiles
8	Ash/unburnt wood ²⁶	Ash and wood unburnt from fires
9	Electrical	Parts of phones, chargers, ear pieces, bulbs
10	Others	Batteries, drugs, disposable nappies, sanitary towels
11	Miscellaneous combustible	Weavon ²⁷ and other combustible materials
12	Fines	Soil, dust
13	Garden waste	Leaves and grass, other garden waste

4.3.8 Identifying waste prevention opportunities

4.3.8.1 Development of a long and shortlist of initiatives

A comprehensive review of global waste prevention was undertaken (see Appendix 6), to generate a long list of initiatives that could help to reduce waste levels (see Chapter 8.2). The list was screened and assessed using the following five criteria: key materials in the waste stream, quick wins, economically viable, building on what already exists, and the likelihood of the initiative working in Jos. Full details of these criteria are presented in Chapter 8.2.1 - Development of a long list of initiatives.

The author based the identification of waste prevention opportunities on a traffic light system where green was allocated two points which meant that the waste prevention initiative completely satisfied the criteria, amber was allocated one point which means that the initiative partially satisfied the criteria, while red was allocated zero points which meant that the initiative failed to satisfy the criteria. Variations of this traffic light screening have been applied in other industries such as employment when screening the suitability of candidates (Know Your Candidate, 2016), in Strategic Environmental Assessment when appraising different strategy options (ERM, 2007), and in Environmental Impact Assessment when evaluating the suitability of potential sites against defined criteria (Terence O'Rourke, 2005). The scoring was informed by data gleaned by the author in Part A of the research, and understanding the local situation. This screening exercise enabled the author to shortlist the preferred waste prevention interventions as they had the highest points. However the author also acknowledge that in order for any waste prevention intervention to succeed there needed to be a more holistic approach to raising

²⁶ To help with analysis residents were asked to bag up ash/unburnt wood separately.

²⁷ Weaveon is artificial hair for women.

awareness of waste issues in the community, and therefore the role of general waste awareness campaigns was also considered.

To further evaluate the appropriateness and impact of the shortlisted interventions, two focus groups discussions were held with PEPSA and household members from Tudun Wada and Jenta. The researcher was again supported by two field assistants, Mr Ezekiel Y. Yenne from the University of Jos and the Mr Ayuba. Y. Dabot from the Plateau State Polytechnic Barakin Ladi. The author integrated both Ketso and SWOT analysis in the focus group discussion. Figure 24 shows a group of household members from Tudun Wada and Jenta in a focus group discussion using the Ketso approach.



Figure 24 Adoption of the Ketso approach for the focus group discussion

Source: Fieldwork

Ketso is a research approach that was first used in Lesotho in the mid 1990s and it means ‘action’ in the Sesotho language (Ketso, 2012). It is a tool that can be used in a variety of research methods – instead of being a method *per se*, it is an information gathering instrument that can be used to: stimulate discussion; ensure that everyone has a say; help participants to visualize and order their thinking and responses to questions; and capture their ideas in the form of written notes on coloured papers (Abigo, 2016). It is particularly useful for stakeholders who need to work together to explore new ideas and develop a plan before taking action within a limited time frame. It has been used to facilitate interactive communication in focus group discussions, with a small group of people discussing key issues at a table with a researcher, and in larger workshops, with a number of groups at once, which can allow for the gathering of information (Ketso, 2012). It has been used in environmental management and sustainability planning, teaching and training and in research by PhD students. For instance Ketso has been used by community planners, teachers, trainers, facilitators, and people running team meetings in private companies. It has also been used in projects at over half of UK Universities

including: Brighton (Abigo, 2016), Glasgow (Njiraini, 2015) Manchester (Hall, 2010), Southampton (Sarky, 2016). It has been used for social vulnerability assessment in Ouagadougou, Burkina Faso and Cameroon, and is being used in research looking at adaptation to climate change in five African Cities (Climate Change and Urban Vulnerability in Africa, CLUVA (undated).

Ketso uses coloured papers to capture each participant's ideas, thus giving everyone a voice, not just those whose voices are loudest. It also makes it easy for participants' to follow the conversation and see all their ideas at a glimpse (Ketso, 2012).

The Ketso approach was used in the focus group discussion session for this study with participants writing down their ideas on paper, concerning the strengths, weakness, opportunities and threats of the five shortlisted waste prevention interventions. This was in order to select the most appropriate waste prevention intervention for the study area.

SWOT is an acronym for Strengths, Weaknesses, Opportunities, and Threats (The Economic Times, 2017). It is an analytical framework that assesses these four elements and can be used in different contexts be it of an organization, project or business venture. It involves identifying the objective of the subject, then assessing its internal strengths and weaknesses, alongside the potential opportunities and threats. These internal and external factors could be favourable or unfavourable for subject depending on their effects on the objectives. Strengths entail the characteristics of the subject that give it an advantage over others, while weaknesses mean the characteristics that place the subject at a disadvantage in relation to others. On the other hand opportunities are elements of the subject that could be exploited to its advantage, whereas threats are elements in the environment that could cause trouble for the business or project.

Humphrey (2005) and Humphrey (2012) have used SWOT analysis within business development. Ifediora et al. (2014) has also utilized the SWOT method in investigating an organization's stability and productivity. SWOT has been used in community work to identify positive and negative factors that could promote or inhibit the successful implementation of a social service and social change efforts (Community Toolbox, 2014). It can also be utilized as a preliminary resource for assessing impact in a community of NGOs (Westhues et al. 2001). In addition it could be used in pre-crisis planning and preventive crisis management, as well as in making recommendations during viability studies or before developing a strategic plan (Our Community, 2014). SWOT is beneficial for community studies as it helps communities to find solutions to their problems and decide on most effective direction to take (Community Toolbox, 2014).

Unlike the four previous focus groups, these two focus group discussions were facilitated by the author. This was due to the technicalities of the topic being discussed. In the focus group the participants were presented with a list of 5 waste prevention initiatives; each of the initiatives were introduced and explained. In addition the waste composition from the study area was introduced and displayed as it partially formed the basis on which the participants were going to make their choices. Thereafter participants were requested to ask questions or seek clarifications on areas that they did not understand. As per the Ketso approach each theme was recorded on different coloured paper: green for strengths, yellow for weakness, blue for opportunities and red for threats. This arrangement was chosen in order to assist the author with efficient collation of information from the focus group members. The information was collated and analysed by the author to evaluate the feasibility of each intervention.

4.3.9 Secondary data

Important information on SWM practices and Jos were collected during the literature review from journals, published/unpublished sources, newspapers, and internet sources. Many policy documents were also used as a source of secondary data. Table 15 displays the list of documents recommended to the researcher following interviews with stakeholders.

Table 15 Documents recommended to researcher during interviews

Document	Key information acquired
Greater Jos Master Plan (2008-2025)	This plan helped to provide useful information on Jos including information on the local government areas that make up Jos, detail on low income settlements within the study area, infrastructural projections, population projections, information about the informal sector, water supply and waste management issues, and environmental problems affecting the study area.
National Environmental Sanitation Policy of the Federal Republic of Nigeria (2005)	Information on Nigeria's commitment to protecting and ensuring a quality environment and the policy to address sanitation problems.
Plateau State Environmental Protection Law 2001, amended 2003	Outlines duties of an owner/occupier of a tenement, the powers of Environmental Health Officers, the power and duties of the authority, information on prohibited acts, general penal provision and prosecution of offences, administration and enforcement and repeals.
Environmental Management and Protection by Uchegbu (1998)	Useful information on Nigeria including the concepts and definitions of environmental management, environmental problems, solid waste constituents and disposal methods, composting.
Plateau State Compendium of Environmental Laws	It is a collection of environmental laws such as Public health law, Public health rules/regulations, Plateau state urban development law, Plateau state rural water supply and sanitation agency law, Plateau state environmental law.
Study for the Construction of	Overview of solid waste management in Jos, the problems of enforcement of relevant waste management legislation, health

Document	Key information acquired
Integrated Waste Management Facility in Jos, Plateau State, volume 1, 2 & 3	and safety of personnel handling waste, waste characterisation, collection, solid waste transfer, solid waste disposal and management techniques.
Some unpublished MSc theses from University of Jos	Some unpublished MSc Theses from the University of Jos document issues like type and sources of waste generated, composition, existing waste collection and disposal practices within the study area. Community participation in refuse waste management, polythene waste materials management, agencies concerned with solid waste management and its responsibility, Jos Metropolitan Development Board (JMDB) and solid waste management, and the operations of private solid waste companies in Plateau State from 2005-2007.

4.4 DATA ANALYSIS

The analysis of data collected during research involves summarising the mass of data and the presenting the results in a way that communicates the most important findings or features. In this research both qualitative and quantitative data were collected. Qualitative data was analysed thematically, while quantitative data was analysed statistically.

4.4.1 Thematic analysis

Guest & Namey (2012) affirm that thematic analysis is the most common form of analysis in qualitative research. It is an analytical method for identifying and analysing (recurrent) patterns or themes arising from the qualitative data (Clarke & Braun, 2013). Thematic analysis is a conducive approach for reducing and managing large volumes of data, for organizing and summarizing data, and for focusing the interpretation (Boyatzis, 1998) and allows for detailed and complex description of data (Javadi & Zarea, 2016).

A wide range of data sources can be used in thematic analysis which includes transcripts, field notes, supporting documents (journals or historical papers), information written by participants (diaries), research memos, pictures, drawings, maps, digital audio files and video files (Guest & Namey, 2012; Joffe & Yardley; 2003; Lapadat, 2010). Thematic analysis was the most appropriate approach for analysing the qualitative data collected and has been used in many other studies to interrogate qualitative data sets such as Abigo (2016) in their study of facilities management of urban marketplaces in Nigeria and Gellatly's (2011) work on mental health.

In this study the researcher used thematic analysis to analyse results from observations, focus group discussions, and interviews in order to describe SWM practices in low income areas, and to identify recurrent patterns and meaning of

themes. Focus group discussions and interviews were transcribed verbatim and compared with field notes for a cross check. Individual transcripts were coded thematically in order to reveal pertinent and developing themes. The transcripts were further organised and analysed in order to identify themes, concepts and relationships within the data and also between the data and literature. In regard to ethical principles concerning participant's privacy, participants for both focus group discussion and interviews were given codes as a substitute for their actual names.

4.4.2 Statistical analysis

Statistical analysis was used for interrogating quantitative data in order to draw meaningful conclusions from the study (Ali and Bhastar, 2016). The main advantage of using statistical analysis is that it enables the researcher to score and analyse large sets of data quickly and accurately (Bryman and Cramer, 2001).

Statistical analysis is used in most experiments by researchers, and there are two types of statistical method used: descriptive statistics and inferential statistics. Descriptive statistical analysis involves the use of frequencies, percentages, means and standard deviation to describe various patterns in data encountered during a study. In this research descriptive statistics were employed for analysing quantitative data obtained from the household questionnaire and waste composition analysis. In the composition study maximum, minimum, mean and median quantities of waste components were determined, and graphical techniques such as tables, pie charts, bar charts and box plots were also used to present results from this analysis. This analysis was undertaken in order to generate a descriptive picture of the data gathered on the demographics of residents, waste management behaviour and waste levels and composition.

Examples of other waste studies that have used this descriptive statistical analysis approach are Guerrero et al. (2013) when studying solid waste management challenges for cities in developing countries, and Ezeah (2010) in his analysis of barriers and success factors affecting the adoption of sustainable management of municipal solid waste in Abuja, Nigeria. This approach to analysing waste composition data is also recommended by Zero Waste Scotland (2013) in their guidance on undertaking waste analysis.

4.5 RELIABILITY AND VALIDITY

Joppe, (2000 p. 1) defines reliability as *“the extent to which results are consistent over time and an accurate representation of the total population under study is referred to as reliability and if the results of a study can be reproduced under a similar methodology, then the research instrument is considered to be reliable”*. Joppe, (2000 p. 1) also defines validity as: *“Validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are. In other words, does the research instrument allow you to hit*

"the bull's eye" of your research object? Researchers generally determine validity by asking a series of questions, and will often look for the answers in the research of others".

From the view point of qualitative research, reliability and validity are theorized as trustworthiness, rigor and quality. It is also through this association that the way to achieve validity and reliability of research get affected from the qualitative researcher's perspectives which are to eliminate bias and increase the researcher's truthfulness of a proposition about some social phenomenon (Denzin, 1978) using triangulation. Triangulation is defined by Creswell & Miller, (2000, p.126) to be *"a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study"*.

Patton, (2001 p. 247) supports the use of triangulation by asserting that *"triangulation strengthens a study by combining methods. It means that using different kinds of methods or data, including using both quantitative and qualitative approaches"*.

The idea behind triangulation is that the more different data sources agree on a particular issue, the more reliable the interpretation of the data. This makes sure that the subject is not looked at from one side, but somewhat through a multiplicity of lenses which allows for many facets of the phenomenon to be exposed and understood (Baxter & Jack, 2008).

Several methods were used to guarantee reliability and validity of the research. Direct observations, focus groups, interviews, questionnaires and secondary data were used to triangulate the results. Yin (2003) specified that data from interviews are often corroborated with data from other sources to increase the validity of the research.

Research assistants who could work effectively with participants and communicate in both English and Hausa were selected and used in this research, so that moderators could clearly explain the research questions to enable the collection of reliable data. Interviews were conducted in quiet places to enable the author to hear and record all responses by the participants. All questions were made simple and clear to avoid ambiguity, and were asked in a logical manner using a guide. Information from both focus groups and interviews were recorded using a voice recorder as well as hand written to enable comparison so that no information was lost. In addition if there was any information that appeared confusing from interviews, the author got back to the participant to verify such information. The research team identified gatekeepers within the study area to help ensure cooperation from households. The author was present at all times with the research team in order to clarify any issues raised by participants. Sample size was an important feature of

this study and as explained there was clear rationale behind the sample sizes used. All these steps were taken to ensure that the results obtained were reliable and valid.

4.6 ETHICAL ISSUES

The author understood the main ethical issues in the research, which enabled the design and execution of an ethically acceptable study. In this research which involved human participants, it was important to observe all ethical guidelines. Punch (1994) observed that the majority of ethical guidelines for research concerning human subjects within the western cultural tradition require that anonymity or confidentiality is guaranteed, consent is informed, dignity is maintained, and on balance, the individual and society receive more benefit than harm. In addition the author followed the ethical principles of beneficence, non-maleficence, autonomy and justice which are the four pillars of ethics and governance listed by Scholes (2014). Furthermore the guidelines stated by Bera (2011) concerning the ethics of respect with the person, knowledge, democratic values, quality of educational research and academic freedom, alongside the “Code of Practice and Regulations for Research Degrees” of the University of Brighton were enshrined in this research.

During the fieldwork the author sought approval and consent from participant stakeholders before collecting any primary data. Similarly consent from households was sought before collecting and taking their waste away for quantification and characterization. Participants were informed about the nature, duration, the methods, purpose and possible risks of the research before they decided to participate. Participants were allowed to decide freely whether or not to participate, and also had the option to withdraw anytime they felt they could not continue. They were asked to fill and sign forms to show their acceptance to take part in the research. The author was responsible for ensuring anonymity and confidentiality of the participants throughout the research process. At the end of fieldwork all data collected was stored, used and reported in a manner that ensured no one, but the author, knows the source of the data thereby guaranteeing confidentiality and anonymity.

4.7 SUMMARY

This study used an exploratory and explanatory research approach that espouses the use of mixed methods. A single case study plan using a pragmatist ideology was embraced for this study. Direct observation, focus group discussion, semi-structured interviews, questionnaires and waste composition analysis were the data collection methods used in this study. Data was analysed using themes and statistics. Ethical guidelines were strictly followed throughout the research process.

Chapter 5 presents the results and analysis of the data collected for Part A of the research focusing on the waste management system in Jos.

5 RESULTS

5.1 INTRODUCTION

This chapter presents the results of investigation concerning how waste is managed in the case study area using a mixed methods approach. The study was undertaken in order to understand the current waste management practice using direct observations in the community and at household level to gain understanding of the real situation on the ground. In addition information was collected from focus groups, questionnaires, and interviews with stakeholders. Table 16 gives a summary of the data collection methods adopted – these are coded and referred to throughout the chapter.

Table 16 Methods used for data collection

Method code	Summary	Number of participants
OBS	Observations by the author in the study areas and Jos in general	--
FGDT1	Tudun Wada focus group 1	8 residents
FGDT2	Tudun Wada focus group 2	11 residents
FGDJ1	Jenta focus group 1	6 residents
FGDJ2	Jenta focus group 2	7 residents
IWMP1	Interview with the representative of the Ministry of Environment	1
IWMP2	Interview with the representative of PEPSA	1
IA1	Interview with academic representative of tertiary institutions	1
IIS1	Interview with recycling entrepreneur	1
IIS2	Interview with representative of a local recycling enterprise manufacturing pot products in Jos from metal	1
QS	Questionnaire survey with households residing in the study area	678

In respect to focus groups, where information or a quote is attributed to a particular participant this is denoted by a number – e.g. FGDT2 001 = Focus Group Tudun Wada 2 participant 1. Where applicable this information has also been supplemented by secondary information that was recommended by those interviewed or subsequently found by the author.

Due to a mixed methodology being adopted there is a crossover of waste management issues in the results from each method. To reduce repetition the results have been synthesized under themes and information presented throughout the chapter. The first section explains in detail the nature and characteristics of the study area. It is followed by the SWM structure in Jos including the roles and responsibilities of key stakeholders. This is followed by waste management practices in Jos per se, and then in low income areas. Under this section the process of waste

management is presented including collection, current reuse and recycling activity, and final disposal. The barriers and challenges that stakeholders face in managing solid waste in Jos and low income areas are also presented. Finally some challenges and recommendations to improve the existing system of managing waste have been raised.

5.2 NATURE AND CHARACTERISTICS OF THE STUDY AREA

As set out in Chapter 3.1 the city of Jos is made up of two local government areas, Jos North and Jos South. Figure 25 shows the study area made up of Tudun Wada and Jenta located in the Jos North local government area.

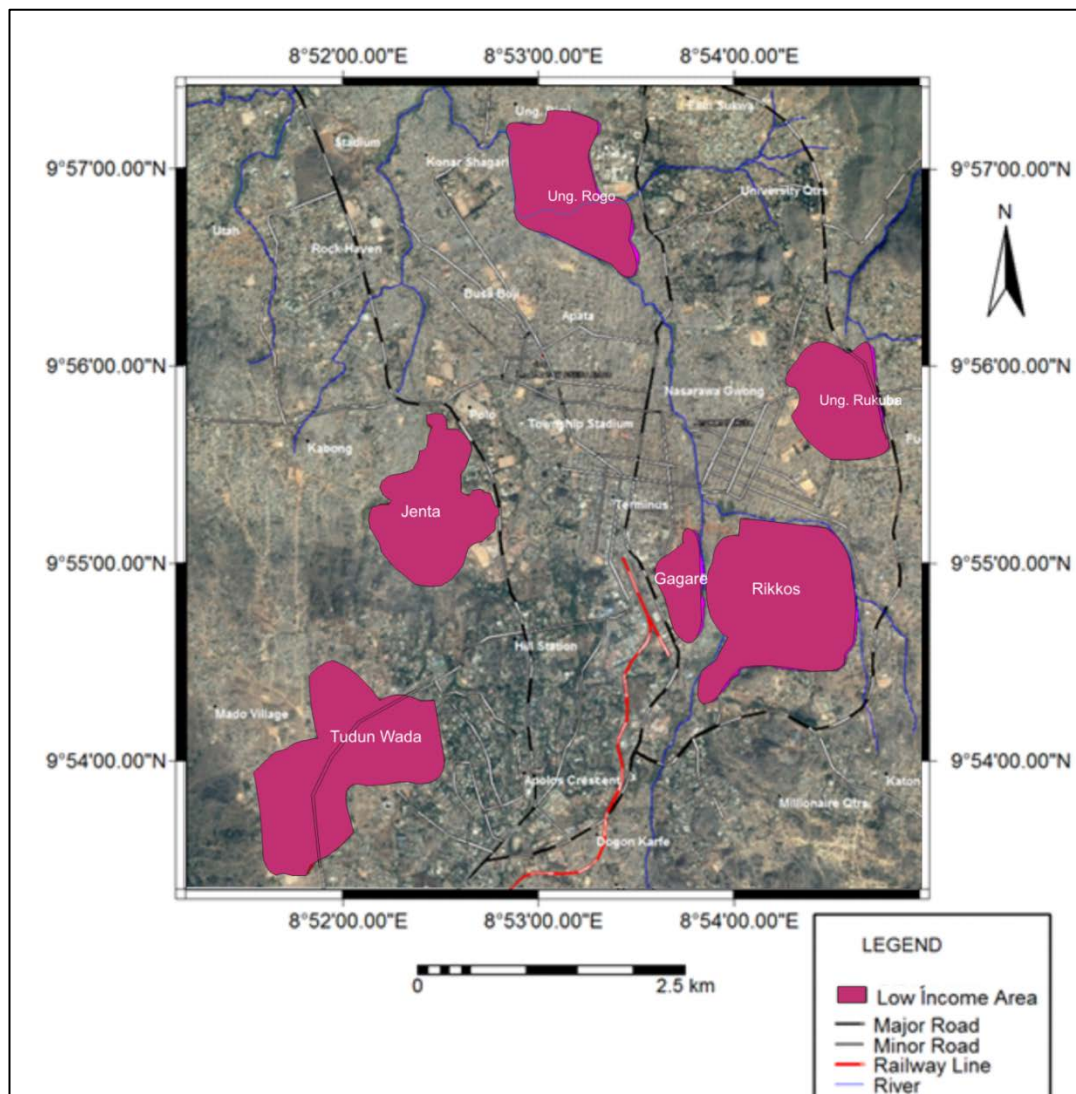


Figure 25 Map of low income areas in Jos including the study area

Source: Produced for this study based on data from observations and literature.

These areas are mainly residential intermingled with small traders, a few hotels, police stations, healthcare facilities, schools and churches.

5.2.1 Housing

Jenta and Tudun Wada are located mainly on rocky terrains surrounded by hills and valleys with limited access roads and drainage. Figures Figure 26 to Figure 28 show the nature and type of houses in the study areas.



Figure 26 A crowded informal settlements in Jenta, Jos, Nigeria

Source: Image taken by the researcher during fieldwork in 2014

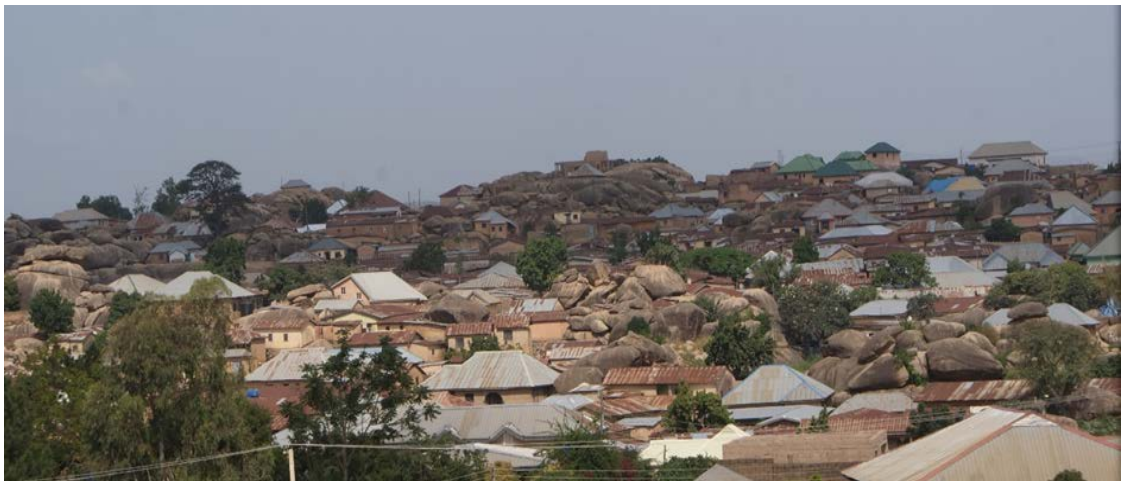


Figure 27 Image showing the unplanned nature of houses in Tudun Wada, Jos, Nigeria

Source: Image taken by the researcher during fieldwork in 2014



Figure 28 Housing in close proximity in Jenta, Jos, Nigeria

Source: Image taken by the researcher during fieldwork in 2014

The majority of housing is compounds – this is a building that has many single rooms, two rooms (a bedroom and a sitting room) or three rooms (two bedrooms and a sitting room) that can accommodate many families. For example a compound can be shared by five different family units, with each family having their rooms but sharing facilities such as toilets and bathrooms, most often such houses have no kitchens.

The areas are unplanned with further observations showing that the buildings are old and closely packed together with no spaces between adjoining buildings such that the roof of one building overlaps the other (see Figure 28). This constitutes a safety risk especially with respect to fire outbreaks. It also presents problems due to the lack of access roads for fire fighting vehicles and waste haulage trucks. The buildings are inferior and mainly made of cement and mud blocks with corrugated iron roofing sheets. However unlike in other low income areas there are few squatter shacks – the structures are permanent (OBS).

Both representatives of PEPSA (IWMP2) and the Ministry of Environment (IWMP1) affirmed that Jenta and Tudun Wada areas are like slums which they described as follows:

“Tudun Wada and Jenta areas are quite old and unplanned settlements, with no spaces, untarred narrow roads, poor electric pole alignment, and lack access roads for SWM vehicles among others” (IWMP2).

“Tudun Wada and Jenta are poorly planned, very unregulated pattern of buildings, people just build anyhow, no access road for our trucks to pass through, not only our trucks, but even the fire brigade and other vehicles cannot pass through to perform their duties, and streets are not provided as people just build anyhow” (IWMP1).

Due to the close proximity of housing very few had yards or gardens. However it was observed that throughout the community in vacant plots or alongside streams some residents had set up small gardens for the production of food such as spinach and tomatoes. For example Figure 29 shows a stream along which residents have set up a garden.

5.2.2 Access to utilities and sanitation

Tudun Wada and Jenta lack safe and secure water and electricity supply. Most households rely exclusively on well water from shallow hand dug wells, with some dependent on stream water or buying water from water vendors – there is no mains water supply. Figures Figure 29 and Figure 30 show examples of streams from which some households depend for domestic water supply, while Figure 31 shows a push cart with water in jerry cans waiting to be sold to households in the study area (OBS).



Figure 29 Stream water in Tudun Wada used for washing and drinking

Source: Image taken by author during fieldwork in 2015



Figure 30 Stray pig eating on waste dumped in the community by stream

Source: Image taken by author during fieldwork in 2014



Figure 31 Water in jerry cans sold by water vendors in Jenta

Source: Image taken by author during fieldwork in 2015

This inadequate water supply affects the level of sanitation of residents in the study area. Stagnant water was seen around some of the houses because of lack of drains for water coming out of their bathroom and toilets which causes the environment to be infested with insects, vectors and pathogens. Some households depend on unreliable power supply from the national grid, or use generators while those who cannot do these use kerosene lamps. Observations (OBS) show that it is very common for the areas to lose power, sometimes for months on end.

It was further seen that residents of both locations keep animals such as dogs, pigs, birds, sheep and goats which often move about freely without restriction which further worsens the sanitary conditions of the study area. The animals upturn and scatter waste that is packed for disposal. The condition of the study areas leads one to assume that these areas have suffered long neglect from government especially in regard to infrastructural development, provision of basic social amenities, and enforcement of development control standards (OBS).

5.2.3 Demographics of residents

Based on questionnaire survey household size ranged from 2 to 15 people with 50.9% of households consisting of 4-6 people, with the average household size being 5.9 (see Table 17). The composition of households in the study area is complex – it is unusual to find a nuclear family living alone and it is common for grandparents, grown up children and extended family to make up a household.

Table 17 Household size distribution based on questionnaire returns

Household Size	Number of participants (sample 678)	Percentage (%)
1	0	0.0
2-4	136	20.0
4-6	345	50.9
>6	197	29.1

Results show that 38% of residents attended secondary school, 32% of the residents have first degree certificates, while 18.6% stopped at the primary school level – this would mean they left education at the age of 10-11 (see Table 18).

Table 18 Educational level of residents based on questionnaire returns

Educational level	Number of participants (sample 678)	Percentage (%)
Primary	126	18.6
Secondary	258	38.0
Graduate	217	32.0
Postgraduate	24	3.5
Other	53	7.8

Table 19 Profession of residents based on questionnaire returns

Profession	Number of participants (sample 678)	Percentage (%)
Unemployed	81	11.9
Artisans	193	28.5
Civil servants	176	26.0
Entrepreneurs	140	20.6
Professionals ²⁸	61	9.0
Retirees	27	4.0

Table 19 presents the profession of residents and confirms that they are mainly made up of artisans²⁹ (28.8%), civil servants (26.0%) and entrepreneurs (20.6%) with 11.9% unemployed. The monthly income levels for households varied significantly with 22.6% earning less than NGN18,000 (£48.78) to 2.9% earning over NGN150,000 (£406.5) (see Table 20). 69.4% could be classified as low income households as defined EFInA (2011) as those who earn NGN50, 000 (£135.5) and below.

Table 20 Households monthly income based on questionnaire returns

Household monthly income (NGN)	Number of participants (sample 678)	Percentage (%)	Category based on EFInA (2011)
<18,000	153	22.6	Low income
18,000 – 50,000	317	46.8	
50,000 – 100,000	143	21.1	Middle/high income
100,000 – 150,000	45	6.6	
>150,000	20	2.9	

²⁸ Professionals are persons engaged or qualified in a profession such as lawyers, doctors, surveyors.

²⁹ Artisans are workers in a skilled trade, especially one that involves making things by hand.

This highlights the complexities of the area with 30.6% of households earning over NGN50, 000 per month. Based on the EFInA (2011) definition these would be classified as middle to high income households.

5.3 SOLID WASTE MANAGEMENT STRUCTURE IN JOS

5.3.1 Role and responsibility of stakeholders

From undertaking the research the main stakeholders involved in SWM in Jos were identified. The key stakeholders are Plateau State Ministry of Environment, PEPSA, *ad hoc* workers, widows, the informal sector and community leaders. Their roles and responsibilities are described in the respective sections below.

5.3.1.1 Plateau State Ministry of Environment

The representative of the Ministry corroborated information from the literature review that in Nigeria environmental issues are overseen by the Federal Ministry of Environment at the national level, State Ministry of Environment at state level, and Environmental Health departments at local government level. The State Ministry of Environment adopt the policies and guidelines concerning SWM from the national government and implement them in the state (IWMP1). Each state is also empowered to make laws that protect the environment within their own jurisdiction. The official stated that the Federal Ministry of Environment organises regular meetings of the National Council on Environment which is an all-inclusive body of environmental stakeholders across Nigeria, and is often attended by all principal administrators from the State Ministries of Environment. The meetings provide a forum for policy and discussion on existing environmental issues as well as offering solutions to some of the problems identified (IWMP1).

The management of solid waste in Jos is the responsibility of the State Ministry of Environment, established in 1999 with eight departments which include the Environmental Health and Sanitation department which is in charge of SWM in the state. The main goal of the Ministry is to preserve and protect the environment from both natural and man-made disasters and to ensure a clean and healthy environment. The Commissioner for Environment heads the Ministry assisted by the Permanent Secretary (IWMP1).

Responsibilities of the State Ministry of Environment include implementing relevant national and state legislation, establishing data on SWM, providing land for siting SWM facilities, and providing logistical support including finance to facilitate private sector participation. The State Ministry of Environment are required to inform the State Government about the Ministry's financial and resource requirements on environmental matters. IWMP1 gave the examples of if the Ministry needed to acquire land for the disposal of waste, purchase more public waste containers, or procure more trucks for waste collection they would submit these

requests. If the State Government accepts and releases these funds, then PEPSA (see Chapter 5.3.1.2) would undertake the work under the supervision of the Ministry of Environment.

Whilst the Ministry has a clear range of responsibilities in reality some of these are often neglected due to the appointment of politicians to head key management positions and that could affect the management of solid waste in the state. For example interviewees stated that:

“The Ministry of Environment is usually led by the Commissioner for Environment who is politically appointed and could be a novice who does not know the technical definition of the environment not to talk of the importance of safeguarding it. Policies could be implemented based on political bias, sentiments, and the rest of them like who gave us the highest number of votes, is who we would want to appoint, not really on professionalism. As such the will power to execute programmes that have direct bearing to the people would not be there, hence the management of waste would encounter some setbacks”. (IWMP1)

“There are always changes going on like in the Ministry of Environment for instance this year alone they have changed three commissioners to satisfy political demands, and you know once a commissioner is removed their plans go with them, so how can progress be achieved with such frequent changes ?”. (IWMP2)

5.3.1.2 PEPSA and Environmental Health Officers

It was confirmed by the representatives of the State Ministry of Environment (IWMP1) and PEPSA (IWMP2) that before the establishment of PEPSA, management of waste in Jos had passed through various organisations. Initially the Jos Metropolitan Development Board was responsible for waste management. They were established in 1974 and lasted until 1984 after which the military through a coup took over governance and introduced Plateau State Capital Development Board (PSCDB). PSCDB metamorphosed to a task force on Environmental Sanitation, then to Plateau State Waste Management Agency (PSWMA) which finally disbanded to the present Plateau Environmental Protection and Sanitation Agency (PEPSA). The aforementioned organisations undertook the same function of managing waste in the state at one stage from 1974 until 2000 when PEPSA was established. Jos Metropolitan Development Board however has continued to carry on the role of infrastructure development and maintenance in the state thereby indirectly assisting PEPSA in the management of waste in Jos.

PEPSA was established as an agency under the State Ministry of Environment in 2000 by an act of the Plateau State Parliament. It was empowered to protect and improve the environment (water, air and land, forest and wildlife) by ensuring the delivery of an efficient and effective waste management system in the state. PEPSA is led by a General Manager who is accountable to the Director of Environmental

Health and Sanitation in the Ministry of Environment. The representative of PEPSA stated during interview that they are exclusively responsible for managing waste in the state – essentially they are the delivery body of the Ministry of Environment. IWMP1 listed the responsibilities of PEPSA to include the daily collection, transportation and final disposal of waste, sanitary inspection of premises (residential, commercial, industrial, institutions and organisations), and the implementation/enforcement of all sanitary laws. In addition it is responsible for public education on solid waste management. Despite the responsibility of SWM vested on PEPSA it still operates as a unit in the Ministry of Environment and does not have financial autonomy (IWMP1). So essentially if PEPSA need any resources, their request would initially go to the State Ministry of Environment, who if they approve the request in turn pass this onto the State Government for consideration.

PEPSA has 97 permanent staff out of which 92 are Environmental Health Officers (EHOs). EHOs are also referred to as Sanitary Inspectors (SI) and their role is mainly to monitor the management of waste from sources of generation through to disposal. They provide technical advice to Plateau State Government and enforce laws and regulations on public health standards. EHOs educate households and communities on sanitation and hygiene matters in order to preserve the health and well-being of the public and the environment (IWMP1/ IWMP2).

5.3.1.3 Ad hoc staff

Whilst it is PEPSA's responsibility to undertake waste collection and disposal, this function is conducted by ad hoc staff. These are typically less privileged members of society employed by Plateau State Ministry of Environment on a contract basis to ensure a clean environment. They are 1,500 in number and in addition to collecting waste their responsibilities include clearing grass and shrubs within Jos (IWMP2).

It is important to note that no waste collection is undertaken directly from households and residents are required to take waste to designated collection points:

“We [sic] visit streets not homes where households are expected to bring their waste to the waste collection centre's (public waste containers) for disposal, and it is our responsibility (PEPSA) to remove the waste from the collection centre's to designated dumpsites far away from the city centre”. (IWMP2)

Ad hoc crews collect and shovel up this waste (see Figure 32) and take it to dumpsites, often they are led by a PEPSA EHO. They also clear waste indiscriminately dumped in communities (see Figure 33). As can be seen there is a lack of uniform and personal protective equipment. As can be seen collection is rudimentary with crews making the most of the limited resources they have. Waste is also transported in open vehicles, which means it can be blown away during collection (OBS).



Figure 32 Ad hoc male staff shovelling waste into an open truck at Jishe, Jos
Source: Image taken by author during fieldwork in 2015



Figure 33 Ad hoc male staff clearing waste from open dumps on the street
Source: Image taken by author during fieldwork in 2015

5.3.1.4 Widows

The term widow in the context of this research is the same as the wider meaning: women who have lost their spouse by death and not married again. They are employed by the Plateau State Government Ministry of Environment as street sweepers in observance of the “Keep Jos Clean Programme” of the State Government. Widows sweep public spaces and gather waste in one place for collection. The State Government introduced this programme and employs 3,500 widows in order to provide them with financial support to take care of their children while providing the service of keeping the streets of Jos clean. They regularly sweep the streets and other public spaces to keep them clean and free from litter and rubbish. They are also responsible for clearing drains and gutters in order to minimise flooding after heavy rains (IWMP1/IWMP2).

Their services had helped in addressing the problem of poor sanitation in the state, but because of irregular payment of salaries they sometimes embark on strikes leading to accumulation of heaps of waste and littering in the city centre.

To avoid all doubt, confusingly the widows and ad hoc male staff are independent of PEPSA, they are employed by the State Ministry of Environment.

5.3.1.5 The informal sector

The informal sector is also known as the “*grey economy*”³⁰ (Henshaw, 2017), and it makes up about 80% of Nigeria’s population (NHP, 2006). The informal sector is made up of two types (Onwe, 2013) – traditional informal sector and modern informal sector. The category of reference in this research is the traditional informal sector. The traditional informal sector is on the increase in LEDCs including Nigeria, and provides employment and income for the poor. The traditional informal sector refers to those workers who are self employed, or who work for those who are self employed. People who earn a living through self employment in most cases are not on payrolls, hence are not taxed. Many traditional informal sector activities are unrecognised, unrecorded, unprotected, unregulated and are in unsecured places (Onwe, 2013). They are largely characterized by low level entries, small-scale operations, skills acquired outside of formal education, and labour-intensive methods of production. They are also defined according to different categories in terms of activity, employment, location of actors, and income and employment enhancing potential. Examples of traditional informal sector include petty traders, small-scale producers, and a variety of casual jobs. In the context of this research, the traditional informal sector encompasses waste pickers or scavengers, recycling entrepreneurs and waste suppliers/dealers.

This research identified numerous people involved in collecting, sorting and reprocessing materials for reuse and recycling in the study area. This included a recycling entrepreneur (IIS1) who buys and sells recovered materials such as plastics, metals, papers and a host of others, and a pot maker (IIS2) making house wares from scrap metal. These were both interviewed and more information on their activities and the reuse and recycling activity in Jos is presented in 5.4.9.1.

5.3.1.6 Community leaders

The representatives of academia (IA1) and the Ministry of Environment (IWMP1) stated that in pre-colonial days when there was not much development, sanitary inspectors used to work with the Native Authority³¹ to enforce sanitation laws. During this time sanitary inspectors would go around and inspect houses, drains, and communities, and whoever was found wanting in terms of poor sanitation was penalized.

³⁰ Grey economy is the part of an economy that is neither taxed, nor monitored by any form of government.

³¹ During pre-colonial and colonial times the chief was referred to as the Native Authority.

In post-colonial Nigeria, chiefs continue to play an important role in society. A chief is an individual that has been appointed to a traditional position of authority by their community and confirmed by the State Governor. They are a direct member of the government in the state, and in Nigeria a chief commands respect from their people and have considerable influence on them. Responsibilities include being the chief executives of their localities which means that it is through them that government decisions can be enforced in the neighbourhood. They are a good link between the people and government, assist in community developmental activities, education, and awareness campaigns and bringing people together.

Nigeria is divided into wards of approximately 10,000 people. These wards collectively make up districts and local government areas. Ward heads essentially replicate the role of chiefs in local communities. They are patrons of community organizations including community development associations and youth organisations. They work hand in hand with chiefs to assist government in improving the situation within their communities. As explained in Chapter 4.2.2.3 ward heads are gate keepers and assisted in facilitating fieldwork for this study.

Both chiefs and ward heads could have an important role to play in influencing the behaviour in their communities towards waste (IA1/IWMP1).

5.4 SOLID WASTE MANAGEMENT IN LOW INCOME AREAS OF JOS

This section covers SWM practices in Jos and the low income areas of Jenta and Tudun Wada. The results are synthesised from the mixed methods applied. The section covers data on the levels of waste arisings, funding of services, and the collection and disposal system. Challenges are also highlight that impact on the delivery of an effective waste management system.

5.4.1 Data on the levels of waste generation

A gap identified in the literature review was reliable data on the levels of waste being generated. Interviews with both the representatives of the Ministry of Environment (IWMP1) and PEPSA (IWMP2) confirmed that there was a poor understanding on the levels of waste being generated in Jos:

“A study was undertaken by PEPSA funded by UN Habitat in 2007. The study was an analysis of solid waste generation and composition in Jos Bukuru metropolis, but the study could not establish the volume of waste generated in the city, it established the composition and percentages of the different categories of waste generated from residential areas, market places, and commercial areas. It is my expectation that one day somebody or a Non-Governmental Organisation (NGO) would help do that for the government”. (IWMP1)

“Records show that research has been carried out by PEPSA for UN Habitat on waste categories in residential and commercial areas of Jos metropolis, but there are no publications to show of such works done. I believe the consistent changes in the administration of PEPSA and the Ministry of Environment is the reason why we have nothing to show for all works done. This is the situation we [sic] find ourselves”. (IWMP2)

In Jos both stakeholders (IWMP1 and IWMP2) attributed the estimated increases in household waste generation to increases in population and economic activities being undertaken at household level.

5.4.2 Funding of the waste management service

As interviewees explained households in Jos do not contribute directly towards the cost of the waste management service:

“Currently no client pays for any waste collection service, we [sic] are doing it as a social service, where all residents (high, middle, and low income) do not pay any money to have their waste collected”. (IWMP2)

Participating focus group members stated that there was no specific payment for solid waste collection. A participant (FGDJ1 004) observed that even areas where public waste containers are provided, no payments are made. Results from the questionnaire survey confirm that all participants do not pay for waste collection services.

Members of the public pay a tax of only NGN50 (12 pence) per month to the Plateau State Internal Revenue Service (PSIRS) who are responsible for collecting all forms of taxes within its jurisdiction. As confirmed by the PEPSA representative this is meant to fund waste and other services:

“These people (members of the public) pay a tax of just NGN50 only per month and they want government to evacuate their waste daily for 365 days in a year, they want government to provide them with light, water, roads, and hospital, and it is this NGN50 that covers for the provision of all these things”. (IWMP2)

It should be noted that this is not the only source of funding for the State Government – it receives a monthly allocation from the Federal Government. The tax described above helps to complement the allocated funds.

5.4.3 Storage of waste

Most households in Jenta and Tudun Wada were observed to have waste storage containers including buckets made from plastic, metal, and raffia (see Figure 34).



Figure 34 Examples of containers used for waste storage
 Source: Images taken by author during fieldwork in 2015

These containers often did not have covers or lids preventing vermin from getting to the waste. The containers are either kept in the kitchen or at the backyard. Householders use these containers to transport waste to public waste containers (OBS). Results from questionnaire (see Table 21) showed that 46.5% use plastic buckets, 34.5% used polythene bags, 14.7% used metal buckets, and the remaining 4.1% used baskets to store and transport their waste.

Table 21 Waste container used based on questionnaire returns

Type of waste container	Number of people (sample 678)	Percentage (%)
Plastic bucket	315	46.5
Polythene bags	235	34.5
Metal bucket	100	14.7
Basket	28	4.1

The issue of waste storage was discussed in focus groups. Some participants (FGDT2 001, 005, 009) stated that they did not have rigid waste storage containers and they would normally collect waste from their household using any plastic bag which they would then burn behind their house. During the rainy season they would throw waste into a stream allowing the water to carry the waste away.

A participant (FGDJ1 003) stated that sharing a waste storage container in their compound was a big problem because other people in the compound would dump waste of any kind including dog faeces, dead chickens, or chicken litter into the waste container, which if not disposed of immediately would smell and attract flies and vermin. A further issue raised was taking responsibility for emptying the communal bins and taking them to the public waste containers. During observations and talking to community members it was also indicated that some compounds in Jos previously had used old metallic drums to store waste. In this situation the waste was burnt in situ since it was difficult to move such a container. Due to these conflicts it is common practice for households who live in compounds to manage their own waste only and not to have a central bin.

It was observed that the containers households used were often in poor condition making them hard to carry waste to the public waste containers. Most members of the focus group discussion lamented that government was not providing households with waste storage containers, and appealed that government should look into it and provide households with appropriate containers for storing and transporting the waste. They stated that government used to provide them with plastic bags to dispose their waste. This was corroborated by the PEPSA official who explained an initiative where residents were given free polythene bags to put waste in for storage and transportation to the public waste containers. However, residents discovered that the bags could be used to preserve and store foods like beans and maize, hence they sold them for NGN100 (21 pence) each at open local markets. Due to this PEPSA stopped supplying bags.

5.4.4 Waste collection in Jos

As set out in Chapter 5.3.1.2 the collection of waste in Jos is the responsibility of PEPSA. Observations revealed that Jos was divided into sections in order to make waste collection easy and effective. This was confirmed during the interview with PEPSA:

“Jos Bukuru metropolis is divided into zones for easy realization of waste collection and management. There were up to 25 zones for waste collection in Jos Bukuru metropolis in the past, but because of the State Governments’ inability to provide trucks for all the 25 zones, PEPSA had to collapse the 25 zones into 4 zones which are still currently in operation, and these zones are Jos central 1, Jos central 2, Bukuru zone, Abattoir Zone. These zones are helping us to manage waste in Jos Bukuru metropolis”. (IWMP2)

Figure 35 shows the distribution of the public waste containers in the four zones of Jos.

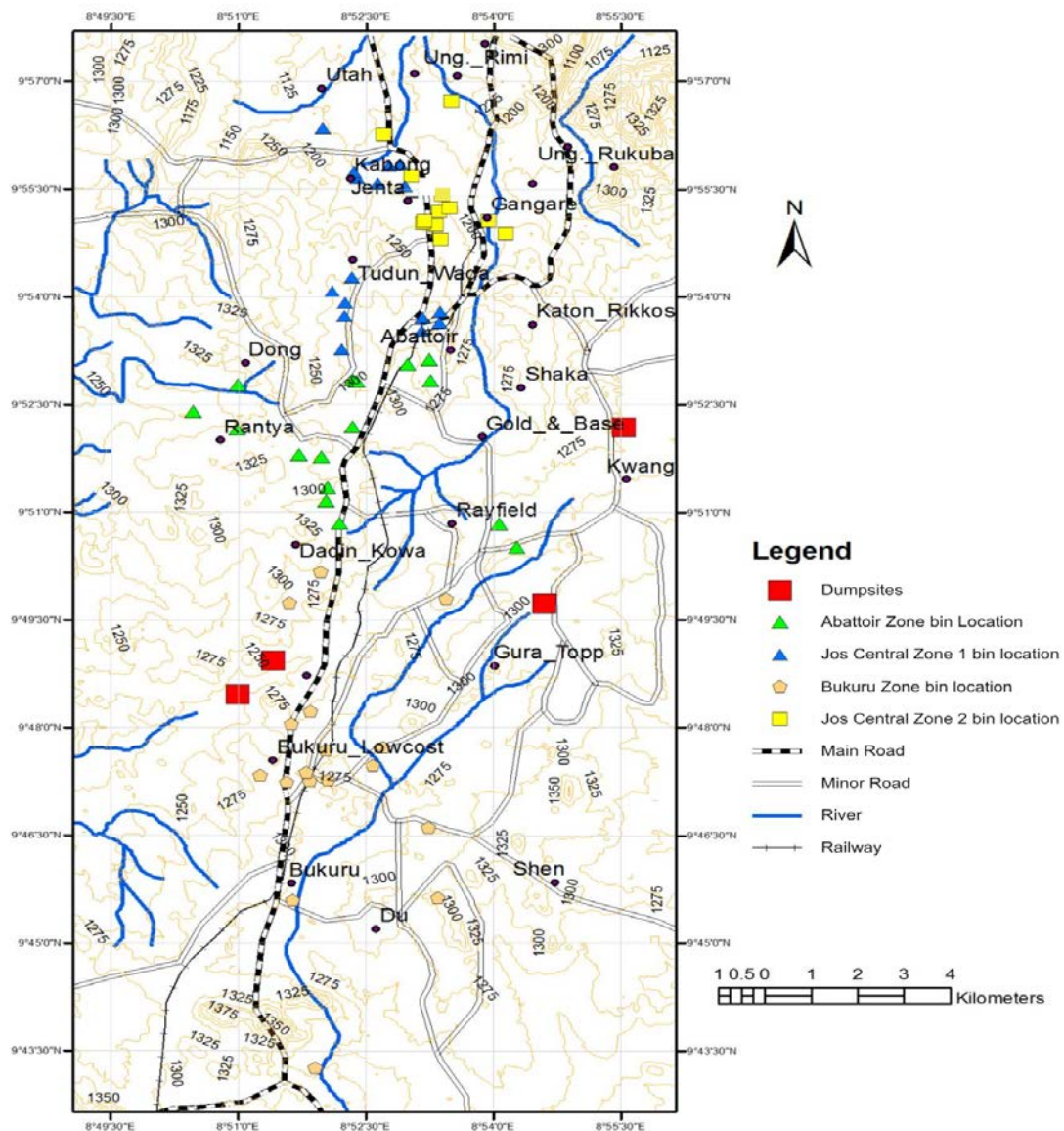


Figure 35 Distribution of public waste containers in the four zones of Jos and the location of dumpsites in use at the time of fieldwork

Source: Figure developed by author based on data collected during fieldwork

As explained in Chapter 4.3.3 the author went out with the collection crews for the different zones and recorded the GPS coordinates to allow the locations to be mapped. The four zones comprised of Jos Central 1 where 15 public waste containers were located, Jos Central 2 which had 12 public waste containers, Abattoir Zone had 16 public waste containers, and Bukuru Zone with 16 public waste containers (OBS). In total 59 public waste containers were seen in Jos at the time of this study and this was corroborated by PEPSA and the Ministry of Environment. Figure 36 shows an example of a typical public waste container – a roll on/off container with a typical capacity of 10-15 cubic meters. This container is usually picked up by a truck which positions itself and hooks the metal handle of the bin then rolls it on the truck until it is comfortably and firmly seated, and then it is

hailed away for disposal. At the disposal site the truck rolls off the waste bin and empties it then brings back the container to its location to drop (OBS).



Figure 36 Example of a public waste container filled to capacity at Tafawa Balewa Street

Source: Image taken by author during fieldwork in 2014

The collection service serves all households of Jos as long as the waste is deposited in a public waste container. Taking waste from home to the container was observed to be mainly the responsibility of children. However questionnaires did not agree with that finding with responses showing that 65.0% of women and 34.5% children were responsible for managing waste from households – for only 0.5% of households were men responsible. Small shop owners engage the services of ‘yan barrow’ (wheel barrow pushers) to convey their waste to these containers (OBS/IWMP2).

Larger businesses and institutions need to make their own arrangements – this would involve paying a private company who would then dispose of the waste. It should be noted that these private companies are not waste management specialists and typically builders or businesses that have truck who collect and dispose of waste a side line (OBS/IWMP2).

Although PEPSA is mandated to manage waste within the whole of Jos, observations indicated that their presence and service did not cover the whole metropolis especially the low income areas. In general the results collated from all methods showed that the collection service in Jos was very poor with public waste containers overflowing and waste dumped throughout the community.

Observations showed it was standard for waste to be dumped in public spaces in Tudun Wada and Jenta and not collected (see Figures Figure 37Figure 38). Waste was often left unattended for weeks or even months. Collection of waste from the public waste containers was expected to be carried out twice a week by PEPSA (IWMP2), but this was seldom done.



Figure 37 Uncollected waste around public waste containers in Jos

Source: Images taken by author during fieldwork in 2014



Figure 38 Waste dumped around Tudun Wada market area (left) and heaps of waste at a roadside in Jenta (right)

Source: Images taken by author during fieldwork in 2014

In respect to the waste collection system interviewees and focus group members expressed their dissatisfaction with the service:

“A major problem that Jos has is that it doesn’t have an organized household waste collection system, like in other countries where they are provided with waste bins or waste bags, public waste bins and they are even expected to sort out their waste before government comes to collect from their doorsteps and take it away for proper disposal. However here in Jos we [sic] don’t have that kind of system at households, especially in low income areas where there is no proper access to organized waste collection system because the houses are just built anyhow”. (IA1)

Focus group members in Tudun Wada (FGDT1 001, 002) and (FGDT2 009) complained that there is no waste collection service leaving residents to manage their waste by themselves. One of the participants stated that:

“I would say waste collection both in the city and Tudun Wada is poor, because even in the city where government has good roads and waste collection containers, there is still waste littered all over around the waste bins because the bins are always filled to capacity without being collected”.

FGDT1 002 observed that public waste containers placed by government for waste collection in public places like schools, markets, junctions are always filled up to the rim, and often overflowing being left unattended by government for weeks. Hence the environment was looking very dirty.

Questionnaire participants were asked to rate the quality of waste collection service being offered. Table 22 presents the result of responses from the participants. Unsurprisingly 67.8% rated the service as very poor and 26.3% poor. Only 1.9% stated they were satisfied with the services they received.

Table 22 Quality of waste collection service

Quality of waste collection service	Number of participants (sample 678)	Percentage (%)
Very poor	460	67.8
Poor	178	26.3
Satisfied	13	1.9
Don't know	27	4.0

The results contain a variety of causes leading to the inadequacies in the waste collection system. These are considered below.

5.4.4.1 Poor governance and funding

A common issue raised in interviews was poor governance and inadequate funding having a direct impact on front line services:

“All problems of SWM are hinged on lack of finance; even the regular workers are not being paid regularly in Plateau State”. (IA1)

“We [sic] make budget proposals yearly; we want to buy trucks, public waste bins, and septic tank emptier, accessible vans and so on. The governor signs and says this is an approved budget, but then no money is released because of lack of funds and this happens often, it is like there is no budget discipline in government as the politicians just divert the money the way they feel like leaving nothing behind for service to the populace. How possible can SWM be without money to finance it?”. (IWMP1)

“I told you today we [sic] worked with only 5 trucks and it is because of lack of funds to put those broken down vehicles into order. For example there are times when N2000 (£5.70) will keep a vehicle down for weeks or months without working. A vehicle which has been down for about a month now just got repaired yesterday with the sum of N1800 (£5.10) and we had to remove the kick starter of one vehicle that stopped working last week to put in this one that we used today because there are no funds to buy a new one”. (IWMP2)

“Sometimes the PLSG does not buy the type of trucks that PEPSA recommends, which are standard refuse collection waste trucks, but instead government gives

contracts to their associates to supply waste trucks in order to empower them, and in the process they supply ordinary open body tippers and PEPSA has no choice but to accept it. Using the open body tipper trucks without covering, during the transportation of waste it makes it easy for wind to blow and scatter the waste which is quite risky”. (IWMP1)

“SWM can be greatly enhanced if government lives up to its responsibility by making available more funds”. (IWMP1)

“If all provisions are made financially, logistically, and otherwise we [sic] will involve whoever is supposed to be involved for the improvement of this activity (SWM) in the state”. (IWMP2)

“Nigerian politics and governance can be likened to a criminal enterprise for advancing and promoting self-interest over public interest, that is why the politicians in government just divert public money the way they feel like for their selfish interest and nothing happens”. (IA1)

5.4.4.2 Lack of collection vehicles

Directly linked to funding was the lack of bins and collection vehicles. Table 23 presents data from PEPSA on the fleet available.

Table 23 Municipal waste collection and transportation vehicles owned by PEPSA

Type of vehicle	Number in existence	Number functioning	% functioning
Tipper	4	3	75%
Roll on Roll- off Skip vehicles	4	3	75%
Tractors	2	1	50%
Automatic compactor trucks	4	1	25%
Side loader trucks	2	2	100%
Pail loader	1	0	0%
Back hoe/bucket loader	1	1	100%
Total	18	11	61%

Source: Data from document supplied by PEPSA (2013).

In total they only have 18 vehicles of which 61% are functional. 4 of PEPSA vehicles are compactors however the composition of waste from Jos is highly organic, so the compaction vehicle is disadvantaged in terms of reducing the density of waste (Imam et al. 2008). It is clear that the fleet is too small to serve Jos efficiently and effectively.

IWMP2 acknowledged that PEPSA lacked equipment for managing solid waste:

“Jos Bukuru metropolis alone needs not less than 50 trucks, but at the moment there are only 18. However as at today the 18th of December 2014 only 9 trucks were functional (5 trucks and 4 roll on roll off), and a pail loader. Roll on roll off (hook loaders) are special vehicles which are ideal for waste transfer and general waste disposal. Each of these trucks uses 2 fork shovels, 2 shovels and a digger which are the requirements per a single vehicle but these are hardly available. PEPSA is expected to have a bulldozer a D7D or preferably a D9 bulldozer with a low bed, but it doesn't have. A bulldozer is a requirement because anytime waste is disposed on a dumpsite, the D9 rolls this waste into the pit and drives over it so that it would compact the waste while continuing to use the facility. About 124 public waste bins are required to cover Jos Bukuru metropolis, but currently only 64 public waste bins are available which is absolutely insufficient to cover the area. How then do you expect PEPSA to serve Jos metropolis with such limited equipment in operation? I tell you if PEPSA were to be given 50 functional trucks for Jos Bukuru metropolis today, PEPSA will be scavenging or hunting for waste in the city”. (IWMP2)

The representative of PEPSA mentioned that each roll on roll off truck was expected to empty at least 5 public waste containers per day. Based upon the assumption of 3 roll on/off trucks being operational, 118 required pickups per week (59 containers x 2 pickups) and working over 7 days, this seems viable. However as observed this is inadequate as public waste containers were overflowing, therefore more containers or more frequent collections would be needed. Moreover problems arise such as strikes, vehicles break down or lack of money to maintain or fuel trucks.

5.4.4.3 Number and location of public waste containers

The lack of public waste bins was highlighted as being an issue:

“There are inadequate public waste collection bins in use within the whole of Jos Bukuru metropolis, as there were only 64 bins instead of 124 waste bins that were initially planned for Jos Bukuru metropolis”. (IWMP2)

Figure 35 shows the location 59 public waste collection containers as mapped by the author as against the 64 mentioned by the PEPSA representative. A problem highlighted was that often containers would be moved to different locations for political reasons:

“I can give you[sic] the locations of most of the 64 public waste bins sited in Jos Bukuru metropolis based on paper work, but if you go there you might discover that they are not there, they may have been relocated because Commissioner “A” may not have been opportune to be in the Ministry before their siting, but today he is posted to the Ministry, so he would want to use his power being the official head of the Ministry of Environment to provide for his people. The commissioner would then order the removal of a public waste bin from point A to point C, and most times when it is removed, the drivers do not know the new location. These drivers are most

times ad hoc drivers because when they get better jobs they move on and a new man comes on board who would give him the 'paper' locations, meanwhile the public waste bins has been moved. These locations may not even be known to the PEPSA officer in charge but only to the Commissioner of Environment and his people. As a result the waste bin may never be emptied, but the waste in it would be burnt from time to time. How then do you expect the best from PEPSA when there is interference in their duties?" (IWMP2)

"If you go to some hotels in Jos city today you would see some of PEPSA's public waste bins right inside the hotel premises, at their back yards. These waste bins were illegally removed from some other public location to the present location in the hotel. How would PEPSA get to know the where about of such public waste bins if not told? Such abuse of office is one of the reasons why PEPSA is not able to function effectively as you can see". (IWMP2)

As presented in Figure 35 the distribution of the public waste containers in the zones is not equal, as two zones had 16 public waste containers each, one zone had 15 and the other had 12 public waste containers. The 59 public waste collection containers shared by the four zones in Jos is grossly inadequate for a population estimated to be about 1.3 million people. Observations show that only three public waste containers were located in the specific study area, one around the market area, and another at Nigerian Mining Corporation (NMC) junction in Tudun Wada, while the only one in Jenta is located at Alheri Private School. With only three containers to cater for the waste of at least 5,895 households it is unsurprising that residents are dissatisfied with the service and indiscriminately dump their waste.

The author observed that some household members were aware of the location of the public waste containers but because of the distance they had to travel to deposit waste, they would opt to manage their waste in the most convenient way to them:

"Managing waste in my household is difficult, because there is no public waste collection bins nearby so it leaves us with a big burden about where to dispose our waste". (FGDT1 008)

Another member added: *"In my compound we (all tenants) used to collect waste together in a drum, but because government does not come to collect the waste from households, neither does government provide waste collection points or centres around, individual families now prefer to collect their own waste and dispose of it". (FGDT1 004)*

It is possible that the distance of the public waste containers from households discouraged residents from taking their waste to the collection points. Some focus group discussion members mentioned that they have to walk 500 metres to 1km in order to access the containers.

Focus group members decried that government was not making enough provision for public waste collection containers in communities. The representative of the tertiary institutions argued that there should be more collection points:

“Ideally there should be public waste dumps within communities who don’t have access to public waste bins, where members of the public could be encouraged to dump their waste so that vehicles could come to collect the waste from there to the official dumpsites, but such are non-existent in Jos. As a result littering of waste in low income communities is common” (IA1).

Observation and information collected from stakeholders reveal the significance of placing containers in convenient and accessible locations for all households as this can minimise littering as well as encourage residents to dispose waste correctly.

It was observed that some public waste containers had been damaged and needed repair (see Figure 39). Though damage is not obvious from the image, IWMP2 had pointed out that a part of the container which hooks onto the roll on roll off truck was broken making it non-functional.



Figure 39 A public waste container waiting to be repaired

Source: Image taken by author during fieldwork in 2014

5.4.4.4 Theft

As observed there are also smaller litter bins throughout Jos. Figure 40 shows typical examples of the smaller waste and side walk bins in situ. However numbers of these bins have been diminished due to theft:

“There are those other smaller public waste collection bins located within Jos Bukuru metropolis, they were about 300 of them, but if you go round now you will not get up to 100 of them available. Informal recyclers have stolen them and sold to the local black smith to produce hoes for farming and gardening”. (IWMP2)

“Jos –Bukuru metropolis had over 2000 walk side bins, but now you cannot see any because they have all vanished in to recycling plants”. (IWMP2)



Figure 40 Example of the smaller waste and sidewalk bins being used in Jos

Source: Images taken by author during fieldwork in 2014

5.4.4.5 Lack of adequate staffing

As well as physical resources the results suggest there is a lack of adequate staffing – this links back to poor governance and funding covered in Chapter 5.4.4.1. Issues were raised regarding the lack of Environmental Health Officers (EHOs):

“Politicians would prefer to go and build a clinic in the village which is something tangible they can hold and point to say we did this and that, instead of employing more EHOs to go and give good doses of health education from house to house , such as this is what you should do, you should cover your wells, make aprons around your wells, don’t leave containers of water around your compounds it will breed mosquitoes, and things like that which is what EHO’s are supposed to do. However nobody is willing to employ more EHO’s because at the end of the day if the politicians say our achievement is that we employed more EHO’s the people may not see it as an achievement. Hence the politicians would prefer to build a gigantic clinic without provision for medical personnel and drugs, and people will see it and say hey they have done something tangible”. (IWMP1)

“The staffing capacity of the Ministry of Environment is not adequate because there are a lot of ad hoc staff or street cleaners but the technical people like the EHO’s or sanitary inspectors are quite few”. (IWMP1)

“At the moment there is an embargo on employment and it is yet to be lifted, hence as few as the EHOs are we [sic] have to continue to manage them since government is not employing for now”. (IWMP1)

“The numbers of our EHO’s are inadequate with only 92 of them taking charge of about 1.3 million people in Jos Bukuru metropolis”. (IWMP2)

“The responsibilities of EHO’s are much, they are expected to go from house to house for sanitary inspection and public education awareness for the whole of the populace, they work from 6am to 6pm and when there is an overflow of waste within the city centre they call for intervention and can work longer”. (IWMP2)

“The official implored government to employ more EHO’s so as to send them to low income areas for public educate awareness in order to curtail/prevent the outbreak of communicable diseases that may arise from indiscriminate dumping of waste”. (IWMP2)

“I advise that more hands or more trained professionals (EHOs) should be employed, since every year professionals are retiring and with globalization the numbers of people moving into the city are increasing likewise waste generation”. (IWMP1)

“To improve household waste management in Jos I [sic] think government needs to improve on the welfare of the few professionals (EHO’s) in the field, you see once the professionals are motivated they will live up to expectation, motivation is the key thing. In addition government should employ more professionals as we [sic] need a reasonable number of professionals, so as to ensure households receive adequate information on SWM”. (IWMP2)

Moreover stakeholders felt there needed to be more front line staff undertaking collections:

“Manpower is another problem because the number of evacuators is not enough we are lacking”. (IWMP2)

Apart from employing more staff to manage solid waste in the municipality, the stakeholders specified that training of the solid waste workers was paramount to a successful solid waste management system plus the appointment of appropriate staff:

“For quite a long time now there has not been any training opportunities for solid waste workers on sustainable methods of municipal SWM, it is high time for Plateau State to introduce such in order to improve the management of waste in the state”. (IWMP1)

“The professional solid waste workers need to receive more training because as we move forward (advancement) things are changing so the scope of professional knowledge needs to be improved as well”. (IWMP2)

“Government should discourage the appointment of non-professionals to head the waste management agencies, for example in this state since the inception of the agency in 2000, this is the first time we [PEPSA] are having a professional appointed as a General Manager of PEPSA. The professional got appointed as a GM in 2013, and one year after things are beginning to improve”. (IWMP2)

Concerns were also raised regarding the resources available to staff when handling waste. IWMP2 explained that the store room for collection staff was expected to be stacked with all required equipment for the proper management of waste including personal protective clothing, boots, goggles, ear plugs, helmets, chemicals,

detergents, nose masks, and gloves. These things according to the officer are a mandatory requirement based on regulation S.1.15 of 1991³² to be provided either daily (face masks) or weekly, because they are important to protect the safety of workers, but most often they are not available.

The officer specified that waste collectors should be given a tin of milk after completing each collection round as it reduces the effect of inhaled dust and fumes, but this is not done and milk is never provided. IWMP2 cited only in exceptional circumstances were the required resources purchased to protect staff. The official cited the example of a bomb blast that occurred at Terminus on December 11th 2014, it was only after this incident that the State Government through the Ministry of Environment bought nose masks for PEPSA staff to use and evacuate the dead bodies.

5.4.5 Waste management behaviour of households in Jenta and Tudun Wada

As explained in Chapter 5.4.4 waste collection system in Jos involves households taking waste to public waste collection containers however the system is inadequate which means bins are overflowing and the public often find alternative ways of managing their waste. Table 24 presents the results from the questionnaire of residents on the main way in which they dispose of waste.

Table 24 Responses to the question of the main way the resident disposes of waste

Way of disposing of waste	Number of participants (sample 678)	Percentage (%)
Burning at backyard	305	45.0
Throwing in water bodies	211	31.1
Takes to public waste container	149	22.0
Throwing in to the pit	13	1.9

Only 22% took their waste to the public waste containers with 45% of residents burning their own waste and 31.1% throwing their waste into water bodies, with 1.9% disposing their waste into shallow pits dug around the house. Under Plateau State Environmental Law (2003) burning waste is unlawful and problematic having a detrimental impact on public health and the environment (see Chapter 2.2.7.1 for literature on the impacts of burning of waste). Unfortunately this is one of the commonest ways of disposing waste by households in the area.

The researcher observed indiscriminate waste dumps behind houses or within communities as a result of people disposing of their waste. This was corroborated in focus groups:

³² Regulation S.1.15 of 1991: National Environmental Protection (Management of solid and hazardous wastes).

“I have personally quarrelled and fought with some members of my community for coming out at night to throw their waste behind my house. I had to monitor to personally see who throws the waste and at what time. My household have suffered the smell from the dump and flies around the house so we decided to clear the waste and put a signpost directing people not to dump waste there anymore, but the signpost was ignored and dumping continued. I personally dump waste far away from my house using the community waste bin, but some other people would not do that, they prefer to inconvenience others by throwing waste in the dark corners within the community. Look at how my neighbourhood is dirty and it smells and I cannot even open my windows”. (FGDJ1 007)

Another participant observed that:

“It is now rather a usual practice or tradition in Tudun Wada for residents to wake up to their daily activities and find waste littering the streets because of poor handling by children who are sent to dispose the garbage at night or early hours of the morning”. (FGDT2 002)

Observations show that using children to dispose of waste increases the level of littering in communities as for some it is too much effort to take waste to the collection points and therefore dump waste where it is convenient. It is interesting to note that members of the community know that dumping and littering is not good, and choose to do that at night when no one sees them. From the observations and focus groups it is interesting to note that people who live directly near the streams or indiscriminate waste dumps do not dispose solid waste into them and they also try to prevent local residents from doing so due to health implications.

Questionnaire participants were asked for the main reason why they disposed of waste in the manner stated. Table 25 shows that 49.3% lacked facilities, 22.6% for convenience, while 22.0% said it was the proper way of disposing waste³³ with 3.8% of them stating lack of awareness and the remaining 2.4% stated lack of penalty.

Table 25 Questionnaire responses to the reason why they manage waste in the manner stated

Reason for waste disposal	Number of participants (sample 678)	Percentage (%)
Lack of facilities	334	49.3
For convenience	153	22.6
Proper way of disposing waste	149	22.0
Lack of awareness	26	3.8
Lack of penalty	16	2.4

³³ i.e. they took it to the public waste container.

Interviews highlighted some other interesting reasons for behaviour. The PEPSA representative reported that a resident of Tudun Wada told a street cleaner that they (residents of Tudun Wada) litter so that the cleaner can continue to earn their salary through sweeping the street. The PEPSA official also highlighted differences in behaviour between residents of Government Reserved Areas (GRAs) who are high income resident, and that of those in the low income areas. They stated that residents in GRAs contain their waste in bags and take waste to the public waste containers supplied hence EHOs and street cleaners don't have problems with those areas (IWMP2). The official put this down to greater awareness of sanitation issues amongst the high income group. This was corroborated by IA1 who felt low income residents lack of understanding of the need to protect the environment due to the lack of public education and shortage of EHOs to sensitize them on the dangers of indiscriminate disposal.

IA1 and some focus group members also believe that the attitude of low income residents is poor due to weak regulations and non-enforcement of public health legislations and bye laws. However only 2.4% of questionnaire respondents stated that the main way in which they managed waste was due to the lack of penalties and enforcement.

5.4.6 Waste disposal

Both representatives of the Ministry of Environment and PEPSA confirmed that there is no sanitary landfill in Jos, and the final disposal sites are mostly uncontrolled open dumps. They emphasized that many of these sites exist because of a lack of permanent disposal site:

"I can tell you for now there is no sanitary landfill in Jos, so we [sic] find some other ways of disposing waste. For example Jos is full of burrow pits because of tin mining activities of the past, so there are lots of waste lands, what we [sic] normally do is to solicit with land owners and they give us [sic] their waste lands which we convert to an open dumpsite, and once it is filled up, we leave it for the land owner and seek for another one. This method of disposing waste is the crude open dumping, not the standard sanitary landfill as government is yet to acquire land and develop for final disposal of waste". (IWMP1)

"The state government is in the process of acquiring an accelerated waste dumpsite which would be developed and used as a sanitary landfill, but for now PEPSA is using the colonial open dumping method (crude dumping) because there is no sanitary landfill in the State". (IWMP2)

The representative of the Ministry of Environment emphasized that every year the Ministry budgets to acquire land for a sanitary landfill site, and the State Government approves the budget but the money is never released for that purpose

and so the Ministry finds other ways of disposing waste from the municipality. This reinforces some of the governance issues highlighted in Chapter 5.4.4.1.

Figures Figure 41 and Figure 42 shows the typical designated waste dumpsites PEPSA were using to dispose of waste at the time of fieldwork.



Figure 41 Burning of waste at Guratop open dumpsite is common practice in Jos

Source: Image taken by the researcher during fieldwork in 2014



Figure 42 An open dumpsite located in Kwang – note the close proximity of housing

Source: Image taken by the researcher during fieldwork in 2014

The designated waste dumpsites were located in Kwang, Guratop, Bukuru Lowcost, and around the market supplying building materials. These were open dumpsites and they remain the cheapest way of disposing of the increasing quantity of waste generated (OBS). Arrangements are made between PEPSA and land owners who want the waste for a variety of reasons. Some of the land owners are farmers and request PEPSA to dump waste there, after which the land owners burn the waste, then use it to farm a variety of crops instead of buying chemical fertilizers. Another reason could be that the land was devastated with mining activities that took place in the state and the land owner wants to reclaim the land. The land may have been affected by gully erosion and the land owner may want to halt further degradation of

the land, and so arranges for waste to be dumped there. Population increases and urbanisation makes the land owners want to add value to their lands by reclaiming and levelling the land in preparation to sale for construction of houses or other uses (IWMP1). The PEPSA representative added that the sites are arbitrarily picked through agreements with land owners and the government pays them a stipend for using their lands as a dumpsite (IWMP2).

Open dumpsites are usually maintained through the continuous burning of waste in order to reduce the quantity of waste at the dumpsite (IWMP1). A typical example of an open dumpsite with waste being burnt is seen in figure 41 above.

IWMP1 and IWMP2 stated that these open waste dumpsites are often located far away from human habitation because of the nuisances of smoke, bad odours, and vermin. However observations contradict this showing that some dumpsites are in close proximity to houses increasing the potential impact on public health (see Figure 42). The dumpsites were observed to not be fenced off and are open to informal workers to sort through the waste to recover items of value.

5.4.7 Impacts of the waste management system

In terms of the impact of waste disposal on the environment and the general public, the representative of PEPSA recognized underground water pollution as one of the biggest impacts. The officer explained:

“The sites where PEPSA dumps waste are not developed; therefore there could be leachate leakages during the rainy season when the water table is high and this could enter the water source leading to underground water pollution”. (IWMP2)

“We [sic] use unlined burrow pits to dump waste and these burrow pit allow seepage and overflow, so definitely a mixture of those waste that we (PEPSA) collect from communal bins and dump without sorting is dangerous to the environment and public health. When there is seepage leachate moves into the water source and people drink this water, as well as wash the vegetables (spinach, carrots, and tomatoes) that we eat. Here in Jos if you visit those places where spinach and carrots are produced and you see where they wash them you will not want to eat them again”. (IWMP2)

The PEPSA official clarified that the public waste containers in Jos were provided as a way of keeping the Dilimi River free from waste otherwise this could have a serious health impact on the general public. The Dilimi River starts from Plateau State and passes through many other states in Nigeria (Bauchi, Gombe, Jigawa, Kano, Taraba, Yobe and Borno) before flowing into Lake Chad. Therefore any pollution into the Dilimi River can have a substantial effect on the population living downstream as it is the major source of water supply to government and citizens of the communities that are along its channels. Citizens of those communities are

mostly subsistent farmers and the river helps them immensely during their dry season farming activities. Hence the pollution of Dilimi River in the long run could prove disastrous (Onyenekenwa, 2011). In addition the Jos Plateau is the source of many other rivers in Northern Nigeria including Kaduna, Gongola, and Benue rivers.

As already covered in Chapter 5.4.4 the results show that the waste management system is adequate. Despite efforts waste is still being dumped along the banks and in the river itself (see Figure 43). During the rainy season the rain and surface discharge washes waste from the bank into the river and transports it downstream.



Figure 43 Waste dumped on the banks of the Dilimi River

Source: Images taken by author during fieldwork in 2014

The representative of PEPSA pointed out the lack of control of open dumpsites can have a negative impact on the environment and public health for example from the burning of waste, attraction of vermin, and ground water contamination. Most focus group members were in agreement that the environment around dumpsites is dirty and odorous harbouring vermin.

A focus group member (FGDT1 008) stated they had lost an aunt and two child relatives during a flood at Angwan Soya in Jos in 2012, as a result of waste blocking

drains and water ways during a heavy rain storm. The flood of that year rendered many families homeless while others suffered losses of their loved ones.

Some other focus group members (FGDJ1 001, 002, 003,005, FGDJ2 006, 007,) mentioned concern regarding contact with waste and diseases such as Lassa fever, Typhoid fever, cholera, malaria, and ascaris. FGDJ1002 observed that smoke from the burning waste is choking and irritating thus making it difficult to breathe. Another member of the focus group discussion (FGDT1 006) pointed out that the aesthetic beauty of the environment is often spoilt as a result of scavengers littering the waste in search of recoverable items.

5.4.8 Environmental Sanitation Day and enforcement of environmental regulations

As set out in the previous section waste is having a detrimental impact on public health and the environment. As covered in Chapter 2.2.7.3 Environmental Sanitation Day has been in operation since March 1984 where residents are required to clean their communities.

In the context of Jos, IWMP1 stated that when the Environmental Sanitation Day was first introduced EHOs went round to enforce the movement restriction order in Jos and they made sure citizens cleaned their environments, while mobile courts tried offenders who broke the law, with fines and corporal punishment meted out. This still happens in Jos every month, as it was confirmed by both representatives of the Ministry and PEPSA. Evidence that this still exists was captured by Saiki (2016) from an announcement from the press secretary to the governor of Plateau state saying:

“The general public are enjoined to note that the Environmental sanitation exercise has not been suspended and as such they are to ensure that the exercise is observed in their various neighbourhoods and residences. Environmental sanitation officers who are EHO/SI mentioned above have been directed to ensure enforcement within the designated time of 7-10am”.

Environmental Sanitation Day was mentioned in focus discussion and a participant pointed out that communities occasionally collaborate to clear such waste for example:

“In my community we engage the youths on Environmental Sanitation days to clear all waste dumps within the community by sweeping and packing them together and burning”. (FGDT2 005)

Some focus group members stated that despite the nonchalant attitude towards waste, the monthly Environmental Sanitation Day should be forced on them and their communities. They stated that the government should collaborate with ward heads to

make them participate in cleaning all areas around their surroundings, and take waste to the public waste containers for collection.

The Ministry of Environment has been making efforts to enforce total compliance with the Environmental Sanitary Day but have been faced with some challenges. Ibrahim (2015) reported that over 15 people were arrested for evading the state Environmental Sanitary Day exercise but were warned and released without any penalty because of the strike action embarked upon by Judicial Staff Union of Nigeria (JUSUN) in the state. When the judiciary is on strike the issue of enforcement by fine or penalty cannot hold, the court is the only body that can prescribe penalty for offenders.

A range of other statements were made regarding enforcement:

“Some of the major problems or constraints to waste management in Jos city are obsolete laws and non-enforcement, as a result littering is a serious problem in Jos Bukuru metropolis”. (IWMP2)

“Another impediment to the enforcement of these laws is the political will of the people, because if you try to force the people today they have their associations and political wards, they will move to the house of assembly and before you realize it, the house of assembly will throw their big hammer on your agency saying that you are infringing on the rights of the people”. (IWMP2)

“We [sic] don’t have problem with legislation per se but we have problems with enforcement. In those days it was easy to enforce the laws because the sanitary inspectors worked hand in hand with the native authorities or the chiefs but nowadays security is a big challenge so laws are not being enforced”. (IWMP1)

“You can see that we [sic] don’t have strong public health legislation and bye laws to enforce on SWM”. (IA1)

5.4.9 Reuse and recycling activity in Jos

5.4.9.1 Current reuse and recycling activity

Data collection highlighted there were no formal recycling collections in Jos however extensive reuse and recycling was found to be taking place. Most focus group members acknowledged that they practiced both reuse and recycling. Questionnaires supported this with 68.7% of participants stating that they recycled while 77.6% reused (see Table 27). Materials commonly recycled were metals (97.9% of those that recycled), plastic (84.3%) and paper (26.6%). Reuse was prevalent (see Table 27) including clothes (88.0% of those that reused), food (43.7%), plastic bags (31.4%), and electrical products (30.6%).

Table 26 Responses to questions on recycling behaviour

Question	Reponse	Number of participants (sample 678)	Percentage (%)	
Do you recycle?	Yes	466	68.7	
	No	212	31.3	
Question	Reponse	Number of participants answering Yes (sample 466)	Percentage (%)	% of all questioned (sample 678)
If yes which materials?	Metals	456	97.9	67.3
	Plastics	393	84.3	58.0
	Paper	124	26.6	18.3
	Glass	19	4.1	2.8

Table 27 Responses to questions on reuse behaviour

Question	Reponse	Number of participants (sample 678)	Percentage (%)	
Do you reuse?	Yes	526	77.6	
	No	152	22.4	
Question	Reponse	Number of participants answering Yes (sample 526)	Percentage (%)	% of all questioned (sample 678)
If yes which materials?	Clothes	463	88.0	68.3
	Food	230	43.7	33.9
	Plastic bags	165	31.4	24.3
	Electrical products	161	30.6	23.7
	Batteries	117	22.2	17.3
	Furniture	79	15.0	11.7
	Other	56	10.6	8.3

Observations showed that households sell reusable or recyclable materials to the informal sector who were established to be of two kinds: those who go from house to house picking or collecting useful items from the bins (itinerant waste pickers), and those who operate only at the dumpsites, collecting recyclable materials from waste being dumped. Those who operate at the dumpsite appeared more organized.

The representative of PEPSA described the recycling scenario in Jos as the following:

“Recycling in Jos for now is a no and yes answers, but the “no” is affirmed because there is no official registered company for recycling waste and so government is not practising it. The “yes” part is because many small outfits exist which I know that recycle waste such as the one along police training school on Zaria Road. They buy slipper wastes and other plastic rubber and recycle to produce plastic kettles and buckets”. (IWMP2)

Materials for reuse and recycling are recovered from households and dumpsites by informal workers for onward selling to recycling entrepreneurs. Information on all reuse and recycling activity observed during the fieldwork has been collated and presented in Table 28 with each material/item listed and along with detail of the reuse and recycling activity.

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Table 28 Information on waste materials being reused or recycled in Jos based on data collected

Materials	How it is reused	How it is recycled
Clothes	Second hand clothes are called ‘gonjo’ (Hausa), ‘okrika’ (Igbo) or ‘bend down boutique’ (English), and can be bought or sold at many markets in Jos (FGDT1 003, FGDJ2 006) (see Figure 44). They are also given out to family members who need them to use again or as rags. 68.3% of those questioned stated they reused clothes.	-
Food waste	Food waste can be reused as animal feed to reduce the cost of buying animal food (FGDT2 004). It can be reused as leftover food by warming it to eat.	It can be incorporated into materials that can be composted (IWMP1, IWMP2).
Food waste (Yam peels)	Yam peels are dried and grounded into yam flour to make ‘amala’ (food from dried yam peels) (FGDJ2 001) (see Figure 44).	-
Bones and Horns	-	Bones are recycled into chicken feed also at Katako market (IWMP2, IIS1). Observations confirmed this was happening at local feed production stores. Horns are used to produce buttons (IIS1).
Plastic and glass bottles	Plastic bottles are reused for local drinks like ‘kunu’ ³⁴ (see Figure 44), to store items like palm oil or ground nut oil, or to light fires for cooking (FGDT1 001, FGDT2 005). Glass bottles are reused in exchange when buying a new bottled drink (FGDJ1 002). However there are some counterfeit drinks such as gin, wine and beer in shops today as a result of reusing bottles (IWMP2) (see Chapter 5.4.9.2).	Observations and interviews show that lots of plastic are collected for recycling in Jos.
Plastic bags	Observations and focus group discussions show that these are reused as shopping bags or waste bags, to store items, to light fire for cooking. 24.3% of those questioned stated they reused plastic bags.	(IA1) stated that plastic bags are recycled by artisans and moulded into statuettes of people and animals and sold in Jos. The representative also stated that people collect wasted bags, clean and shred them in Rantya (Jos) to make feedstock for new products. The plastic is transported for sale to Lagos, Kano, Kaduna and other states, and used for production of bathroom slippers, plastic overhead tanks, and other products. The same happens with other dense plastics (IIS1, IWMP2).
Plastic jerry cans,	These are reused for fetching and storing water, or as storage for	

³⁴ Kunu is a local Nigerian drink made from guinea corn.

Materials	How it is reused	How it is recycled
drums and buckets	other items like beans (FGDT2 003). Figure 44 Examples of reuse and recycling activity in Jos shows plastic buckets/drums waiting to be sold for reuse.	Observations confirmed this at a shredding centre at Katako Market, and at police training school along Zaria Road, Jos.
Metals - large milk tins such as Dano, Nido, Peak	These large milk tins are reused as storage tins for other things like oil, flour, and other items that need to be stored in air tight containers (FGDJ1 007, 004)	Due to its value unsparingly lots of metal is recycled in Jos and 67.3% of people questioned said they recycled metals. Aluminium drinks can, left over aluminium roofing sheets, and other aluminium metals are recycled by blacksmiths at Katako market in Jos to produce cooking pots, and other utensils (IWMP2, IIS1, and FGDJ1 005). Most focus group members affirmed they had benefited from these products. See Figure 45 for examples of products. Other examples include iron rods and other metals being melted at Katako market to produce new rods or other products (IIS1, IIS2). IIS1 stated that copper was being recycled into earrings and necklaces, brass to make locks, door knobs, ammunition casing and tutiya for handbags and button (IIS1).
Metals - small liquid milk tins	These small milk tins are reused as a measuring tool to get the right quantity of either rice or beans to cook. Market women in Nigeria use them to measure and sell gari, oil, flour, sugar and salt. They are also used for making ‘moin moin’ (FGDT1 005, FGDJ1 003).	
Metal – miscellaneous metals including aluminium and iron items, metal drums, and car parts	Mechanics use parts to repair cars; carpenters use them to produce doors, buckets, pails, stoves and other products (IIS1).	
Metals - wheels from motor cycle and the wire mesh from the rims of tires	There are local outfits in Jos who produce gauze for roasting, smoking or drying meat and fish (IWMP2). Figure 44 Examples of reuse and recycling activity in Jos shows a gauze ³⁵ for roasting or smoking meat and fish	
Metal - copper	See recycling	
Metal - brass		
Metal - tutiya ³⁶		
Electrical products - TVs, fridges, generators, DVD	Observations show that there is a high rate of electrical products repaired and reused in Jos – 23.7% of questionnaire respondents reused electrical items. They are also being sold openly as	Observations and literature show that old unrepairable electrical products are crushed and useful components are picked and used to produce new electronic products.

³⁵ A very fine wire mesh.

³⁶ Zinc oxide is a metal known as tutiya.

Materials	How it is reused	How it is recycled
players, and phones	second hand products in the market as new ones are very expensive and beyond the reach of low income families. Electrical products are voluntarily given or donated to other less privileged family members and friends (FGDT2 001). Figure 44 Examples of reuse and recycling activity in Jos shows WEEE products being sold for reuse.	
Ash, Chicken litter	-	Literature and observations indicate that ash and chicken litter can be used as fertilizer for farming or incorporated into compost (Pasquini, 2002).
Papers - newspapers	Focus group members disclosed that newspapers are reused as packaging materials for foods like 'akara', 'suya', 'masa'.	Observations show that newspapers are collected and sent back to the industries to be reused again in printing or recycled in the community to make egg cartons.
Papers - cartons/cardboard	- Cartons are reopened and turned inside out, and then stamped with the name of new products and repackaged for reuse (IWMP2). However as explored in Chapter 5.4.9.2 this leads to problems of counterfeit goods.	-
Batteries	Batteries are refurbished for reuse (IIS1), some batteries can be recharged.	-



Figure 44 Examples of reuse and recycling activity in Jos

Source: Images taken by author during fieldwork in 2015. Clockwise from top left - market for second hand clothes (gonjo) in Jos; dried yam peels waiting to be milled for amala; Kunu packaged in reused plastic bottles; a gauze for smoking or roasting meat made from a reused wheel; repaired/reused WEEE products on sale; plastic buckets and plastic drum ready for reuse.

Observations showed that in Farin Gada and Bauchi Road there were many private recycling entrepreneurs handling a range of materials including plastics, metals, tin cans, cartons and car parts – images of activity are presented in Figure 44.

Recycling entrepreneurs sell the recovered materials to small scale or large scale processing industries outside of Jos. There are also businesses that reprocess recyclable material in Jos. The recycling entrepreneur (IIS1) and the representative from a recycling enterprise (IIS2) were able to provide a wealth of information on reuse and recycling activities in Jos. Both representatives had been playing active roles in waste management for the past 10 years.

IIS1 stated that currently there are 5 people involved in managing their recycling business sourcing and selling recyclable materials. IIS1 stated monthly revenue depends on how much material they receive, but stated that they gain NGN50 (13 pence) on every kg of aluminium sold to other organisations, for example they buy a kg of aluminium for NGN100 (26 pence) and sell for NGN150 (39 pence). They sell materials to both local and bigger companies that require them. They handle a wide range of materials - for example they buy bones at NGN45/kg (12 pence) and sell them for NGN55/kg (15 pence) to Grand Cereal and Oil Mill Limited (GCOML) who are the major producers of chicken feed in Jos. The representative emphasized that recycling is a good business which is not capital intensive and has made them self-dependant since they earn their own money. It also helps them to take care of their needs and that of their families. Despite this there are negatives including working in sometimes dangerous conditions:

“When we cut the metals it can wound us and that means we have to get treated because of tetanus infection, and we do inhale dust as well in the process of cleaning the items which is dangerous to our health, but in life everything that has an advantage also has a disadvantage. We feel quite happy and comfortable because our business gives us a source of livelihood, many do not have what to do but we are earning money from this business”. (IIS1)

IIS2 stated 8 people are involved in their business of producing local pots, stands, spoons and other products from recycled metal. Examples of their products are shown in Figure 45. It was observed that the pot producing enterprise was thriving. They buy the aluminium from informal workers, entrepreneurs, or householders, and explained that there are times they exchange the metals for already made pots or other items they make – hence metal becomes a currency.



Figure 45 Examples of products made in Jos using scrap aluminium

Source: Images taken by author during fieldwork in 2015. Clockwise from top left - a stack of pots produced from recycled aluminium products; a pan for making masa; pot stands designed for a local stove; a pot and spoon.

5.4.9.2 Quality of products and counterfeit goods

Under Nigerian law any company wanting to embark on the production of an item needs to register with the Standards Organisation of Nigeria (SON) so they can check on the items to ensure their quality. However there is a lack of enforcement of these regulations and it is therefore not surprising that substandard or counterfeit products exist in Jos. Businesses package up counterfeit goods in reused packaging and sell the produce. PEPSA official pointed out that:

“There is a counterfeit Niger bar soap in the market as a result of many outlets producing bar soaps and repackaging them in cartons to look as if they are original Niger bar soap while they are not”. (IWMP2)

“There are some gin, wine and even beer in shops today in Jos as a result of buying their bottles to reuse”. (IWMP2).

When there is a report of such activity, the enforcement agency takes action by investigating and penalizing the outfit involved. For example IWMP2 stated that many such businesses were closed down some time ago at Rukuba Road in Jos by National Agency for Food and Drug Administration and Control (NAFDAC).

5.4.9.3 The role of government in recycling

Interviews suggested that the stakeholders thought government should be taking a more active role in promoting and supporting recycling:

“Government is not recycling anything, but there are scavengers that move from dump to dump, house to house, trying to source for metals, plastics and other categories of recyclable waste. The scavengers collect and sell to local recycling entrepreneurs or transport it to sell to larger companies in cities like Kano, Lagos and the rest in trailers. That is what I[sic] often observe; I have not seen any government recycling plant yet in this city”. (IWMP1)

“Government should embrace recycling because it is the happening thing in the world today, and Plateau State should take its turn to benefit from such laudable programmes which would help catapult the economy of the state, as well as improve the management of solid waste within Jos Bukuru metropolis, thus promoting a cleaner environment and good health”. (IWMP2)

5.4.9.4 Composting

There was no obvious sign of composting seen in Jos at household or community level during observations and this was confirmed during interviews with the stakeholders. As highlighted in the statements below it appears there have been attempts to engage in composting but without any success:

“Currently the PLSG is not practicing composting, but it is a well-known fact that compost grown fruits are the best because they have no side effects on the people consuming it, and that is the reason why government needs to invest in compost production in order to protect the people”. (IWMP1)

“Composting is not taking place in Jos now but during former governor Dariye’s regime a fertilizer blending company was set up mainly for that purpose in Bokokos. At that time the GM of JMDB together with a colleague were always packing ash to go and have some trials on composting in preparation for the take-off of the fertilizer blending plant, but somehow that did not happen, so composting is not going on now”. (IWMP2)

“Communal waste management can be possible because what the community needs to do is to create awareness in the community and secure a land for the community to dump all their waste to enable for primary sorting, and thereafter begin to make

compost. Compost can be produced and used by the people or sold to the public to make money”. (IA1)

“Farmers will buy it (compost), especially the fadama³⁷ farmers because they know the importance of this organic manure, and they even give money to PEPSA drivers to take the waste and dump on their farms for them to burn and use as fertilizers”. (IA1)

“There was a research commissioned by the European Commission and another by Jos-Durham, which was not on waste per se but on the resources and ecology of Jos Plateau environment, but a component of that research was on how they could use some of the solid waste manure (compost) as organic nutrient to enrich the fadama irrigation that was taking place in Jos”. (IA1)

“One or two people have made attempts to produce these organic manure (compost), the former General Manager (GM) of JMDB actually became interested and around Kwang village some years back tried recycling to produce organic manure (compost) but one organization (ECWA) came and packed the organic manure (compost) to try on their farm in Makurdi Benue State, but never came back to pay, and that was how his company collapsed”. (IA1)

Focus group discussions highlighted that members of the public did not know much about composting, likewise the questionnaire survey (see Table 29) indicated that 94.8% participants were not composting. The main reasons stated by those not composting (94.8%) include lack of space (43.7%), not knowing how to compost (30.0%), lack of awareness (22.1%) and that it consumes time (3.3%). However 5.2% of respondents claimed to compost.

Table 29 Response to the question on composting

Do you compost?	Number of participants (sample 678)	Percentage (%)	Of those not composting the main reason given (sample 643 – 94.8%)
Yes	35	5.2	-
No	643	94.8	- Lack of space (43.7%) - Don't know how to (30.0%) - Lack of awareness (22.1%) - Consumes time (3.3%)

Both IWMP1 and IWMP2 acknowledged that farmers often solicited waste to be disposed on their farms. The author accompanied trucks loaded with waste for disposal on two different occasions to farms located at Kwang and Du areas, not far from Jos. Observations confirmed that PEPSA drivers were given money by farmers to dump the waste collected. It is interesting to note the paradox in financial transactions with on one hand farmers covertly giving money to PEPSA drivers to

³⁷ Fadama is a Hausa name for irrigable land—usually low-lying plains with shallow aquifers found along major river systems.

dump waste collected from public waste containers on their farms so that they could use it as fertilizer, and secondly the government through PEPSA paying land owners so that they can use the land as a dumpsite. The reason why the farmer would pay is that there are different sites competing for the waste and therefore payment to the crews is necessary to ensure they get the waste.

5.4.10 Recommendations from stakeholders to improve the waste management system

Throughout the chapter some challenges and recommendations to improve the existing system have been raised. The specific issue of recommendation to improve the waste management service was covered in the questionnaire with participants asked “*What could improve the management of waste in the community?*”

Responses varied as can be seen from Table 30 with respondents only allowed to choose one option. The most popular recommendation with 44.7% was community education and workshops, 30.8% said community involvement, while 22.4% preferred effective house to house collection, and 2.1% incentives.

Table 30 Questionnaire responses on interventions to improve waste management in the community

Intervention	Number of participants (sample 678)	Percentage (%)
Community education & workshops	303	44.7
Community Involvement	209	30.8
Effective house to house collection	152	22.4
Incentives	14	2.1

Given the low income study area, one would have expected a higher number of participants choosing incentives but the opposite was the case. This could possibly be because they have lost faith in the Plateau State Government where some of them work as they have not been paid their salaries for months – therefore they would be sceptical that an incentive would ever come into fruition. A case in point is that of the ad hoc male staff and widows contracted by the Ministry of Environment. At the time of fieldwork they had not been paid for over seven months and many had stopped working. Also surprising was the low number who would support collections directly from home rather than public waste containers – this is explored in more detail below.

It was interesting to note the popularity of raising awareness through education. The representative of PEPSA stated public awareness campaigns have not been carried out in Jos since 2000. A key reason cited was that due to the insecurity in Jos the EHOs, who would carry out the awareness raising, would need to work with the

police when embarking on such campaigns. However there are inadequate police available to support such activities.

As highlighted in Chapter 5.4.2 and 5.4.4.1 there are issues with funding waste services in Jos. Residents were asked if they were prepared to pay for collection services to improve the waste management system. Unsurprisingly 65.5% were not willing to pay for the service, while 34.5% were willing to pay (see Table 31).

Table 31 Questionnaire responses on willingness to pay for waste collection service

Willingness to pay?	Number of participants (sample 678)	Percentage (%)	Of those not willing to pay the main reason given (sample 444 – 65.5%)
Yes	234	34.5	-
No	444	65.5	- Government responsibility/Social Service (52.6%) - Non-provision of waste collection services (47.4%)

Of the 444 people not willing to pay, 52.6% believed it was government's responsibility to collect waste as a social service, while 47.4% said they would not pay due to non-provision of waste collection services. This could relate back to the low number of respondents who thought collections from homes would improve the waste management service – they are sceptical this would ever happen.

5.5 SUMMARY OF CHAPTER

This chapter has contributed in providing a better understanding of the current waste management system in Jos, including Jenta and Tudun Wada. It is clear from the research that both of these low income areas lack access to SWM services. The Plateau State Ministry of Environment, through PEPSA, is responsible for waste services. The results have highlighted gross inefficiencies in service provision with 5,895 households of the study area being serviced with only 3 public waste collection containers. Therefore, it is unsurprising that waste is strewn throughout the community with residents openly dumping and burning their waste.

The results have also highlighted the lack of reliable data on waste generation, lack of implementation of an effective strategy and poor enforcement of regulations. The waste service is grossly underfunded and poorly resourced and suffers from poor governance. However, there is a rich culture of reuse and recycling taking place due to the informal sector. The following chapter discusses the results and considers the challenges posed to sustainable waste management and reflects on some recommendations to overcome these challenges.

6 DISCUSSION

6.1 CHALLENGES TO SUSTAINABLE WASTE MANAGEMENT IN LOW INCOME AREAS

Results of data collected from fieldwork show that the study area faces many challenges to sustainable solid waste management. These have been categorized into four major themes as set out in Figure 46: the role of government, solid waste management practice, resource allocation, and the attitudes of the public towards waste. Each theme and associated subthemes are subsequently discussed in the following sections.

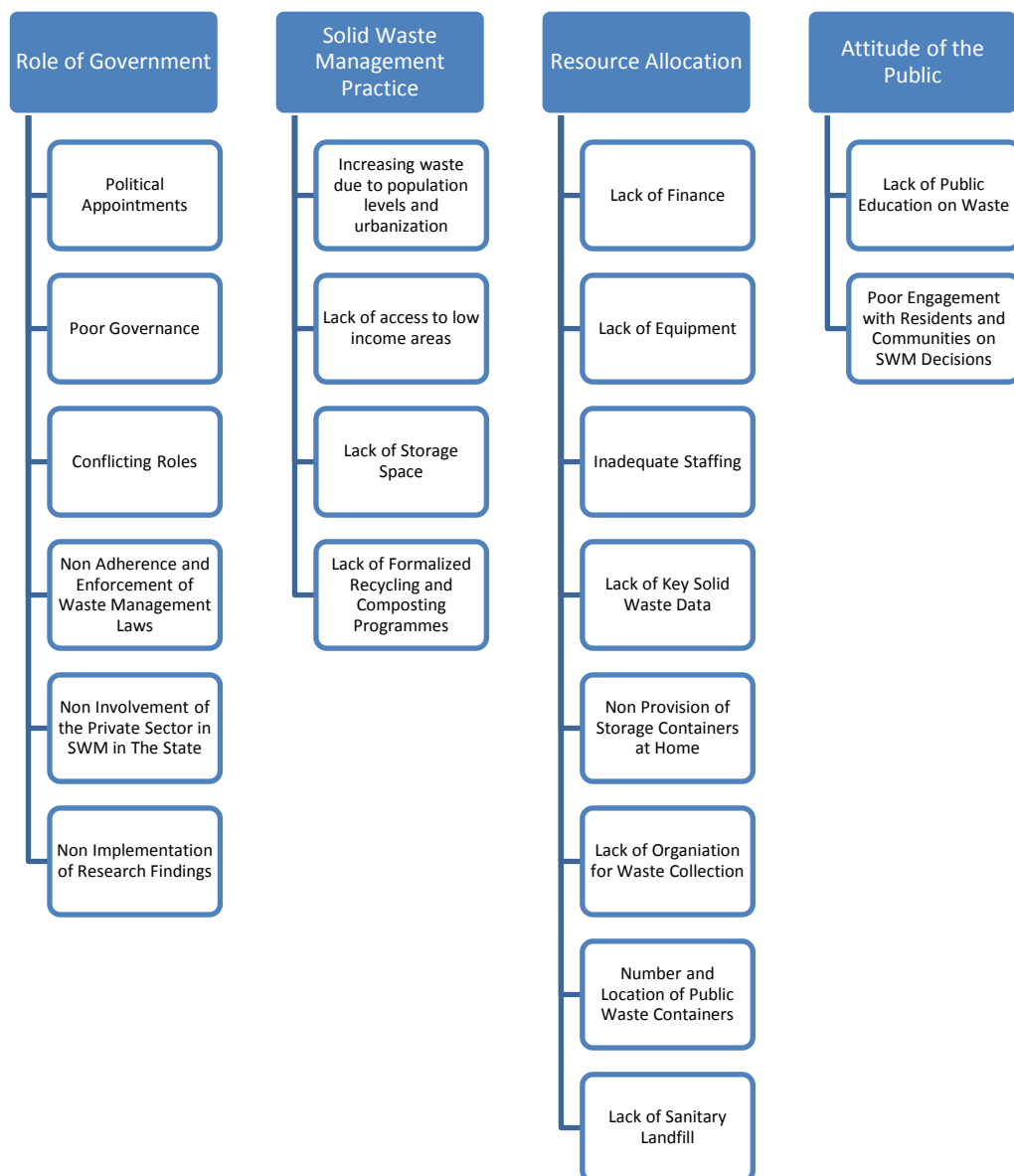


Figure 46 Identified challenges to SWM in low income areas of Jos

6.1.1 Role of government

Data collected from fieldwork through observation, focus group discussion, interviews and questionnaires highlights that the governance structure presents challenges to developing effective waste management in Jos. Identified challenges are political appointments, poor governance, lack of adherence and enforcement of waste management laws, lack of involvement of the private sector in SWM, and lack of implementation of research findings. Each of these challenges is considered below with reflection on how these challenges are considered in existing literature.

6.1.1.1 Political appointments

Nigeria operates a democratic system where the elected governor is at liberty to appoint people whom he/she feels can assist in governance of the state through various ministries. In terms of SWM in Jos the State Commissioner for Environment is such an appointee on the basis of party politics. The Commissioner is the political head of a Ministry and provides leadership and guidance in the implementation of government policies and directives. Data collected during this study (interviews with IWMP1/IWMP2) suggests that the appointment of the Commissioner based on party politics contributes to the waste management problems experienced. The Commissioner is expected to be a professional who is knowledgeable on issues of SWM so as to improve it, but is often not (Uwadiogwu, 2013, Uwadiogwu & Iyi, 2014). Being a non-professional on SWM issues means the Commissioner can be less concerned about the topic or not understand its implications for public health, environment and economic development. They may make decisions based on party politics rather than sound science thereby prioritizing issues that could make their political party more popular, rather than address issues which are of concern to members of the public. Political appointees often lack political will power and commitment to execute SWM programmes that have direct bearing on the population.

Data collected from fieldwork through observations, focus group discussions and questionnaires during this research has highlighted the significant problems with the system in Jos with 94.1% of questionnaire respondents rating the service as poor or very poor, however the government has not taken any serious measures towards solving the situation. The representative of PEPSA (IWMP2) emphasized that there has not been any concrete plans and strategies ever in terms of SWM in Jos because of frequent changes in the State Ministry of Environment as a result of politics. The official revealed that proposals may be written by one person today, but tomorrow that person may not be there to continue, and another person would come on board with completely new ideas, therefore there is no continuity.

The problem of political appointees supports the findings of Peter (2016) and his work on Jos, while Ezeah (2010) and Iriyaga (2012) suggest that this is common to other Nigerian cities. The stakeholders (IWMP1, IWMP2, and IA1) suggest that Government should refrain from playing politics on issues that impact directly on

public health and appoint professionals who understand the challenges and develop long-term sustainable solutions.

6.1.1.2 Poor governance

Poor governance is the inability of government to manage public affairs and resources well in order to meet the needs of society. In terms of SWM the Federal Ministry of Environment is responsible for drafting policies and passing it down to the states to implement in their areas of jurisdiction. Poor governance has been identified as one of the challenges to efficient SWM services in Jos as this simply is not happening and policy is not being implemented at all.

The findings of this research concerning poor governance (IWMP1, IWMP2, and IA1) support the opinions of Adama (2007), Ezeah & Roberts (2014), and Nzeadibe et al. (2010) who have all attributed the poor state of SWM in Nigeria to poor governance. The lack of environmental reforms in Nigeria has worsened the situation of waste management in urban areas. For instance whilst some states such as Lagos and Calabar have shown a considerable level of resolve to take proactive steps in fighting waste management challenges, the rest of the states including Plateau have merely been paying lip services to issues of waste management indicating a lack of interest to develop the waste sector (Bakare 2016).

6.1.1.3 Conflicting roles in managing waste

A key issue identified in this research in Jos was the arrangement between the Plateau State Ministry of Environment and PEPSA. The constitution of Nigeria gives the responsibility of managing waste to the local government councils. However in situations where more than one local government makes up a city, waste management responsibilities become that of the state government. This arrangement is not enshrined in the constitution and the origins appear to be linked with financial drivers with politicians wanting money diverted to state level where they have more control (IWMP1, IWMP2).

This is the case in Jos which is made up of 3 local government areas, therefore management of waste in the city becomes the responsibility of Plateau State Government. PEPSA is an agency within the Ministry of Environment and their function is to collect and dispose of waste, clear streets, enforce regulations and engage with the public on waste education. The representative of the Ministry of Environment specified that although PEPSA is currently in charge of SWM it is not given a free hand to operate (IWMP1). It receives instructions and directives from the Ministry of Environment, and this administrative protocol makes it difficult for PEPSA to function effectively leading to tension and ineffective services (IWMP2, IWMP1). These can be confirmed from the statements of the representatives of PEPSA and the ministry of environment below:

PEPSA is answerable to the ministry of environment which is a serious impediment to the management of waste in Jos, as our entire request for funds, equipment and

other logistics for SWM from government has to go through the ministry, and unless the ministry endorses it there will be no such releases. Any release of funds, equipment and others are made to the ministry, and the ministry manages them on our behalf, how do you expect us to function effectively? (IWMP2)

The representative of the ministry of environment stated that the institutional arrangement between the ministry of environment and PEPSA is not good. For example the ministry manages the funds, provide trucks, repair and maintain trucks, and fuels the trucks. PEPSA only collects the trucks daily to use them and bring them back to the ministry. There are times when these trucks are not available for PEPSA to use due to breakdown or lack of fuel. At such times the ministry will blame the governor for not providing the money for fuel, and repairs, and when the city is dirty the populace blames PEPSA for failing to perform its duty. This kind of arrangement can cause disaffection between the ministry and PEPSA, leading to inadequate service delivery (IWMP1).

For example there is a long winded and inefficient system for procuring the required resources, this was evident when IWMP1 accepted that PEPSA always makes yearly budget proposals and the proposals are on a regular basis approved, but often with no cash backing. PEPSA could identify the resources they need and make the request from the state government through the Ministry of Environment. If the Ministry then decide that they support this request it is passed onto the state government for consideration. Stakeholders even cited examples where the finances were approved but no money filtered down leading to the purchase of the resources required. Moreover even though PEPSA is responsible for delivering the service they have no control in regards to the recruitment of staff (IWMP2, IWMP1).

The representative of PEPSA (IWMP2) stated that unless there is separation of powers to show who is responsible for SWM, with funds, equipments, and other logistics released to them directly removing undue protocol, hence making SWM easier and better.

DungGwom et al. (2008) highlighted that conflicting roles in waste management is not a new issue, also in the past there were overlapping functions on waste management between Jos Metropolitan Development Board (JMDB), Direct Labour Agency (DLA), and PEPSA making them work at cross purposes rather than address different issues and problems. Afun (2009) identified there is no clear allocation of roles and responsibilities in terms of SWM in Nigeria, and emphasizes that an overlap in the agencies responsible for enforcement of the various laws create problems for effective waste management. Adewole (2009) gave an example where Lagos State Waste Management Authority is the agency responsible for waste collection and disposal in Lagos however it is competing with other bodies including the local government authorities and Lagos State Environmental Protection Agency

in the management of waste leading to an inefficient system. Therefore the situation in Jos is replicated in other parts of the country.

6.1.1.4 Non adherence and enforcement of waste management laws

There are many laws and regulatory measures that have been put in place by government to promote sustainable waste management (see Chapter 2.2.2). For example the National Environmental (Sanitation and Waste Control) Regulations, S. I. No.28 of 2009 provides the legal framework for the adoption of sustainable and environment friendly practices in sanitation and waste management in order to minimise pollution. Although such laws exist they are not enforced, and as a result waste is not managed as expected, for example Under Plateau State Environmental Law (2003) burning waste is unlawful and problematic having a detrimental impact on public health and the environment. However as highlighted in the questionnaire 45.0% of residents stated that burning of waste is the main way in which they manage their waste, and burning of waste is widespread on dumpsites endorsed by PEPSA. Therefore PEPSA who are expected to enforce the regulations are themselves breaking them. This was confirmed by the representative of PEPSA when he stated that the wastes at public dumpsites are most often managed through burning in order to reduce the volume of the waste. In addition observations and literature (Abila & Kantola, 2013) have found that wastes are often burned at public dumpsites.

Non adherence and enforcement of waste management laws is a barrier to sustainable SWM in Jos. Failure of the state government to enforce SWM legislations in the municipality is a clear sign of lack of concern for SWM issues in the state. Non adherence and enforcement of waste management laws is in agreement with Peter's (2016) findings on Jos, while Afun (2009), and Imam et al. (2008) state that the regulatory structure that supports SWM in Nigeria is totally inadequate. Afun (2009) added that most legislations or regulations will succeed if they are understood and accepted by the entire public, and strictly enforced.

Non adherence and enforcement of waste management laws in Jos and Nigeria is similar to other countries in LEDCs as stated by Mrayyan & Hamdi (2006) in terms of lack of waste regulations, and Seng et al. (2010) in terms of weak regulations, lack of implementation and enforcement, which often lead to waste producers using the cheapest means to dump their waste (UNEP, 2015). Therefore government at the federal and state levels need to revive its regulatory frameworks and enforcement in order to enhance SWM.

6.1.1.5 Non-involvement of the private sector in SWM in the state

The private sector has not been engaged in SWM in Jos since the system failed in 2007, where 24 contractors were appointed with many failing to collect waste (see Chapter 3.2.3). Since then PEPSA has been exclusively responsible for the

management of waste within Jos. As highlighted SWM is a challenging task for PEPSA due to insufficient waste collection equipment and personnel.

Some stakeholders believe that engaging the private sector in SWM in Jos is a good idea because they appear more organised and could be effective, especially for the low income areas since government is not able to serve them effectively. Peter (2016) supports this approach with Binbol et al. (2013) suggesting government needs to invest heavily in waste management and consider reengaging with the private sector. Similar problems with SWM across Nigerian cities have been reported by Alakinde (2012), Ezebilo & Animasaun (2012), Ibrahim (2014), and Ogu (2000) and they are in agreement that in order to improve the waste management system Private Sector Participation (PSP) in SWM is unavoidable. Ibadan, Lagos and Kano already engage with the private sector in solid waste management in their states helping to improve the service (Ibrahim, 2014; Ibrahim et al. 2014; World Bank, 2017).

6.1.1.6 Non implementation of past research findings

Non implementation of past research findings (see Chapter 4.3.9) is another barrier to sustainable waste management in Jos. In spite of the fact that studies have been conducted in Jos which all advocate for improvements, evidence on the ground indicates little has been implemented hence improvement is lacking. During interviews stakeholders (IWMP1 and IWMP2) acknowledged that there was collaborative research between UN Habitat and PEPSA on SWM in Jos. Both representatives directed the researcher to the General Manager of PEPSA to collect the report. The researcher made many trips to the office but could not have access to the report as they claimed they did not know its whereabouts.

A stakeholder identified that non implementation of research recommendations as one of the biggest challenges against developing an efficient waste management system in Jos and Nigeria as a whole. The stakeholder stated that:

“The application of past research findings in Nigeria is almost tending towards zero, because even when research results have been published, public officers don’t tend to use it or implement it, so is a very big issue, as a result the linkage between universities and governance is not really useful” (IA1).

In addition some of the participants were reluctant to take part in the research because research has been conducted in the past with nothing useful coming out of it, hence they felt it was a waste of their time responding to questions or questionnaires since nothing will change. This was corroborated by the academic representative of tertiary institutions (IA1), when he accepted that there have been many researches on SWM in Nigeria in the past, but the application or implementation of these research findings is almost zero. According to the scholar even when research results have been published, public officers do not have a tendency to use or implement it, hence eroding the trust placed in researches.

The PEPSA official stated that whilst such research studies might have been useful, the continual changes in government mean a long term sustainable waste strategy have not been developed.

6.1.2 Solid waste management practices in low income areas of Jos

Solid waste management practices in low income areas refer to the handling of waste materials from generation at source, through to collection and disposal processes at both Tudun Wada and Jenta. Field investigations show that SWM practices in Jos and low income areas encounter challenges such as increasing levels of waste generation due to continuous population increases, lack of access to low income areas, lack of storage space for waste in homes, and lack of formalized recycling and composting programmes. These challenges are considered below.

6.1.2.1 Increasing levels of waste due to population increases and urbanization

The population of Jos has been increasing over the years, so also is the rate of urbanisation. Binbol et al. (2013) rightly pointed out that Tudun Wada is an all comer's zone and shares similar characteristics with Jenta, being densely populated and characterised by low planning standards. Literature (Ogwueleka, 2009) has established that population dynamics often have significant influence on the level of waste generation in communities, and this development is the geneses of waste management problems in Jos especially in low income areas. The results of the study clearly show that the existing system for managing waste is inadequate, let alone capable of catering for the projected increases due to population growth.

6.1.2.2 Lack of access to low income areas

Lack of access to low income areas emerged as a key barrier to solid waste collection from the study area. Results show the study area lacks infrastructure and access due its unplanned nature, location on rocky terrain, haphazardly and densely built housing without access roads for the provision of waste management and other services. The buildings are old with no spaces between adjoining buildings such that the roof of one building overlaps the other. The conditions of the study area have led one to assume that these areas have suffered long neglect from government especially in regard to infrastructural development, provision of basic social amenities, and enforcement of development control standards. As a result of the aforementioned features, the stakeholders interviewed likened the areas to slums. UN Habitat (2013) defines slums as neglected parts of cities which are unplanned and lack basic amenities or services, with substandard houses, overcrowded with unhealthy living conditions.

The bad and narrow roads could be the reason why waste in the community is neglected. Focus group participants emphasized the need for government to create accessible roads so that trucks can have access to collect waste that is left in open spaces within their neighbourhood. In addition the representatives of the ministry of environment and PEPSA (IWMP1, IWMP2) emphasized the need for Tudun Wada,

Jenta and other low income areas which have accessibility problems to be re-planned in order to make them more accessible, hence enhancing SWM. IWMP1 opined that collaboration between the Ministry of Lands and Survey (who have responsibility for the planning and development of urban cities) and the Ministry of Environment could make it possible for low income areas in Jos to be re-planned, thereby enhancing SWM in the state. This finding corresponds with that of Binbol et al. (2013) for Jos, and Kayode & Omole (2011) for Nigeria who argue that low income areas need to be redeveloped to improve accessibility and sanitation.

6.1.2.3 Lack of storage space for waste in homes

Lack of storage space for waste at households was an issue raised by focus group discussion members (FGDT1 003, FGDT1 005). They argued that it was the reason for disposing of waste immediately it is generated as they have no space to keep it. More so that the nature and kind of waste they generate quickly rots, creating odours and attracting flies and vermin. Others stated that when the waste is put outside the house it gets vandalized, or scattered by dogs. Observations confirmed the lack of space in and around their homes. Houses are built without any standards or provision for waste storage, and the nature of the waste generated from households makes it difficult to be stored within the homes. As a result of lack of storage space in the homes households tend to dispose of waste immediately. As highlighted in the questionnaire residents use the option quickest and most convenient for them with 45.0% burning their own waste and 31.1% discarding of waste into waterbodies. The lack of storage space might also be a reason why only 22.4% of questionnaire respondents identified collections from the home as their preferred option to improve waste collection in the community (see Chapter 5.4.10), there might be concerned that they do not have the space to store several days waste prior to collection.

Otitoju (2014) in his investigation of individual attitudes towards recycling of municipal solid waste in Lagos, reported that one of the reasons for not recycling was a lack of storage space, likewise Okorhi et al. (2017) established that a key factor influencing e-waste management is lack of storage space.

6.1.2.4 Lack of formalised recycling and composting programmes

Majority of the focus group members stated that they were recycling, while 68.7% of questionnaire respondents also recycled. Although reuse and recycling is going on in the study area and Jos in general, no formal recycling system exists in Jos – however there is an active informal sector. However no information on the scale or impact of these activities was established since the author could not ascertain the number of people engaged in these activities in Jos. Peter et al. (2014) has reported on similar practice in Jos, and the informal sector is common across Nigerian cities (Nzeadibe & Ajaero, 2010) and globally.

Observations and focus group discussions show that little is known about composting in the study area; questionnaires corroborated this findings with 94.8%

of residents stating that they did not compost. This could be because government is not actively supporting it.

Non-involvement of government in supporting recycling and composting and helping to set up formal systems, or supporting the informal sector, is a barrier to sustainable SWM. The informal sector recycles in a crude manner hence degrading the environment. Composting can be particularly helpful to communities managing their waste, thus reducing the waste that needs to be managed by the municipality and its subsequent impact on the environment. Two of the stakeholders interviewed (IWMP2 and IA1) stated that attempts have been made to produce compost but failed partly due to the lack of support from government. They both emphasized the need for government to support composting. IA1 noted that if compost is embraced and produced it could be bought by fadama farmers and other farmers who are already using ash derived from burning of waste as a fertilizer, and compost could be a more attractive proposition due to its richer nutrient content.

It is important that government supports the informal sector. This would enable the sector to grow and help support the development of the economy in the state. Though some of the jobs the informal sector provides maybe low paid and without security, it still helps in alleviating poverty. The informal sector provides an opportunity for a large number of people and they contribute to the economy of the nation through output and employment. The informal sector activities though unrecognised, unrecorded, unprotected, and unregulated by government, are not only restricted to peripheral activities but also comprise profitable enterprises in manufacturing activities.

The informal sector should be strengthened through policy restructuring for its optimal contribution to the development of the economy. Moreover over time the formal sector developments has been managing waste in Jos, attempts should be made to integrate the informal sector, not to replace it.

6.1.3 Resource allocation

The research has highlighted a lack of resourcing is underpinning the waste management system in Jos. Resource allocation is a vital driver for SWM and without it many aspects of the management are impacted. Challenges identified in this research are lack of finance, lack of equipment, inadequate staffing, lack of reliable solid waste data to help plan services, non provision of storage containers at home, lack of organisation for waste collection, the number and location of public waste containers, and lack of sanitary landfill.

6.1.3.1 Lack of finance

The Plateau State Government relies mainly on the annual budgetary allocation from the Federal Government and the collection of all taxes by the Plateau State Internal Revenue Service (PSIRS) for its funding. Locally members of the public pay a tax of

only NGN50 (12 pence) per month to PSIRS. As confirmed by the PEPSA representative this is meant to fund waste and other services, which according to the PEPSA representative is clearly too little to develop an effective waste system.

Both annual budgetary allocation and taxes collected by PSIRS have not been able to yield adequate funds to finance waste management in the state especially with increasing population and resulting waste generation. In addition there is stress on the national budget from competing priorities which makes it very difficult to get sufficient allocation of funds to finance waste management. The outcome of this financial limitation leads to many aspects of SWM being affected.

The stakeholders reflected on the political appointments that do not see waste as a priority area. IWMP2 and IWMP1 reiterated that every year PEPSA proposes to buy new trucks and public waste containers. They submit their request to government, but for as long as government officials see waste being collected from government house³⁸ and the secretariat³⁹ to collect their own waste, they are not concerned for the rest of the community. Until the government is convinced about the need and importance of a programme they will not just release funds for environmental matters.

Some focus group members highlighted there are wider financial issues including the non-payment of salaries to State civil servants (FGDJ1 003, FGDT2 002). The author learnt that at the time of this fieldwork some staff at the Ministry of Environment, including the widows and ad hoc staff used for collecting waste, had not been paid for 7 months. This leads to demotivated staff members who do not fulfil their responsibilities. Moreover if staff salaries have not been paid for this length of time it would affect the revenue being generated in the state through taxes thus limiting the resources of the state which have many competing demands.

Peter (2016) shares the same thoughts about limited finance for SWM in his study of Jos, while Agbola (2003), Fobil (2010) and Iriyuga (2012) have similar opinions for Nigeria. Another study by Babalola et al. (2010) revealed that inadequate infrastructure and funding are obstacles to a successful waste management system. Iriyuga (2012) stated that without monetary resources to buy waste trucks and waste bins, build and maintain waste sorting facilities, local government are completely incapable of operating successful waste management facilities.

6.1.3.2 Lack of equipment

Results from this research have highlighted that waste services in Jos are poor because of the lack of waste management equipment and resources. Effective collection, transportation and disposal of waste depend on the availability of suitable equipment and money for its maintenance and management.

³⁸ Government House is the office and residence of the Governor.

³⁹ Secretariat is the office of all state ministries.

A variety of vehicles are used to collect solid waste from the study area (see Table 23). It can be seen that the fleet has a limited number of functioning vehicles; hence PEPSA finds it difficult to serve the increasing population of Jos. This is in agreement with the findings of Binbol et al. (2013) who stated that PEPSA was finding the management of waste in Jos difficult because of insufficient vehicles. However it has been on record that the resources for waste haulage in Jos has been inadequate for decades with Pasquini (2002) reporting that Jos city commissioned 23 waste disposal trucks in the 1980s, but by 2001 these were reduced to just four due to vehicle breakdown and non-maintenance culture of the municipality. On the day of interview with IWMP2 there were only nine trucks available and the author witnessed a vehicle being repaired (see Figure 47). In addition the PEPSA representative explained that there are trucks that have broken down since 2008 which have still not been repaired.



Figure 47 A broken down truck undergoing repair

Source: Image taken by author during fieldwork in 2014

The lack of equipment for managing waste in Jos is comparable to other cities in Nigeria as observed by Adewole (2009) and Ogwueleka (2009). Ogwueleka specified that 60% percent of trucks available for waste management in most Nigerian cities are out of service at any one time, which Agunwamba et al. (2003) attributes to overuse as a result of shortage.

This research has also highlighted the lack of other resources that are required to protect staff under the Regulation S.1.15 of 1991: National Environmental Protection (Management of Solid and Hazardous Wastes) including boots, gloves and clothing. It should be noted that the research has shown that resources do exist however it is not always spent appropriately. For example a new public waste container (Dino bin) was seen lying stationary at the Ministry of Environment. This had been purchased by the Ministry but PEPSA were unable to use it as they did not have the required truck. Similarly the Ministry of Environment found funds to purchase masks

following the bomb blast of December 11th 2014 – they act in a reactive rather than proactive way.

6.1.3.3 Inadequate staffing

Inadequate staffing, especially of technical and professional staff, is a challenge to sustainable SWM in Jos.

The representative of the Ministry of Environment assessed the staffing capacity of the Ministry of Environment and PEPSA. The officer (IWMP1) declared that staffing is unbalanced and made up mainly of inexperienced staff members that have no formal training on waste handling. For example the Ministry of Environment has 162 permanent staff on their payroll including PEPSA, out of which 92 are Environmental Health Officer (EHOs) who are involved in a variety of activities as set out in Chapter 5.3.1.2. These 92⁴⁰ EHOs are deemed inadequate given the diversity of their role and covering a population of 1.3 million people. According to the official, the Ministry of Environment has not been able to increase EHO numbers because of the embargo placed on employment by government as a result of lack of finance. The inability of government to increase the number of EHOs contributes to the poor waste management system – for example in regards to enforcement and raising public awareness of waste issues. The stakeholders stated that any improvement in SWM would require the employment of more professionals and that the ad hoc involved in collecting the waste should be trained in order for them to improve their handling of waste. The issue of inadequate staffing and training in waste is supported by Ola-Adisa et al. (2015), while similar views regarding the lack of both skilled and unskilled staff were made by Kayode & Omole (2011) for Ibadan, and Iriyuga (2012) and Uchendu (2016) for Nigeria.

6.1.3.4 Lack of key solid waste data

The availability of accurate information on waste generation rates and composition is a prerequisite for effective SWM planning in any setting. In Jos municipality no reliable records exist of the quantity of MSW generated from households to enable for proper planning and management of the waste. As covered in Chapter 6.1.1.6, even when work has been commissioned it can go missing and recommendations not acted on.

This is in consonance with Peter's (2016) investigation on Jos, similarly literature shows that systematic records of waste data are virtually non-existent or not easy to come by in Nigeria (Afun, 2009; Agunwamba, 1998; Enete, 2010). Peter (2016) while investigating planning for municipal SWM stated that lack of accurate waste generation data and characterisation is one of the factors that constrains effective planning and organisation of municipal waste management in Nigerian municipalities. Proper waste audits are required in order to determine the actual

⁴⁰ The remaining 70 staff made up of administrative staff, security, cleaners and messengers in the office.

waste generation rates including composition so as to plan an effective SWM in Jos including low income areas.

6.1.3.5 Non provision of storage container at home

Households in the study area store their waste in any available container such as plastic or metal buckets, polythene bags, and baskets (see Chapter 5.4.3) before disposing of it – PEPSA does not provide containers for waste storage at home. Yawa (1999), Peter et al. (2014), Peter (2016), and Eche et al. (2015) have each reported similar ways of storing waste by low income households in Jos.

Focus group members identified non provision of storage containers as a barrier to sustainable management of waste from their homes. FGDT1 003 mentioned non provision of a proper waste container to store waste in the house makes it difficult for households to properly manage their waste. According to the participant householders use any containers available to them which ordinarily do not have proper handles and cover, hence waste stored in them generally smells and attracts flies. The containers were old and often broken making it difficult for households to carry their waste to the designated collection points – this could be a contributing factor to waste being burned or dumped in close proximity as its too much effort to carry the waste. This supports the findings of Yawa (1999) who highlighted poor container provision was a barrier to effective waste management.

Focus group members suggested that government should provide appropriate waste containers with a cover so that waste can be stored and taken to the public collection points for proper disposal. Interestingly the author came across a stack of wheeled bins at the Plateau State Ministry of Environment lying in waste without being put to use (see Figure 48). Further investigations revealed that the contractor who supplied the storage containers had a case with the state government in court; as such the containers were not available for use.



Figure 48 A stack of wheeled bins at the Ministry of Environment

Source: Image taken by the researcher during fieldwork in 2014

There seems to be a contradiction in the results with participants on one hand demanding the provision of an appropriate waste storage container, yet the same participants are complaining of a lack of storage space for waste in their homes. Perhaps the provision of appropriate containers with handle and cover, which could be used to help transport the waste for disposal at the public waste containers, and therefore useful to households, could overcome the concern of storage space.

6.1.3.6 Lack of organisation for waste collection

Even if the residents could carry their waste to the public waste containers it is clear that Jos lacks organisation for waste collection. Collection of waste from public waste containers by PEPSA is expected to be carried out twice a week; however this is not often the case as many public waste bins spend weeks without collection. The research supports the findings of Binbol et al. (2013) and Peter et al. (2014) that waste is not collected in many locations within Jos especially the low income areas. Some focus group discussion members opined that the lack of organisation in waste collection is because of non-involvement of the private sector, and communities, hence they called on government to involve the communities in order to reorganize waste collection. The poor service can be linked to the lack of resources as covered in Chapter 6.1.3.

Due to lack of waste collection services, focus group discussions with householders established that most residents of the study area burned (45.0%) and openly dumped (31.1%) their own waste corroborating the findings of Babayemi & Dauda (2009), Daffi & Kassam, (2013), Igoni, et al. (2007), Onwughara et al. (2010), and Peter (2016). Araba (2010) found that Nigerians consider dumping and burning a cheap and cost effective way of disposing of their waste.

6.1.3.7 Number and location of public waste containers

The research has highlighted the inadequate number and location of public waste containers. 59 public waste containers were seen in Jos at the time of this field study to cater for the needs of 1.3 million people – each bin is scheduled to be collected twice a week. Figure 35 shows the location of these bins across the 4 zones of the city. It is important to note that the zones vary in population density - Jos central zones 1 and 2 (where Jenta and Tudun Wada are located) have a higher population density than Abbatoir and Bukuru zones. It is difficult to estimate the population density of the low income areas, however the population density of Jos North was given as 1,913.1 inhabitants per km² (City Population, 2015). Observations indicated that public waste containers were not allocated based on density of areas, but rather on the ease of waste containers being collected for disposal. IWMP1 and IWMP2 stated that the unplanned and inaccessible nature of low income areas made it difficult for PEPSA to provide public waste containers in good locations. IWMP2 observed that in high income areas like the Government Reserved Area (GRA) there were often more public waste containers there than anywhere else because of

accessibility and convenience, and being a planned area there is also enough space to place public waste bins in good locations.

Top level calculations suggest that 20,313⁴¹ persons are allocated per public waste container. Based on this figure, when multiplied by the per capita waste generation rate of 0.47 kg/cap/day determined from the waste composition analysis (20,313 x 0.47 kg/cap/day), it means 9.5 tonnes of waste is generated per day for each bin. The average capacity of the public waste container was established from the representative of PEPSA to be 13 tonnes. It then means that two days' worth of waste generation is enough to overfill each bin. Therefore collecting waste from public waste containers twice a week is not realistic, more so that the population must have changed since the population count ten years ago and this does not take into account additional waste from businesses and other sources.

The specific low income areas in this study have only three public waste containers allocated to them: two in Tudun Wada and one in Jenta. The population of Tudun Wada was estimated to be 61,000 (NPC, 2006) meaning 30,500 people rely on each public waste bin. This number of people when multiplied by the per capita per day (30,500 x 0.47) would generate 14.3 tonnes of waste per day exceeding the 13 tonnes bin capacity in one day only. Even if the public waste container was being emptied every day it is still inadequate.

Focus group discussion members from Tudun Wada corroborated the claim of improper location of public waste containers by stating that one of the public waste containers in Tudun Wada is located by the market place, which is far from most residents hence their only option is to burn it or dump it. This is a common practice in Nigeria and has been acknowledged by many scholars (Araba 2010; Daffi & Kassam 2013; Dauda & Osita 2003; Igoni et al. 2007; Nabegu 2010).

Most members of the focus group discussions were of the opinion that government is not serious about SWM issues, *“they just often pay lip service without any accompanying action, and if not how can government provide only two public waste bins to manage waste in the whole of Tudun Wada area?”* Another member added that *“even the two waste bins provided, they don't come to empty it as it is often burnt in place, so where is the waste management here?”* (FGDT1, 004, 007).

As mentioned previously stakeholders have argued for the re-planning of low income areas therefore improving accessibility and the number of suitable sites for bin location. In addition IWMP2 advised that Plateau State Government should provide more public waste containers in the future especially with due consideration to the growing populace in order to take care of new settlements and the ever expanding low income areas within Jos. Alternatively IA1 stated that ideally there

⁴¹ Based on 1.3 million in 2008 (National Population Commission, 2008) and assuming 64 public waste containers are in place as per information from PEPSA

should be designated public waste dumps within communities where residents could dump their waste, from which waste collection trucks could come to collect the waste for proper disposal at the government designated dumpsites. This is not being practiced in Jos but does happen in other parts of Nigeria. Of course all of these things require proper funding and resourcing from the state government.

6.1.3.8 Lack of sanitary landfill

The safe disposal of solid waste through controlled methods is a fundamental element of a SWM system. Investigations established that no sanitary landfills exist in Jos for waste disposal, and this situation is replicated across Nigeria (Centre for People and Environment (CPE), 2010). The stakeholders interviewed emphasized that lack of a sanitary landfill is a major barrier to SWM in Jos, as this encourages PEPSA to continue to dump waste openly in government designated open dumps. All the open dumps visited located at Kwang and Zaria, Guratop and Bukuru Lowcost were not fenced off and had settlements in close proximity. Linking back to poor governance, the research identified that funds and land had been approved for the development of a sanitary landfill but this have never come into fruition.

6.1.4 Attitude of the public towards waste

The attitude of the public towards waste was identified as a key issue towards improving the waste management system. Specific challenges were identified on the general lack of public education on waste within the study area, plus poor engagement with residents and communities when making SWM decisions.

6.1.4.1 Lack of public education on waste

The way people think and feel about solid waste determines their waste behaviour. In Nigeria waste is viewed as dirty and so no one wants to be associated with it (Oyeniya, 2011). The lack of concern from residents of Jos, PEPSA, and government officials who lack the will power to improve the management of waste is a challenge supporting the findings of Iruaga (2012). In general the attitude and perception of people towards environmental issues affects how they obey environmental policies and engage with environmental programmes. For instance a person who does not think proper waste management is important to their personal or community health may not comply with waste collection service requirements even if all arrangements are in place for it (Uchendu, 2016). Therefore a nonchalant attitude is a challenge to effective SWM. Currently there is a lack of awareness and concern on environmental issues which influences waste behaviour. Adewole (2009) and Nabegu (2010) reported similar behaviour in Lagos and Kano due to ignorance and poverty.

The stakeholders interviewed and focus group members highlighted the attitude of residents towards waste was a challenge to effective waste management in Jos. Poor attitude towards waste was observed in the way household members from Jenta and Tudun Wada handled waste, discarding it anyhow in public spaces without regards to public health and the environment. Discarding of waste throughout the community

instead of designated public waste containers, makes it difficult to collect waste, resulting in unsanitary environments.

Some focus group members acknowledged that government has some good policies and intentions but the impact of these interventions are impacted by the attitude and behaviour of residents. For example as discussed in the focus group and highlighted by IWMP2, initiatives to give bags to residents to contain waste were abused by residents who ended up selling them. The residents of Tudun Wada were observed setting the public waste container around the market on fire. A further example is the theft of small public waste bins and side walk bins from the streets in Jos by residents to sell to recycling entrepreneurs. These small waste bins and side walk bins are meant for the collection of waste from passers-by from public spaces. The absence of small public waste bins and side walk bins from the streets escalates the levels of littering.

IWMP2 stated the low level of understanding of waste from the public was one of the biggest challenges being faced. In order to improve waste management in the study area, residents and the community need to be educated on how to manage waste safely and effectively so as to protect their health and environment. From the results it was established that for the past 17 years there has not been any form of government led public awareness education for the general public, mainly due to lack of funds and insecurity in the state. In order to develop an effective waste management system the appropriate services are required coupled with education so the public understand why and how they should use these services as the two works in tandem. Public awareness campaigns for Jos were supported by Binbol et al. (2013), Jatau (2013) and Peter et al. (2014), as they all believed that public awareness on waste management can create an impact on all stages of the municipal solid waste management process, especially when those with lower level of education are targeted as studies (Jatau 2013) has shown that they have the poorest attitudes towards waste management practices.

The inability to educate members of society on SWM issues could be the principal reason behind the indiscriminate disposal of waste in Jos. It could also be responsible for the public's poor awareness of important issues relating to the environment and public health.

A contributing issue towards the lack of waste awareness programmes is that the police would be needed to accompany EHOs on public awareness campaigns because of the security situation in Jos. A tradition in Nigeria is to hold rallies or events in public places when trying to raise awareness of important civil society issues – however these could be a potential target for terrorists. The lack of EHOs coupled with limited police and resources, which have priorities elsewhere, are a barrier to rolling out programmes. Members of the public have developed a habit of shunning public places because they have been targeted for incessant bombings in

the city. The state of insecurity due to Boko Haram activities has crippled public awareness programmes in Jos since EHOs and the general public cannot move about freely.

6.1.4.2 Poor engagement with residents and communities on SWM decisions

Interview with a stakeholder (IWMP2) and focus group discussions (FGDT1 002) with households has highlighted that government has not been engaging with residents and communities in discussions regarding SWM. This can be confirmed through statements with stakeholders:

Currently households and communities are not involved in SWM decisions because government laws or policies have not made it possible (IWMP2)

A member of the focus group discussion (FGDT1 002) observed that the state government is managing waste in isolation without engaging with us the householders and generators of the waste, and not even engaging with our community leaders or ward heads.

The implication is that residents and communities feel neglected; as such they manage waste in the most convenient way for them. This situation is common to urban cities in Nigeria and LEDCs as observed by Nabegu & Mustapha (2014).

Whilst there has been considerable attention on the need for community participation and involvement in wider processes of public decision making (Barstein, 2000; UNEP-IETC, 2003; Zurbrugg & Ahmed 1999) to date there has been little evidence of such participation in Jos.

6.2 RECOMMENDATIONS

Based on the findings from the research, the author has made recommendations under three themes to address and improve the management of solid waste from households in low income areas. It is acknowledged that some of the recommendations are long term and aspirational, and under the existing governance system would be difficult to implement.

6.2.1 Changes to the political structure

i. Political appointments

The study has shown that political appointments create problems and hamper the development of an effective waste management system. There is a need for government to dissociate politics from governance by appointing only professionals of SWM into key positions of the Ministry of Environment and PEPSA.

ii. Autonomy for PEPSA

Due to the current bureaucratic relationship between the Ministry of Environment and PEPSA, waste management issues are not being addressed appropriately. PEPSA need autonomy to function freely, independently and effectively. By doing this PEPSA would have direct responsibility for purchasing the equipment they need and the recruitment of staff which they do not currently have.

6.2.2 Resourcing of the waste management system

iii. Provision of sufficient funds

In order to improve the waste management system the declining financial sources for waste services need to be dealt with. Both the Federal and State governments have to improve the financial allocation to waste management if the desired improvements are to be achieved. Specifically in Jos additional funds are needed for PEPSA to deliver an effective service. Moreover PEPSA is encouraged to find ways to generate additional revenue to help fund their operations. The provision of funds could be through the involvement of qualified financial and accounting staff that can identify viable sources of funds, for example charging larger businesses and waste generators for waste services as at present they are receiving these services for free.

The contribution of households towards waste management services also needs to be considered. Households pay NGN50 (12 pence) per month to Plateau State Internal Revenue Board and this revenue is divided across all services including health, education, water provision and waste. At present waste is treated as a social service and although some revenue from local taxes is generated to fund waste services, the amount is paltry.

Although most residents of low income areas are not willing/or are unable to pay for waste collection, the case may be different with middle and high income areas. Moreover as highlighted in the research 30.6% of households were middle and high income households and therefore have the means to potentially fund improved services. Improving the funding of waste services will help to acquire and maintain infrastructure and equipment to provide better waste collection and disposal service. The research has noted that money is wasted on buying the wrong containers or equipment that is never used – there needs to be a *smarter* use of the funds available. A further option is to seek funding from international bodies and donors.

iv. Increase staffing levels

Inadequate staffing of EHOs and technical staff is an obstacle to the waste management system. A solution to this problem is for the government to lift

the embargo placed on employment so that more EHOs and technical staff can be employed. Apart from employing more staff there is a need for training to upskill those working in providing waste services to better understand the implications of poor waste management and also the health and safety issues relating to waste collection. As per Recommendation iii the government need to increase funding for SWM to take care of increased staffing. This as part of a wider strategy would help to improve the waste management system. The upskilling of these workers would also increase their long term job prospects.

v. Improved container infrastructure at household and community level

At present households are not provided with containers to contain their waste and often have to travel long distances to make use of the public waste containers. This leads to waste being poorly contained at home with waste often being accessible to vermin and waste strewn throughout communities. Moreover the public waste containers are often overflowing or waste burnt in situ. Therefore a more strategic approach is needed from the authorities. Containers should be provided to households to help properly contain the waste and help to facilitate waste being taken to the public waste containers. Moreover the public waste containers need to be more strategically located thereby encouraging use by households. It is clear that there are insufficient containers at present and the capacity needs to be increased. If budgetary requirements prevent the purchase of further containers, satellite sites should be allocated in the community where householders can take waste for disposal which can then be cleared by the municipality.

vi. Improved accessibility

As highlighted in this research a barrier at present is accessibility of collection vehicles to low income areas. In order improve the waste management system it is crucial that the State Government empowers and authorizes the Ministry of Land and Survey to re-plan and restructure low income areas by coming up with new or different plans especially in the layout of buildings and roads in order to make them more accessible so that waste collection trucks can have access to the area, and public waste bins placed in strategic locations (IWMP1, IWMP2). Literature (Peter, 2016) has shown that if proper planning is effected and public waste containers are strategically and conveniently located, households would be encouraged to dispose waste rightly thereby enhancing SWM.

Where this is not possible an alternative model could be developed where informal workers of these areas could be paid by PEPSA to collect this waste and manually transport it to more accessible central collection points. This

would mean more money but would improve the local environment whilst also creating local employment.

vii. Development of sanitary landfill

Further to providing funds for the purchase of equipment and logistics, it is important to also provide land and investment for the development of a sanitary landfill sites for waste disposal in Jos. The State Government should engage the services of professionals in identifying and acquiring a suitable land bearing in mind the environmental and social impacts of the site. There are numerous examples of sanitary landfill sites which have been funded and developed through the Clean Development Mechanism (CDM). The Clean Development Mechanism is a mechanism set out in the Kyoto Protocol (IPCC, 2007) which aims to reduce global emission of greenhouse gases. Infrastructure projects that lead to a reduction in greenhouse gas emissions generate Certified Emission Reduction unit (CERs). These CERs can be traded and sold, and used by MEDCs to help meet their emission reduction targets under the Kyoto Protocol. Companies work with governments to invest in LEDCs to improve local environmental conditions, such as developing sanitary landfills that result in greenhouse gas savings, who in turn trade in the resulting CERs.

viii. Embracing the informal sector

Recycling is a very important aspect of waste management (IWMP2), and currently there is a glaring absence of formal recycling in Jos. As a result, the informal sector has taken up the responsibility of filling the gap. There is no published data on the recycling rate in Jos, but anecdotally the informal sector is helping to achieve significant levels of recycling, plus the associated social and environmental benefits. Nationally the government needs to enact a clear policy on solid waste management and recycling that recognises the informal sector. Legislative changes that incorporate inclusive policies and approaches to SWM involving the informal sector would help to improve the waste management system, create awareness and improve attitudes towards waste (Adama 2012, Nzeadibe, 2009). The informal sector could specifically be engaged with to help collect waste and recycling in low income areas which are inaccessible to PEPSA.

ix. Involvement of the private sector

Literature (Ezeah et al. 2013) has shown that other Nigerian cities have worked effectively in partnership with the private sector to improve the waste management system. Working with the private sector has helped generate additional finance and resources that the public sector alone may not have been able to supply. Whilst previous attempts to work with the private sector

in Jos proved to be unsuccessful this is something that decision makers need to revisit.

x. Intelligence-led decision-making

There is a lack of reliable data on municipal solid waste in Jos. For example no data on waste arisings, how waste is being managed and the composition of materials – this research helps to fill some of these gaps. This lack of intelligence inhibits planning an effective waste management system. In order to overcome this problem the government and its agencies should develop a new data collection protocol to in order to generate reliable and ongoing data on the waste situation in Jos. This should include working alongside the University of Jos and other research organisations to increase capacity and assist in the planning and implementation of SWM operations. Students at the University of Jos have undertaken many past studies on waste and they could provide critical mass to help collect and analyse this data on an ongoing basis.

6.2.3 Education and engagement

xi. Greater awareness of waste

The poor solid waste situation can be partially dealt with through increasing public education and awareness campaigns of waste issues. The campaigns could be integrated with a range of approaches adopted.

Due to the limited resources available and the ongoing security issues thereby inhibiting the role of EHOs, a more community based approach could be adopted. Greater awareness of waste education could be undertaken through churches, schools, mosques and the media working closely with community gatekeepers, the chiefs, ward heads and religious leaders. Whilst a holistic approach should be adopted to reach all of society the research has shown that women and children are mainly responsible for managing waste in the household – therefore some targeted campaigns could be developed to increase awareness, change behaviour and promote waste prevention. There needs to a concerted national effort through radio, television and newspapers to raise awareness amongst the general public. In Nigeria government still has a key role in television and radio broadcasting. Nationally there is the National Television Authority (NTA) and Federal Radio Corporation of Nigeria (FRCN), and states have their own stations, for example in Plateau State there is the Plateau State Radio & Television Corporation (PRTVC). Being state run these stations have minimal broadcasting costs and an effective strategy could be developed for disseminating information to the public on waste. It should be noted that most residents in the study area have small transistor radios and many have televisions.

Waste and sanitation should be introduced into educational programmes in Nigeria and made an integral part of the basic education curriculum, while Universities and Polytechnics should be encouraged to introduce programmes on environmental management, including courses on solid waste management, to train qualified personnel for the sector thereby increasing critical mass.

xii. Inclusive policy making

The National Environmental Sanitation Policy (2005) sets out to achieve a clean and healthy environment for all Nigerians. A clean and healthy environment can only be possible when all stakeholders, from waste producers to waste managers, are involved in the process (Ahmed and Ali, 2004). However residents or communities who are among the biggest generators of waste have not been involved in making decisions concerning SWM in the study area. The solution to this problem is for the government and PEPSA to engage with the chiefs, ward heads and other community leaders, in all decisions concerning SWM including the development of collection services and location of disposal sites. The chiefs, ward heads and other community leaders are respected in the community and will greatly influence the behaviour of residents. This research recognizes household involvement as being vital to sustainable and effectual SWM in Nigeria and other low income countries.

xiii. Increased role of waste prevention

As acknowledged in this research some of the recommendations require significant changes in political structures, resources and funds. Whilst there is a significant level of reuse already underway in the study area, more could be done to promote waste prevention, especially using low to no cost interventions. Research (Mbah & Nzeadibe, 2016) has shown that Nigerian authorities have a tendency to overlook the importance of waste prevention strategies in spite of them being the priority of the waste hierarchy. There is the opportunity to build upon the existing behaviour in the community to help reduce the quantities of waste that need to be managed.

This research established an increasing waste generation and complexity in composition of waste as a result of increases in population, urbanization and consumerism. In order to solve this problem or improve on it, government is advised to pursue an alternative path that attempts to prevent the problem which is adopting waste prevention measures.

6.3 LIMITATIONS TO THE RESEARCH IN PARTA

The author acknowledges some limitations in the research. A key issue was the ongoing security situation in Jos. Although there have been ethno-religious tensions since 1992, the security situation escalated during fieldwork with Boko Haram targeting and bombing Jos many times. Two bombings in May 2014 killed 118 people, another bombing in December 2014 killed 30 people, and in July 2015 44 people were killed. This boko haram attacks has led to tension and suspicion in the city. Undertaking research under these conditions was challenging especially when trying to interview persons in authority. The security situation on ground made movements difficult when collecting primary data.

Another challenge was the political situation at that time of undertaking fieldwork. Elections were held in March 2015 and in the build-up there was much political tension. The author had to reschedule interviews and focus group meetings several times due to subsequent clashes with political rally dates and meetings. It is important to understand that politics works very differently in Nigeria than in Europe. For example, at political rallies people attend because they know they will receive money from those seeking election, hence they would rather attend a rally than be engaged in fieldwork.

Electricity and power failure was an issue during the fieldwork. For example one focus group was moved from 2pm to 6pm at Tudun Wada to accommodate a political rally, however not long after the discussion started there was power failure. The research team had to look for lamps and torches so that the venue could be lit allowing for discussion to progress.

The author noted that some residents were reluctant to participate in the research. This was partly due to the political and security situation meaning people are suspicious of strangers. They are also sceptical of research as residents do not see developments and improvements within their community. Some participants said people have been coming to do research year in year out but they do not see any useful outcomes, hence it amounts to a waste of their time granting interviews and responding to questionnaires. To overcome these challenges the author tried to utilise gate keepers to get buy in from residents.

From undertaking the fieldwork it was clear the awareness of waste issues in the community was low and this could impact on the reliability of the responses to questionnaires. Attempts were made to clarify any points by the research team during administration of questionnaires, however this could have inadvertently influenced the responses. On reflection the questionnaire itself contained some questions which were not useful and not included in analysis. Similarly the questionnaire was conducted prior to the waste composition analysis (see Chapter 8) and the survey contained questions on food waste prevention activity. However, it

was evident from the survey and from the composition that very little unavoidable food waste was generated hence some of the questions were not needed.

For the majority of the duration of research the author was based in the UK. This impacted on when it was possible to undertake fieldwork in Jos which was further complicated by the security situation as described above. Some activities including organising primary data collection, and follow up work to corroborate queries, had to be conducted long distance.

6.4 SUMMARY

The data collected during this research shows that Tudun Wada and Jenta face a lot of challenges to sustainable waste management. These challenges have been categorized into four major themes: the role of government, solid waste management practice, resource allocation and the attitude of the public towards waste.

Based on the findings from this research which include poor management of solid waste inspite of the increasing quantity of waste being generated due to some challenges, the author has made recommendations under three themes to address these challenges. Some of the recommendations are long term and aspirational, and under the existing governance system could be difficult to implement.

Part A of this research has helped the author to develop an understanding of how waste is managed in Jos, and identified the challenges to developing the sustainable waste management system, as well as present recommendations to address these challenges thereby satisfying Objectives 1 and 2.

As highlighted in this research there are already limited resources to manage the current waste levels. Given the poor existing waste management system, the projected increases in population and waste arisings are concerning. One approach to help address this problem is in implementing an effective waste prevention strategy. Part B of this thesis evaluates the waste prevention options available to improve waste management in the study area and to address some of the challenges identified.

PART B

7 WASTE PREVENTION

7.1 WASTE PREVENTION IN CONTEXT

Waste generation and resource shortages have long been recognized as the two utmost challenges facing society (Hou et al. 2012). The quantity of waste currently being generated is increasing, and the nature of waste is also changing due to changes in society and technology (Hornweg & Bhada Tata, 2012). The products now contain a mixture of materials such as plastics, metals and hazardous materials that are problematic to deal with safely. The EU (2013) states that good waste management starts with waste prevention, since what is not produced does not have to be disposed of. As global population increases and eats away at our limited resources, waste prevention is becoming increasingly important. Waste prevention has been embraced in MEDCs even though Wilson et al. (2010) observed that it had taken over 30 years to focus more seriously on waste prevention, but only now is its significance becoming fully recognized.

In LEDCs, including Nigeria, little is being said and done about waste prevention in spite of its increasing benefits, however reuse and recycling culture has been very common (Abila & Kantola, 2013; Bakare, 2016; Nnaji, 2015). As presented so far large parts of low income areas hardly receive even the most basic waste services. Some of the benefits of waste prevention to society include reduction in the cost of waste management, protection of the environment and public from the harmful effects of pollutants, and promotion of resource efficiency (EC, 2013). Waste prevention offers the best chance for reversing the current trends in waste generation in Nigeria and other LEDCs. The funds and costs associated with waste can be prohibitive in LEDCs however many waste prevention interventions are low to no cost, thereby presenting effective and viable solutions. These are actions individuals could take thereby reducing over reliance on government. Similarly there is a lack of research in low income areas and this makes the research very important and timely.

7.2 WASTE COMPOSITION ANALYSIS

7.2.1 Introduction

Household waste analysis was conducted within the study area in order to determine the quantity and composition of solid waste generated. The methodology used for the waste characterisation study has been presented in Chapter 4.2.5. A weeks waste was collected from 74 households and characterised at the Zaria Road dumpsite. Analysis was conducted for each individual house rather than bulk analysis, therefore generating more detailed results and analysis. Participating households also

completed the same questionnaire as used in Part A to collate information on their household characteristics and waste management behaviour. The key objectives of the study were to calculate the per capita generation rate of household waste from the study area, to determine the composition and relative quantities of the household waste stream, and identify priority materials for waste prevention.

7.2.2 Results and analysis

Table 32 and Figure 49 Overall waste composition of the study area by weights how the composition of solid waste collected. The total quantity of waste generated from the 74 households was 658.19 kg, with 466 persons residing in the households sampled, this equates to 0.47 kg/capita/day.

Table 32 Overall composition of waste sampled by weight and percentage

Category	Total waste (kg)	% of waste sampled
Food	192.1	29.2
Ash/unburnt wood	121.2	18.4
Plastic films/bags	89.7	13.6
Fines	44.7	6.8
Misc. comb	32.0	4.9
Paper/card	30.8	4.7
Textile	29.2	4.4
WEEE	24.3	3.7
Glass	23.7	3.6
Metals	21.0	3.2
Others	20.6	3.1
Dense plastic	17.9	2.7
Garden waste	10.9	1.7
Total	658.2	100.0

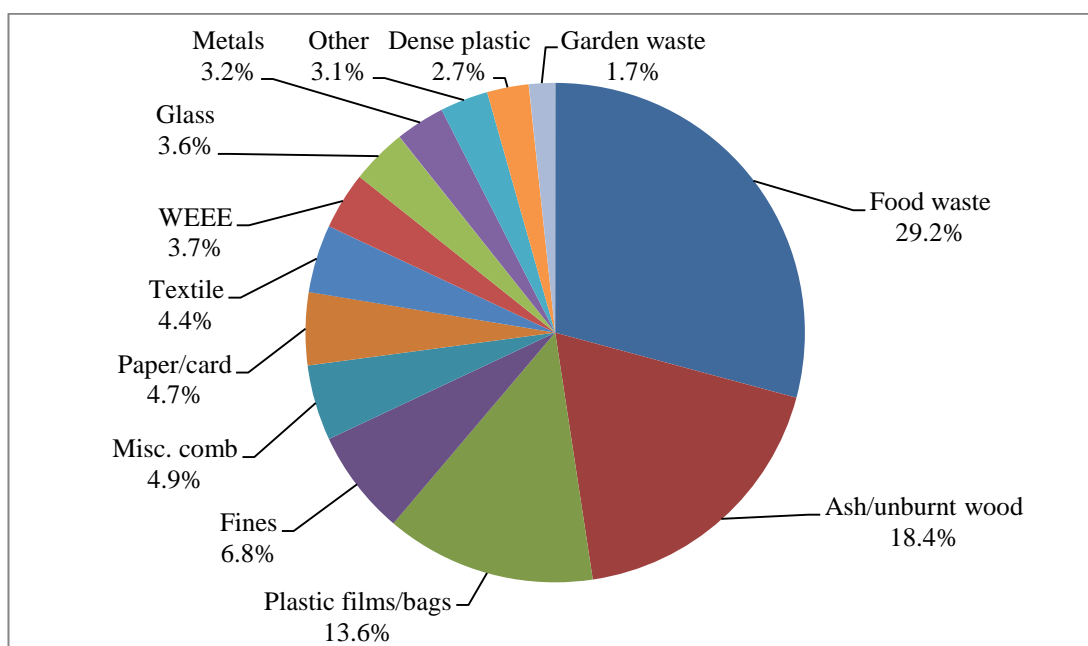


Figure 49 Overall waste composition of the study area by weight

The largest fraction was food waste which made up 29.2% of the total waste sampled. The food items were unprocessed with high moisture content consisting mostly of unavoidable waste materials. Figure 50 provides examples of unavoidable food waste sampled including bitter leaf stems, spinach stems, ogwu ribs, mango and yam peelings.



Figure 50 Examples of food waste sampled mainly stems and peelings

Source: Image taken by author during fieldwork in 2015

Figure 51 shows the level of food waste in relation to the total waste generated for each household. It can be seen that the levels of food waste from households varied from 0.65 kg/household/week to 7.05 kg/household/week.

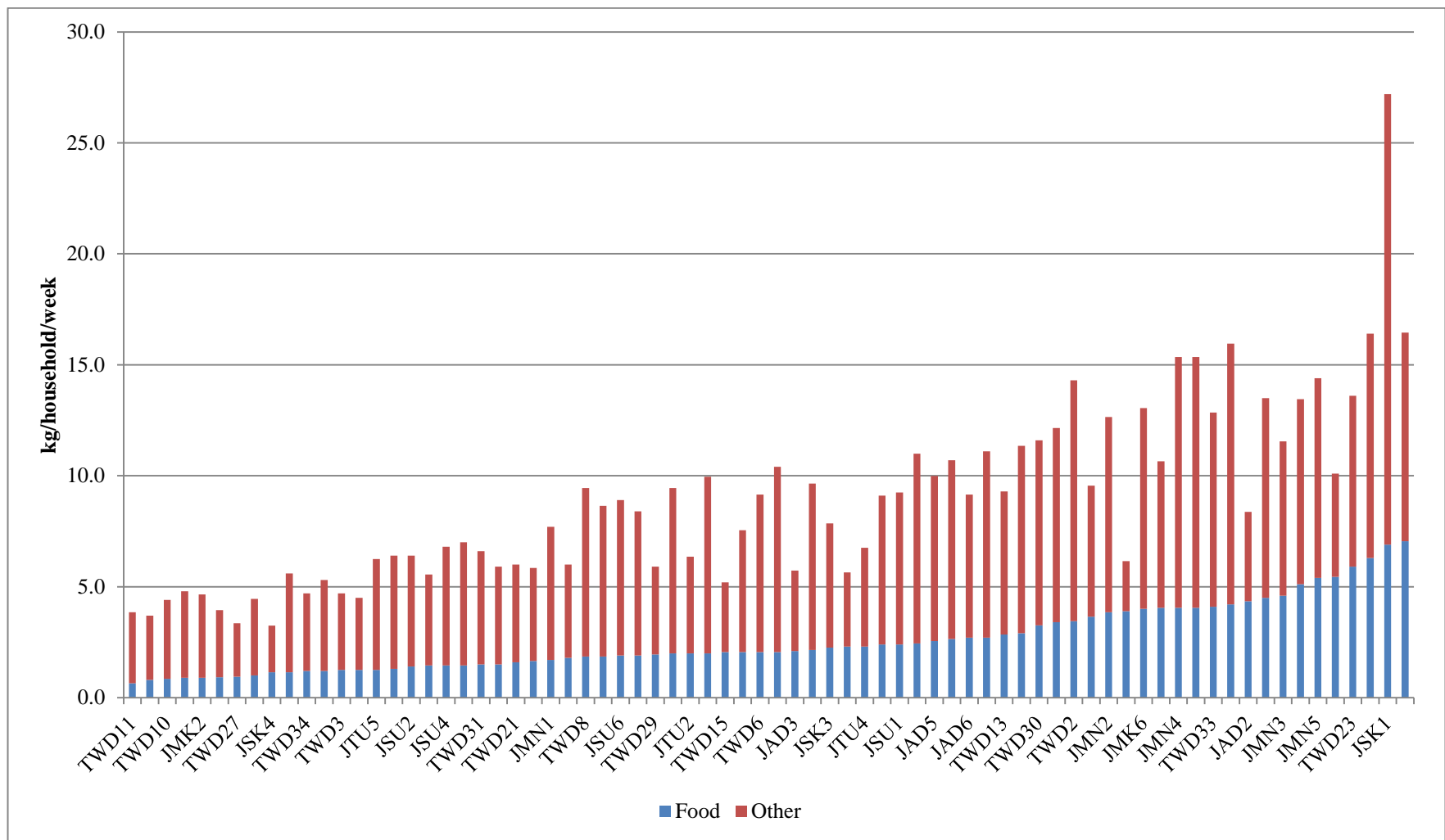


Figure 51 Variation in food waste levels of households sampled (in relation to total waste for household) – kg/household/week

The percentage of ash/unburnt wood in the waste stream 18.4% reflecting the lifestyle of the households sampled. Plastic films/bags constituted 13.6% of the waste stream. This is due to plastic films/bags being prevalent in Nigeria to package items from markets and shops. In addition the consumption of sachet water is common due to the lack of good quality drinking water within the study area. In the methods adopted all plastic films and bags were grouped together, anecdotally it is estimated that 3/4 were single use plastic bags representing 10.2% of the overall waste stream.

Fines, consisting of soils and dust, made up 6.8%. The level might be due to most floors in compounds or homes not being cemented and made up of soil.

Paper/card formed 4.7% of the waste stream made up mainly of newspapers, cartons and cardboard packaging. Textile made up 4.4% of the waste stream, the majority was offcuts from tailoring works, as some households had tailoring shops within their yards. Electrical and electronic waste materials were mainly broken phones and chargers, ear phones and calculators, and constituted 3.7% of the waste stream. Glass was 3.6% of the waste and made up of bottles, broken glass windows. 3.2% of the waste was metals of different kinds ranging from pieces of iron bars, nails, drink cans and pieces of roofing sheets.

Dense plastics made up of plastic bottles, plates, cups and pieces of broken buckets and jerry cans contributed 2.7% of the waste. The low percentage of dense plastic in the waste could be attributed to levels of reuse and recycling taking place (see Figure 44).

A wide variety of other materials were present including drugs, sanitary towels, nappies, and hazardous items like batteries. Miscellaneous combustibles included weave on (hair extensions) as some householders used their homes to do hair dressing/platting. Analysis of the variation of waste components is very important, as it helps municipalities and waste planners to plan on its management.

Table 33 shows the maximum, minimum, mean and median quantities of waste components from households in the study area, this was for the purpose of plotting boxplots. Figure 52 presents the boxplots of this waste components showing maximum/minimum, mean and median values. Boxplots provide comparative data on waste composition for the different waste groups.

Waste materials were grouped into three broad categories based on their composition: biodegradable, recyclable and residual (see Table 33 Maximum, minimum, mean and median quantities of waste components – kg/household/week). 65.2% of the waste was classified as biodegradable, 13.2% recyclable and 21.6% residual. Figure 53 provides a breakdown of results for each household sampled. Biodegradable materials in the waste stream per household ranged from 1.7 kg to

18.3 kg per week. The recyclable materials produced by households varied from 0.4 kg to 2.9 kg and residual waste ranged from 0.6 kg to 6.0 kg per week.

Table 33 Maximum, minimum, mean and median quantities of waste components – kg/household/week

Category	Classification ⁴²	Kg/household/week			
		Maximum	Minimum	Mean	Median
Food	Biodegradable	7.1	0.7	2.6	2.1
Ash/unburnt wood	Biodegradable	4.3	0.1	1.6	1.7
Plastic films/bags	Residual	5.2	0.4	1.2	1.1
Garden waste	Biodegradable	3.5	0.3	0.9	0.6
Fines	Biodegradable	2.1	0.1	0.7	0.7
Misc. comb	Residual	1.3	0.1	0.5	0.4
Paper/card	Recyclable	1.4	0.1	0.4	0.4
Textile	Biodegradable	1.1	0.1	0.4	0.4
WEEE	Recyclable	1.2	0.1	0.4	0.3
Glass	Recyclable	1.0	0.1	0.3	0.3
Others	Residual	1.2	0.1	0.3	0.3
Metals	Recyclable	1.1	0.1	0.3	0.3
Dense plastic	Recyclable	1.0	0.1	0.2	0.2

⁴² It is note that for some materials there is an overlap between biodegradable and recyclable.

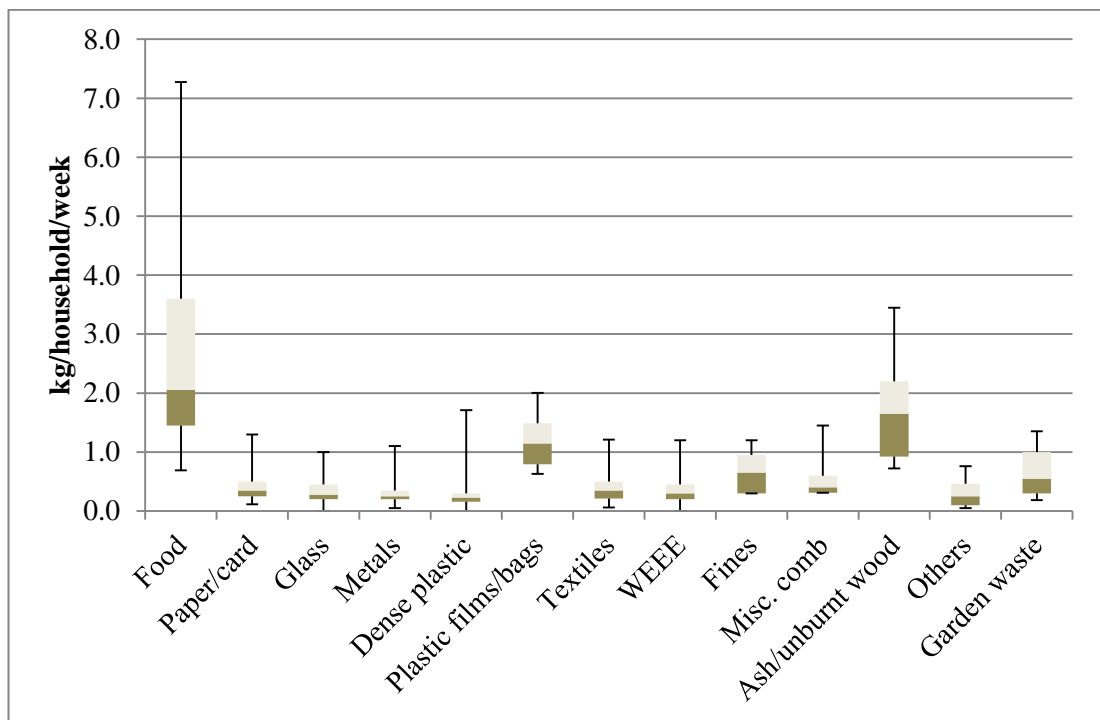


Figure 52 Box plots of maximum, minimum and median waste components sampled

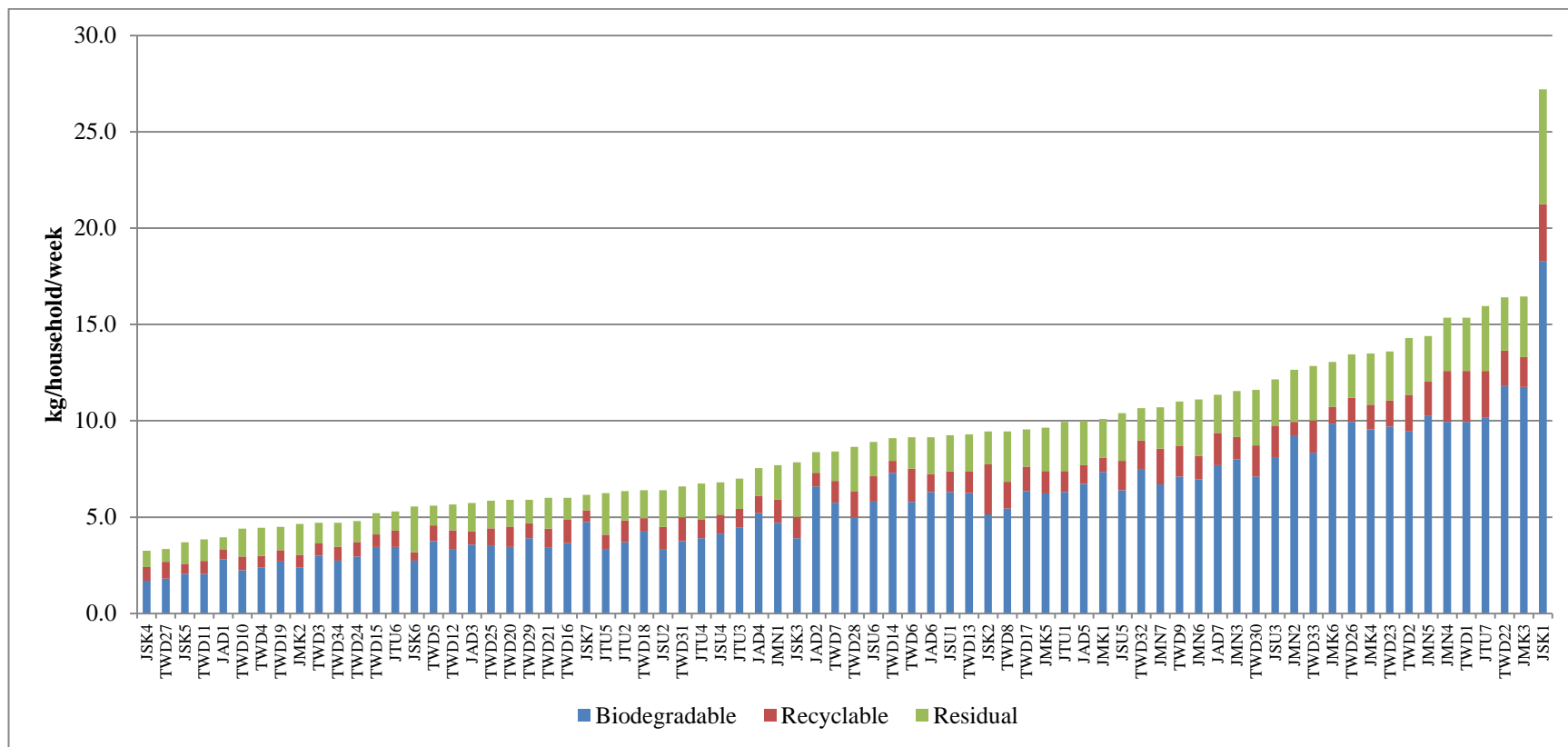


Figure 53 Composition for each household sampled based on biodegradable, recyclable and residual waste components

7.2.3 Discussion

7.2.3.1 Composition

7.2.3.1.1 Food waste

The waste composition study indicated that 29.2% of the waste is made up of food waste consisting mainly of vegetable, fruits and other scraps resulting from food preparation. The result differs from household waste characterisation studies carried out in other Nigerian cities by Abur et al. (2014), Bichi & Amatobi (2013), and Igbinomwanhia et al. (2014). Abur et al. (2014) in their study of Abuja discovered that 52.0% and 56.2% of waste generated was food during the dry and rainy season respectively. Bichi & Amatobi (2013) putting food waste at 57.5% in Kano with Igbinomwanhia et al. (2014) reported 51.3% to be food waste in Amassoma in Niger Delta. Although the percentage of food waste reported in this study falls below that of other cities in Nigeria, it clearly shows that food waste constitutes the highest percentage of the Jos waste stream. The total biodegradable waste was 65.2% - it could be that there were methodological differences in this study with those cited above, and that they included other biodegradable wastes within their food waste category. Moreover as mentioned in Nigeria many households have businesses that operate from home, and it could be that these other studies had higher levels of food based businesses operating from home compared to the study area. There is variation in other studies on the reported biodegradable waste level in Nigeria range from 50% to 90% of the total waste (Cointreau, 1982; Nabegu, 2012; Ogwueleka, 2009; Otti, 2011) – therefore the findings from this study falls within these levels. The presence of other waste materials will also influence the contribution of food waste to overall arisings – for example in this study the levels of ash/unburnt wood were high.

7.2.3.1.2 Ash/unburnt wood

Ash/unburnt wood⁴³ constituted the second largest component in the waste stream at 18.4%. Participating households were asked to bag up their ash thereby making it easier to analyse and not contaminate the other waste sampled. The levels were similar to the findings of Nabegu (2010) who stated ash/dirt made up 22.5% of the waste stream in Kano. However it is difficult to compare the level of ash and unburnt wood with other studies because it is often grouped together with other categories. For example Abur (2014) observed that 25.6% of waste from Abuja was made up of ‘other’ forms of waste among including ash and unburnt wood. Similarly an analysis of household waste by Amori et al. (2013) from junior staff quarters in selected tertiary institutions in Nigeria show that 14% of the waste stream was made up of other wastes including ash and unburnt wood.

The high level of ash and unburnt wood at 18.4% was mainly due to low income households being unable to afford cooking fuel such as kerosene and gas, so they use firewood and charcoal to cook with. In addition ash is dense and tends to dominate

⁴³ Wood that was placed on a fire but only partially set alight or fully broken down to ash.

the weight of the waste stream. In this research ash/unburnt wood has been included in the biodegradable element – this was based on the work of Pasquini (2002), focus group discussions and interview (IWMP2) which indicated that households were using household waste ash as a fertilizer on their farms. Observations also confirmed that household members from the study area had a habit of collecting ash from their daily cooking with wood and spreading it on farms⁴⁴ as fertilizer. Literature (Pasquini & Harris, 2004; Pasquini, 2006) exists on the use of household refuse and ash waste in urban agriculture around Jos.

7.2.3.1.3 *Plastics*

Plastics constitute 16.3% of the total waste stream from households, comprising of plastic films/bags (flexible plastic) (13.6%) and dense plastic (2.7%). The results compared closely with studies carried out by Oyelola & Babatunde (2008) at 11.32%, Amori et al. (2013) at 13.0% (bags only), Bichi & Amatobi (2013) at 17.6% in Sabongari, Kano, and Obateru (2016) 20.0% for Nigeria.

Observations show that plastics are seen littered everywhere in the study area especially plastic bags (see Figure 54). The impacts of plastic bags include pollution, clogging of drains and water channels thus causing flooding in urban settlements. During collection and disposal at waste dumps, plastic bags get blown around by wind hence littering the environment and constituting an eyesore and a source of danger to animals when eaten. The impact of plastics on the environment and public health in Jos has been documented by Ahovi (2017).

Plastics are displacing traditional materials used in everyday life. For example in the past people would collect banana leaves to prepare moin moin⁴⁵. They would use the leaves to wrap food for steaming, however for convenience people are now using plastic films which is to the detriment of the environment because plastics are non-biodegradable.

Dense plastic included water bottles, jerry cans, plastic buckets and plastic plates. These were however few in quantity because observation showed that they were highly being reused by households as can be seen in Chapter 5.4.9. In spite of the fact that some plastics are being reused to package items, they remain a challenge to the environment.

⁴⁴ In Nigeria it is common practice for citizens to farm on available land that is not being utilised.

⁴⁵ A traditional Nigerian dish made from beans that have been steamed.



Figure 54 Examples of plastics littering the study area

Source: Images taken by author during fieldwork in 2014/2015

7.2.3.1.4 Other materials

Materials such as electrical and electronic waste, glass, and metals made up 3.7%, 3.6%, and 3.2% of the waste respectively – again as covered in Chapter 5.4.9 there is an established informal infrastructure in place to reuse and recycle these materials in Jos.

7.2.3.2 Solid waste generation rates

Achi et al. (2012) used a questionnaire to derive the waste generation rate for Abeokuta. Achi et al. stated it was however difficult to conclude an accurate value because 58.1% of the respondents could not estimate their solid waste generation rate, therefore an estimated value of 0.60 kg/cap/day was assumed. The approach adopted in this study of collecting weight data and information on household size overcame the challenge encountered by Achi et al. (2012), thereby generating a more reliable data.

The average household size from those sampled was 6.3⁴⁶ and the generation rate was 0.47 kg/capita/day. This is in line with World Bank data for LEDCs which is between 0.30 to 0.60 kg/capita/day (Hoornweg and Bhada Tata, 2012). Similarly it is comparable with other studies undertaken in Nigeria: Sha'ato (2007) obtained 0.48kg/capita/day for Makurdi, Bichi and Amatobi (2013) found 0.31 kg/capita/day

⁴⁶ This compares with 5.9 persons per household from the main questionnaires presented in 5.2.3. The median value for the sampled households was 6.0 persons per household.

for Kano, while Solomon (2009) had presented 0.49 kg/capita/day for average Nigerian communities with households and commercial centres.

7.2.3.3 Factors affecting solid waste generation in households

Literature (Kayode & Omole, 2012) lists factors that could affect the characteristics and composition of waste from households, other examples include Afroz et al. (2010), Grover & Singh (2014), and Sivakumar & Sugirtharan (2010). Nnaji (2015) cited factors such as time of the year, economic status, population density, lifestyle/habits, coverage of the study in terms of time and space and seasonality (rainy or dry season). The research method applied in the study helped to identify some of these factors influencing waste generation rates.

7.2.3.3.1 Household Size

Household size refers to the total number of people living in a household – this was captured from questionnaires. The average household size was found to be 6.3 this compares with the average household size in Nigeria at 4.6 (Nigerian Demographic and Health Survey (NDHS), 2013) while that of Jos Bukuru Metropolis was 5.5 (Knoema, 2016). This shows that the average household size for the low income areas in Jos is higher than the national average and that of greater Jos.

As set out in Table 34 the household size varied from 1 to 15 while the median was 6.3.

Table 34 Household size and mean waste generation per capita per day

Household size	Number of households	Average per capita generation rate (kg/capita/day)
3	6	0.45
4	7	0.47
5	15	0.48
6	14	0.48
7	13	0.45
8	10	0.48
9	5	0.52
10	3	0.34
15	1	0.60

It also shows the difference in the per capita waste generation rate against household size in the study area (also see Figure 55). There seems to be no direct relationship between household size and the average per capita waste generation rate, and the low sample size is noted. Ogwueleka's (2013) survey of household waste composition and quantities in Abuja revealed no statistically significant difference between household size and daily per capita household waste generation in low-income group.

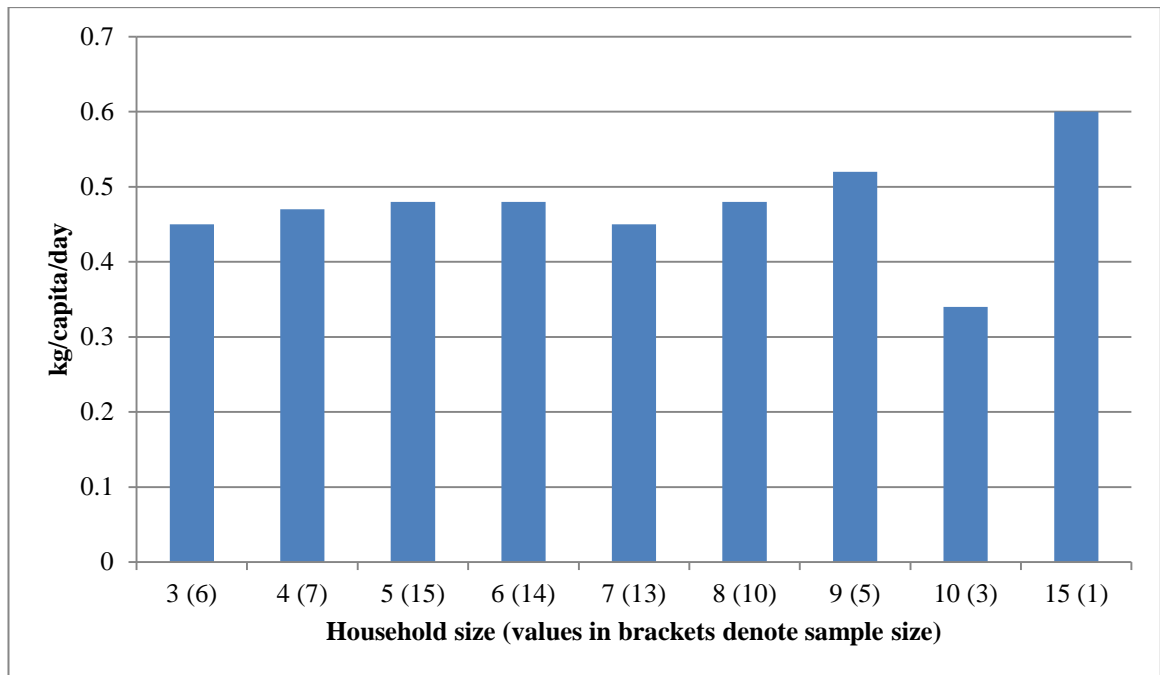


Figure 55 Per capita waste generation rate vs household size

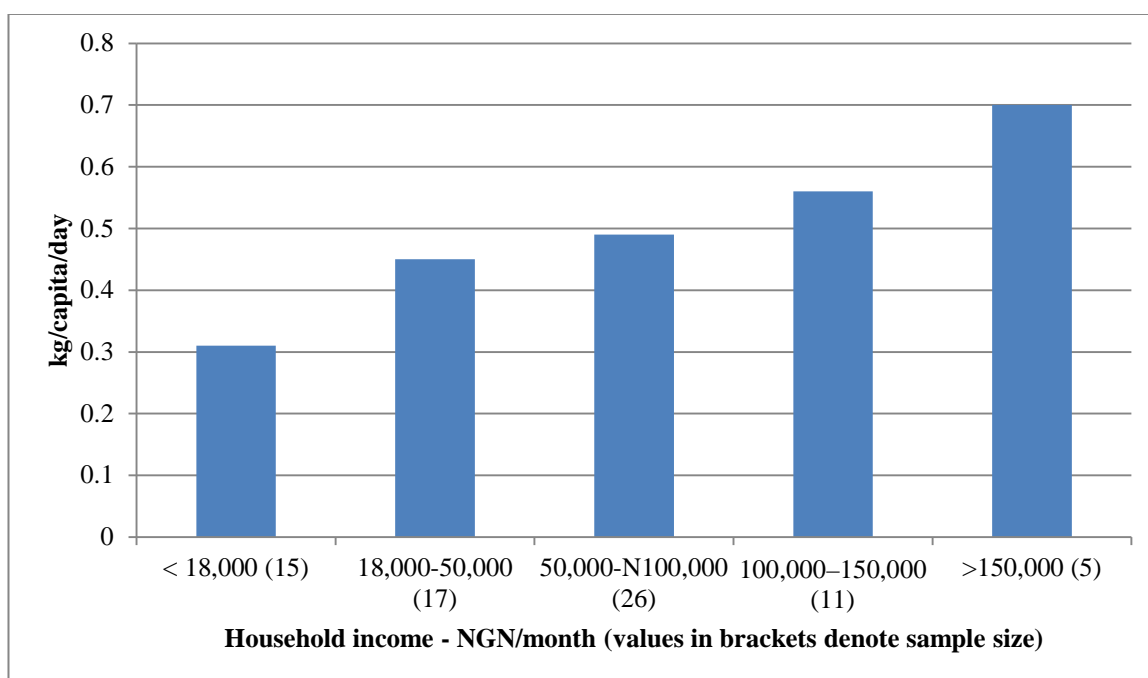
It is important to note that majority of the households claimed that their household size was not stable, as family members come and go back to school, and relations and friends also come for holidays either from the village or other parts of the country. As mentioned in Chapter 5.2.3 the typical make up of households in the study area is complex and it is usual to find grandparents, grown up children and other relations making up extended family households, with only a few nuclear families.

7.2.3.3.2 Income

The minimum wage in Nigeria is currently NGN18, 900 (£47.54) per month and households that earn less than NGN50, 000 (£135.50) are classified as low income households (EFInA, 2011). Responses from the questionnaire show that only 43.2% of households sampled had an income of less than NGN50, 000 per month with 56.8% having middle to high income. As with the research in Part A (see Chapter 5.2.3), the results show that the demographics of low income areas are complex and that they are home to middle and high income earners. Table 35 on income and average waste generation was used to plot the relationship between waste generation per capita and the household income (see Figure 56).

Table 35 Income and mean waste generation

Household monthly income (NGN)	Number of households	Average waste generation rate (kg/cap/day)	Category based on EFInA (2011)
< 18,000	15	0.31	Low income (43.2%)
18,000 – 50,000	17	0.45	
50,000 - 100,000	26	0.49	Middle/high income (56.8%)
100,000 – 150,000	11	0.56	
>150,000	5	0.70	

**Figure 56 Per capita waste generation rate and household income levels**

In this study there is a relationship between the quantities of solid waste generated and level of income of the households. Figure 56 shows that households with the highest income of more than NGN150, 000 per month had the highest per capita daily waste generated at 0.7 kg, compared to 0.31 kg for households on less than NGN18, 000. It can be observed that there is a consistent increase in the per capita waste generated with increasing income. Ogwueleka (2013) associated the consumption pattern of households to increases in income resulting in changes to the composition and quantities of household waste generated. In a survey of household waste composition and quantities in Abuja, Ogwueleka (2013) discovered that even a slight increase of income caused eating patterns of people to change.

This study is in agreement with Hoornweg & Bhada Tata (2012), Ogwueleka (2009), and Sivakumar & Sugirtharan (2010) that the quantity of solid waste generation depends on the income level of households, which applies to both LEDCs and MEDCs (Visvanathan & Trankler, 2006) including high and low income households (Sujjaudin, 2008). The implication of income on consumption is that as the economic situation of households improves their living standard goes up, changing consumption patterns leading to increased waste generation. In the same manner the increase of waste is associated with growth of GDP per capita (Shan, 2010).

7.2.3.3.3 *Lifestyle related activities*

Lifestyle in the context of this research refers to how citizens live their everyday life; their actions can influence waste generation levels. Some of the lifestyle characteristics which were observed during this research include daily cleaning, economic activities within households, recovery of materials, and cooking and eating habits.

Observations showed that waste resulting from business activities taking place at households could contribute in increasing the quantity of waste produced from households. Some households were observed to carry out business activities from home as their main source of income. Examples included food vendors (mama put⁴⁷) where food is prepared from home before being taken to be sold in public places. As well as influencing food waste levels, associated waste such as ash could be increased from escalated cooking activity. Two households (JSU7 and TWD23) were observed to be food vendors who prepared most of their foods at home: JSU7 generated 5.45 kg/week food waste and 4.40 kg/week ash/ unburnt wood, while TWD23 generated 6.30 kg/week food waste and 3.15 kg/week ash/unburnt wood – this compares to median values for of the sample of 2.05 kg and 1.65 kg for food and ash respectively.

Corn millers had milling machines in their yards where customers come with their corn to mill and leave the chaff with the millers. JMN3 ran a corn milling enterprise, the food waste generated from their home was 7.05 kg/week, most of all households sampled. Other home-based business activities included having small shops, tailoring, hairdressing, selling fire wood or charcoal, roasting yam, dodo⁴⁸ or maize, shoe repairs, selling fruits and vegetables, and keeping poultry in homes. Further research needs to be carried out on households that conduct these businesses in order to determine the impact of these economic activities on waste levels.

As explained in Chapter 7.2.3.1.2, the use of firewood and charcoal as a cooking fuel was observed with households therefore ash/unburnt wood made up 14.3% of the

⁴⁷ Mama put is a Nigerian term for food vendor. It refers to women who sell food around business, office, school or market areas.

⁴⁸ Plantain.

waste stream. It is also a common practice in low income areas to see people using plastics, paper or grass to ignite fires.

Domestic food making and consumption patterns would also impact on the levels of waste. Observations indicated that some households cook once a day in the evening. In such households, members usually leave home in the morning and buy either 'akara', 'masa', 'akamu', 'moinmoin' or 'chinchin' from food vendors or hawkers for their breakfast and eat on their way. They also use 'mama put' or food vendors for their lunch at their workplace, market, office or school. This would reduce the quantity of waste generated in their homes. Direct observations revealed that the high quantity of food waste was as a result of consuming unprocessed foods such as yam, potatoes, vegetables and fruits, while the low content of metal waste materials was the result of not eating canned foods or selling metals to the informal workers.

In the study area observations were made where household members were seen sweeping their houses, yards and surroundings in the morning – this is typical in Nigeria. This could have an effect on the waste characteristics, as all wastes resulting from the cleaning process would enter the residual waste stream. As explained some yards and houses had soil floors and this would impact the levels of fines present.

7.3 SUMMARY

The main findings from the waste composition study show that the waste generated from the study area was made up of biodegradables (65.2%), recyclables (13.2%) and residuals (21.6%). The waste materials that are of priority for prevention are the biodegradables which could potentially be composted and used as organic fertilizer. These materials consist of food waste, ash/ unburnt wood, fines, paper, textile and garden waste. Those which can be reused or recycled are dense plastic, electrical and electronic waste, glass, and metals. This means that 78.4% of the waste stream from households of the study area could be managed through waste prevention or recycling.

The data collected from the composition analysis was used as criteria to identify priority waste prevention interventions for the study area. The process of identifying these waste prevention interventions is presented in the following chapter.

8 WASTE PREVENTION OPPORTUNITIES

8.1 AN OVERVIEW OF HOUSEHOLD WASTE PREVENTION

From an environmental perspective, waste prevention is the preferred option for managing waste compared to recycling, energy recovery and landfill (Cleary, 2010; Gentil et al. 2011). Waste prevention is internationally recognised, and it is clear that increasing waste quantities, varying waste types, and associated threats, have intensified the necessity for governments to strongly pursue waste prevention as a vital plan for a sustainable future (OECD, 2000).

In Europe waste prevention was identified as one of the top priorities in the EU's 6th Environment Action Programme (EC, 2013b). The Roadmap to a Resource Efficient Europe recognised the need for additional efforts to reduce waste generation both per person and in absolute terms (EU, 2013). The amendments to the European Union Waste Framework Directive required all member states to formulate a national waste prevention programme which aims to break the link between economic growth and the environmental impacts associated with the generation of waste (Eionet, 2015). However, the European Environment Agency (EEA) (2015) note that effective waste prevention measures in some member states have not been established. There are many grassroots and community organisations throughout Europe that are campaigning for waste prevention such as Zero Waste Europe.

In the UK, DEFRA established the Waste and Resources Evidence Programme (WREP) in 2003, and waste prevention was made a priority (Cox et al. 2010). For this reason research on waste prevention was increased and many studies were commissioned by DEFRA such as Fell et al. (2010), Sharp et al. (2010a) and Sharp et al. (2010b).

The progress towards waste prevention has been slow. Wilson et al. (2010) specified that it took over 30 years for MEDCs to focus more seriously on waste prevention; nonetheless it is now considered a priority however there is still work to be done. The Chartered Institution of Waste Management has acknowledged the important role that prevention has to play. Bates (2016) in her inaugural Presidential Lecture placed further emphasis on waste prevention through increased policy focus on waste prevention and reuse. Bates said: *"Although the ways in which we treat and recycle waste are constantly improving, I am concerned that we focus too much on these aspects of the waste hierarchy without sufficient consideration of the options at the top, which will, I believe, be essential to delivering on a circular economy – whatever our (UK) version of a circular economy may be"*.

Waste prevention has been adopted in some LEDCs such as Argentina and Brazil (Bortoleto, 2014). For instance, in 2005 the City Council in Buenos Aires passed

Integral Management of Solid Urban Waste (Goldstein, 2008). The law established goals and milestones to reduce the volume of municipal solid waste going to landfill for disposal. The first milestone was a 30% reduction of waste to landfill by 2010, which was followed by a 50% reduction by 2012, and a 75% reduction by 2017. The law prohibited landfilling of biodegradable and recyclable waste by 2020.

Whilst in Nigeria there is rich culture of reuse and recycling mainly informally, waste prevention has received very little attention from government and wider society. As already discussed the poor enforcement of environmental laws, and the myriad of challenges facing municipal solid waste management could be a reason why waste prevention has received little attention. More so that Wilson (2007) pointed out that some countries including Nigeria are more concerned about their survival than issues of waste management, hence waste management issues are relegated to the background without featuring strongly on the list of public concerns. As a result municipalities of such countries are predominantly preoccupied with waste collection and disposal services rather than education and preventative actions. Although it is true that the principle of waste prevention is generally acknowledged, the practice has a long way to go in order to achieve its potential (Bortoleto, 2014). Zorpas and Lasaridi (2013) observed that some nations struggle with the concept of waste prevention and “*understanding something that is not there*”. Recycling is an easy concept to explain as you have the materials which can be quantified, but prevention is a harder approach to articulate. For this reason it is necessary to make members of the public understand waste prevention and how it can positively affect them. McAllister (2015) suggested that in order to make progress in SWM, countries and communities would need to embrace new systems for SWM that are participatory such as waste prevention.

8.2 IDENTIFICATION OF WASTE REDUCTION OPPORTUNITIES

8.2.1 Development of a longlist of waste prevention initiatives

For this research a comprehensive review of global waste prevention was carried out. For brevity and to not interrupt the flow of information, the review is included in Appendix 6. The review was aimed at developing a long list of waste prevention initiatives that could potentially be applied in the study area to address the waste management challenges identified.

In Nigeria and other LEDCs poor attitude is one of the fundamental problems linked with SWM (Ifegbesan, 2009) hence the management of waste from households is tied to perceptions and socio-cultural beliefs and practices of residents (Banjo et al. 2009). Communication is capable of raising public awareness, perceptions and attitudes to solid waste management (Patrick & Ferdinand, 2014). The public have an important role to play in waste prevention; once they are educated and

knowledgeable their general attitude and behaviour can change towards waste, as a result they would engage in waste prevention activities. Following the identification of the challenges to waste management in the study area, a recommendation was to implement waste awareness campaigns which could integrate waste prevention messages. Therefore approaches to increasing waste awareness were included in the interventions considered. More detail on the methodology adopted is presented in Chapter 4. The long list was then screened and assessed against five criteria to evaluate the applicability of the initiative for Jos:

i. Key materials in the waste stream: It is imperative that the initiatives which address materials prevalent in the waste stream are prioritized. For example, as shown from the waste composition analysis (see Chapter 7.2.2), targeting food waste would have a larger impact than focusing on metals.

ii. Quick wins: For waste prevention to gain impetus it is important to consider its ease of implementation. This includes waste prevention initiatives that have fast, immediate impacts so that the public can see the benefits and be encouraged.

iii. Economically viable: It is important that a waste prevention intervention is economically viable. The more affordable a waste preventive activity is, the more feasible it would be for Jos.

iv. Building on what already exists: As identified there is already a lot of reuse and recycling of waste taking place by individuals and the informal sector in Jos. This is mainly on a local scale since government is not involved. Communities need to be recognized and supported to build on the good work they have started. Money and effort has already been invested by the informal sector and they have become experts in the topic. It is important that interventions can build on what already exists.

v. Likelihood of the initiative working in Jos (Applicability to Nigeria): Not all interventions identified might be applicable to Jos. This might be due to cultural differences, the material the initiative tackles, the economic/political context, and the resources needed.

Each waste prevention initiative was graded against the 5 criteria. If the initiative fulfilled the criteria it scored 2 (green), if it partly fulfilled the criteria it scored 1 (amber) and if it did not fulfil the criteria it scored 0 (red).

Table 36 displays the long list of waste prevention initiatives, a brief explanation of what it entails and an evaluation on the applicability of each intervention against the 5 criteria described. The total score for each intervention was summed, initiatives ranked based on the total score, and an explanation provided on if it was shortlisted. The initiatives are presented in order under the following themes: 1-2 strategies for biodegradable waste, 3-9 reuse interventions, 10-15 awareness raising programmes and 16-17 governance.

Table 36 List of waste prevention initiatives

Waste prevention initiatives	1. Key materials in the waste stream	2. Quick wins	3. Economically viable	4. Building on what already exists	5. Likelihood of the initiative working in Jos	Score	Shortlist?
1. Home composting - Composting at home by residents. This could be through a composter they build themselves or a pre-moulded unit. The output would be compost that could be used for growing food or flowers. Based on the composition analysis 65.2% of the waste was biodegradable and much could be composted.	2 - Based on the composition analysis 65.2% of the waste was biodegradable and much could be composted.	1 - On one hand there is the immediate benefit of waste being diverted, however it will take a number of months before the compost is produced	1 - This depends on the approach adopted i.e. if households make their own units or if fabricated units are made available. Costs would also be incurred due to training.	1 - Some limited evidence of composting in the community (5.2% based on the questionnaire)	2 - Very applicable as can be adopted at a household level and handles much of the waste stream identified.	7	Y - Shortlisted due to the levels of compostable material in the waste stream therefore having a significant impact on waste diversion.
2. Community composting - Composting practiced at a community level.	2 - Based on the composition analysis 65.2% of the waste was biodegradable and much could be composted.	1 - On one hand there is the immediate benefit of waste being diverted, however it will take a number of months before the compost is produced though this would be quicker than home composting.	1 - Costs needed to resource the intervention - for example preparation of the land, and equipment. There could potentially be income generated through compost sales.	1 - Some limited evidence of composting in the community on larger scale on farms	2 - Very applicable as can be adopted at a community level and handles much of the waste stream identified.	7	Y - Shortlisted due to the levels of compostable material in the waste stream therefore having a significant impact on waste diversion and the potential for income generation.
3. Reusable Nappies - Cotton nappies can be washed and reused over again in preference to disposable nappies	0 - Very few disposable nappies in the waste stream as households already use washable nappies made from cotton squares.	0 - As households already use reusable nappies.	0 - This could be expensive to administer in purchasing nappies plus an unnecessary use of funds as nappies were not identified as being a problem.	2 - Further promotion would build upon existing practice in the community.	2 - Already working in Jos.	4	N - Reusable nappies already prevalent in Jos.
4. Reusable shopping bags - Reusable bags in place of single use plastic bags for shopping. At present in Nigeria single use plastic bags are given away freely to customers.	2 - Single use plastic bags made up 10.2% of the waste stream. In addition plastic bags were noted to be littering the community.	2 - Immediate benefits cutting down on plastic bag use.	1 - This would require the support of government and businesses to make bags available for free or subsidised to make them accessible.	1 - The questionnaire (24.3%)/focus group results indicated that some householders were reusing plastic bags already (however this could have been to dispose of waste).	1 - The scheme could work in Jos but as in other countries where similar initiatives have been implemented could require government or business intervention. There are also perceptions of citizens in regards to reusing bags/liking free bags every time they go shopping.	7	Y - Shortlisted due to the number of plastic bags in the waste stream and littering the community

Waste prevention initiatives	1. Key materials in the waste stream	2. Quick wins	3. Economically viable	4. Building on what already exists	5. Likelihood of the initiative working in Jos	Score	Shortlist?
5. Shops selling used products - Shops selling second hand products that might have been repaired or reused. These are varied and could include everyday items, furniture through to building materials.	1 - Due to the type of initiative a wide range of materials could be handled.	0 - As presented in the results there is already a rich culture of reuse and repairing in Jos, and Nigeria per se.	1 - This would involve entrepreneurs setting up businesses which would incur costs.	2 - There are many examples already in place.	2 - Already working in Jos.	6	N - Although this intervention would have benefits it mimics what is already in situ.
6. Refillable water bottles - Rather than using water in single use packaging - be it plastic bottles or sachets, households are given a reusable container which can be filled up from taps.	2 - Lots of plastic water sachets present in the waste stream (these would be included in the plastic bag/film category).	2 - Immediate benefits cutting down on plastic bag use.	0 - Significant economic implications. Outlay would be required from government/business to make bottles available for free or at a subsidised rate. However a more pressing issue the availability of water - 90% of people require boreholes or wells for water. There is not a secure supply of water or taps in public spaces hence the reliance on water contained in sachets.	1 - Observations from the community show that some residents are already reusing bottles.	1 - As mentioned a barrier would be the accessibility of water to refill bottles.	6	N - Whilst this intervention has promise as outlined a key issue is providing the infrastructure for secure water supply.
7. Rechargeable batteries - The use of rechargeable batteries in preference to disposable batteries.	0 - Batteries were included in the hazardous category in the composition analysis and made up less than 1% of the waste stream. However it is noted that batteries would be generated infrequently.	0 - Very few batteries in the waste stream, there would be limited impact.	1 - Rechargeable batteries could be subsidised by the government to make them more accessible to households, however this could require significant expenditure. Rechargeables are more expensive than disposables and therefore rarely used.	1 - 9.2% of residents stated that they reused batteries - however it is likely this would be referring to mobile phones rather than household batteries.	1 - This could work however there would need to be subsidy of the rechargeables to make them accessible. Moreover there is unreliable power supply which could impact on the viability of recharging batteries - thereby citizens could prefer to use disposables for reliability.	3	N - A good idea in principle however restricted due to the costs incurred and poor power infrastructure of Jos.

Waste prevention initiatives	1. Key materials in the waste stream	2. Quick wins	3. Economically viable	4. Building on what already exists	5. Likelihood of the initiative working in Jos	Score	Shortlist?
8. Online material exchanges - Online exchanges which promote reuse of goods directly (or indirectly).	1 - Due to the type of initiative, a wide range of materials could be addressed.	1 - Potentially however not all residents will have internet access.	1 - Typically set up by private businesses/entrepreneurs.	1 - There are already many examples of online exchanges in Nigeria e.g. OLX.	1 - This is already working in Jos.	5	N - Online exchanges already work in Jos, and more widely in Nigeria. Combined with the shops selling second hand products, it is likely that most products of value are already being reused/sold. It is also likely that low income households would have very limited internet access.
9. Clothing reuse - There are multiple ways in which old clothing can be reused: donations to charities, passing down to family members, using old clothing to make new clothes or products, selling.	0 - Textiles made up 4.5% of the waste stream - however most of the textiles were offcuts from tailoring operating from home rather than garments that could have been reworn.	0 - It would have very little impact due to the levels of clothing.	2 - Cheap as it is undertaken by the individual.	2 - Already a rich infrastructure in place for the reuse of clothing.	1 - This is already working in Jos.	5	N - The reuse of clothing is already prevalent in Jos therefore any initiative will have minimal impact.
10. No junk mail promotion - No junk mail campaigns are popular in MEDCs due to the amount of unsolicited mail/leaflets posted through the letter box. Campaigns typically would involve householders placing 'no junk mail' stickers on their letter box.	0 - Although Paper/card made up 4.6% of the waste stream most of this was not junk mail but newspapers or packaging.	0 - It would have very little impact due to the levels of junk mail. Moreover households do not have letter boxes and receive mail typically through institutions or have post boxes.	2 - Cheap to introduce with minimal costs.	0 - No such initiatives.	0 - Unlikely due to the limited junk mail in circulation, postal system.	2	N - The initiative does not transfer well from MEDCs as there is limited junk mail in circulation and most households do not have letter boxes.
11. General waste prevention campaign - This is the generic term for campaigns which aim to increase awareness of the problems and impacts associated with waste and encourage waste prevention. This could be delivered through a wide range of activities including workshops, tv and radio adverts and literature.	1 - Due to the type of initiative, a wide range of materials could be addressed.	1 - This depends on the type of initiative including which materials are being targeted and the form of campaign.	1 - This depends on the form of campaign in terms of approaches used to deliver messages, partners involved, and the geographic reach of the campaign.	0 - No examples of such initiatives in Jos. The last waste education programmes in Jos were in 2000.	1 - As with Eco-Schools there is a lot of potential however this depends on the resources available and the strategic approach adopted.	4	Y - Although not ranking higher for any waste prevention scheme to succeed there needs to be wider awareness of waste issues. Therefore it was shortlisted in order to get input from focus group members on how such an approach could be implemented in Jos.

Waste prevention initiatives	1. Key materials in the waste stream	2. Quick wins	3. Economically viable	4. Building on what already exists	5. Likelihood of the initiative working in Jos	Score	Shortlist?
12. Promote smart shopping - This encourages people to think when they go shopping to reduce levels of waste. For example buying products with less packaging and only buying food that is needed.	1 - Smart shopping is fairly generic however it predominantly focuses on packaging and food waste. The composition analysis highlighted that there was limited packaging in the Jos waste stream and the food waste that was generated was largely unavoidable (peelings etc.).	1 - Very few targeted materials present in the waste stream.	1 - This would require government/NGO involvement which would incur costs.	0 - No examples of such initiatives in Jos.	0 - Schemes need the support of government and NGOS - moreover focusing specifically on smart shopping does not address key issues prevalent in Jos.	3	N - Whilst smart shopping promotions are popular in MEDCs they are addressing issues not necessarily applicable to Jos i.e. food waste and packaging.
13. Food waste awareness schemes - Due to levels of avoidable food waste dedicated food waste campaigns such as 'Love Food Hate Waste' are popular in MEDCs. These provide guidance to householders on how to reduce waste through purchasing, and food management in the home through correct storage, using food before it goes off and recipes encouraging the use of leftovers.	1 - Whilst food waste is prevalent in the waste stream at 29.0%, the majority of this was unavoidable such as peelings, bones, stems.	1 - For the reasons stated this would have limited impact. The residents waste little avoidable food.	1 - This depends on the form of campaign in terms of approaches used to deliver messages and use of community partners.	0 - No examples of such initiatives in Jos.	1 - The initiative could work but would have limited impact.	4	N - Most food waste in Jos is unavoidable and as such this intervention would have limited impact. However as Nigeria develops longer term such an initiative could become more relevant.
14. Eco-Schools - Eco-Schools is an international initiative which promotes sustainability and environmental issues with children. The philosophy is that children subsequently influence the behaviour of their family and peers.	1 - Due to the type of initiative, a wide range of materials could be addressed.	1 - This is a longer term strategy that requires planning and implementation.	1 - It requires government investment and resources including the training of teachers.	0 - No examples of such initiatives in Jos.	1 - The initiative has much promise and could facilitate broader behaviour change across the community in Jos. However as addressed would require suitable resourcing.	4	Y - Although not ranking higher, as with the 'general waste prevention campaigns' there needs to be wider awareness of waste issues. Therefore Eco-Schools was shortlisted in order to get input from focus group members on how such an approach could be implemented in Jos. Moreover as identified in the questionnaire, in 34.5% of households surveyed children were responsible for managing waste. Therefore educating children could have a positive and wider impact in the community.

Waste prevention initiatives	1. Key materials in the waste stream	2. Quick wins	3. Economically viable	4. Building on what already exists	5. Likelihood of the initiative working in Jos	Score	Shortlist?
15. Waste prevention directory - A directory of waste prevention interventions and initiatives in the local community - either hosted on the internet or as a hardcopy.	1 - Due to the type of initiative, a wide range of materials could be addressed.	1- Uncertain however the information would need to be compiled.	1 - Due to the power issues and very few residents having access to the internet, a hard copy would need to be produced which has economic implications. Moreover there would be costs compiling the directory.	0 - No directory already exists.	1 - A directory could work.	4	N - It is likely that residents would already know of initiatives in the community and as such the directory could have limited impact or become out dated quickly. Anecdotal evidence suggests that residents might not even look at it.
16. Establish waste minimisation targets - Some countries have set waste minimisation targets to encourage initiatives to reduce waste.	1 - Due to the type of initiative, a wide range of materials could be addressed.	0 - As highlighted there are more pending waste management problems in Jos and there is not reliable data to measure progress against.	2. No financial implications setting targets.	0 - As presented there is a lack of existing strategy to address waste issues.	0 - As explained there is a general lack of strategy at present.	3	N - Premature for such targets due to the poor existing strategy and system in place. Setting such targets would be meaningless and due to the lack of reliable data progress would not be able to be measured.
17. Restricting volumes - In some countries local authorities set limits on how much waste households can put out for collection e.g. the number of bags or size of bin. This encourages residents to reduce their waste in order for their waste to be collected.	1 - Due to the type of initiative, a wide range of materials could be addressed.	0 - Due to the existing waste management system in place, and limited resources, implementation of such an intervention is unrealistic.	0 - The resources already are limited, therefore the additional resources required for enforcement would be unlikely.	0 - The existing waste management system is poor and there are no existing limits.	0 - As explained this would not work due to the existing system.	1	N - This approach seems to work well MEDCs but is unrealistic for Jos.

After assessing the long list of waste prevention interventions the following shortlist of five initiatives were chosen:

- Home composting
- Community composting
- Reusable bags
- Eco-Schools programme
- General waste prevention campaign

8.2.1.1 Home composting

Home composting refers to composting by citizens at home (Open BIO, 2014). It is considered as a waste prevention method at source (European Week of Waste Reduction (EWRR), 2014; Harris 2012), and is one of the most rewarding and popular prevention methods. Literature frequently mentions home composting as a waste prevention activity (Cox et al. 2010; EC 2012) since biodegradable waste is treated at the point of origin and diverted from being collected and disposed. Many local authorities in MEDCs have established home composting schemes to encourage individual homeowners to compost their own organic waste. In Europe home composting is widely practiced in Belgium, France, Finland, Germany, Norway, Spain, Switzerland and the UK (Boldrin, 2009; Colon et al. 2010; European Bioplastics, 2013; European Compost Network (ECN) 2014; Gray & Toleman, 2014; and Sollod, 2013).

WRAP has been promoting home composting in England and Scotland since 2003 and has published many studies providing estimates of the quantity of biodegradable waste diverted. WRAP (2009) established that home composting can divert 150 kg per household per year of organic waste from disposal. WRAP also estimate that about 40% of an average waste bin content is suitable for composting, thereby helping to cut down on the quantity of waste collected. Research by Cox et al. (2006) suggest that the public's behaviour is more likely to be influenced by fellow members of their community rather than the council. There are many examples of initiative where members of the public are trained on how to compost, and then they offer support and offer advice to households in their community. For example in Flanders, Belgium over 4,000 Masters of Compost have been trained up over the past 15 years. It is estimated 52% of households' in Belgium compost and the Masters of Compost offer assistance. In West Sussex the Waste Prevention Advisor scheme has been running since 2006 where similar advice is offered, not just on composting, but waste prevention in general (Woodard, personal communication, 8th August 2015).

Home composting exists in LEDCs though not as common as in MEDCs. UNEP (2005) reviewed sustainable consumption and production in Africa and reports that home composting has been in operation in Benin, Cameroon, Kenya, Ghana and

South Africa. However the practice is often localised on a small scale rather than being widely adopted thereby having an insignificant impact on waste levels across a jurisdiction (UNEP, 2005). Moreover anecdotal evidence suggests that home composting in some of these countries is conducted in more affluent areas rather than low income areas. For example in South Africa it is common to see prefabricated home composting units in use, but these rarely seen in low income parts of the country (Woodard, personal communication, 16th July 2015).

The raw materials which are appropriate for home composting from the household waste stream include vegetable and fruit waste and yard waste such as leaves, grass and cuttings (Hoornweg et al. 1999). All of these biodegradable materials are freely found in municipal waste generated in LEDCs.

One of the principal advantages of home composting is that the point of waste generation is also the point of management since the compost produced is used directly by the producer. Encouraging residents to participate in home composting schemes has major potential advantages. It provides the householder with the opportunity and motivation to take responsibility for their own waste and potentially offers an effective method of diverting biodegradable matter from dumpsites or landfills thus reducing methane emissions. It is the lowest cost alternative for reducing the amount of waste produced at source, since the waste does not have to incur collection and transportation cost to centralized facilities. It also removes biodegradable materials from people's bins, thus keeping the rest of the rubbish cleaner and easier to recycle. It reduces the need for chemical fertilizers, enriches soil moisture content and supplies essential nutrients, and reduces erosion (Bell & Platt, 2014; Boldrin, 2009; Colon et al. 2010; ECN, 2014; EPA, 2016; Platt, 2016; Platt & Goldstein, 2014; Slater et al. 2010; Sollod, 2013).

8.2.1.2 Community or Decentralized Composting

Slater et al. (2010) observed that community composting (or decentralized composting) involves collecting biodegradable waste from households and composting it at a neighbourhood or communal level by a group of people at a relatively low cost. It is an extension of home composting and it deals with the waste as close as possible to the source of its production. This approach is suitable for households, shop owners, schools and others, who are interested in composting but have limited space to compost, but instead use public spaces or community gardens to compost. WRAP (2017) encourages this type of composting especially where home composting is not viable due to spatial constraints. This approach is different to centralised composting which is done on a larger scale, is more mechanized and capital intensive, and is typically undertaken for economic reasons to produce compost to generate revenue.

This type of composting arrangement could be supported by local government through land provision, helping with start-up costs, public education, while using the

compost in public spaces. Community composting is one of the most sustainable ways of managing organic waste because of the environmental, economic, social and personal benefits (Ali, 2004; Kibbler, 2007). The compost produced is often used by households participating in the scheme, hence closing the loop of waste generation and use. UNEP (1996) mentions that care should be taken to ensure that the composting operation is environmentally and socially acceptable. They suggest some requirements when developing such as sites including making the site accessible to all individuals who use it, the site is approved by the local community, it has adequate controls to prevent the site from becoming an area for local dumping, and having appropriate drainage to accommodate the leachate.

According to Dohogne (undated) there are many examples of community composting programme in Europe. For instance in 2008, 69 active community composting parks were in operation in Flanders extending over 46 local authorities. Zürich began a comprehensive community composting scheme in 1992 and by 2008 there were more than 900 active community composting sites. These sites exist in all forms and sizes, ranging from smaller initiatives with 2–10 participating families, to bigger initiatives where over a 100 families participate. Hundreds of community compost sites exist in New York City with 225 of these affiliated with New York City Community Composting (NYCCP) (2014). Community composting can create jobs, develop skills transfer and helps to protect the local area (Platt et al. 2013). It brings members of the community together and reduces the cost of managing waste.

In terms of community composting in LEDCs there is a legacy in India since the 1990s where small scale composting sites have been in operation with various levels of successes. The projects were initiated by communities, NGOs, community-based organizations, or motivated individuals and supported by international funds (Ali, 2004). The National Institute of Urban Affairs (NIUA, 2015) compiled a collection of good practice in urban solid waste management in Indian cities including examples of decentralized composting in Bangalore, Chennai, Pune, and Mumbai. Zurbrügg et al. (2004) specified that 17 community composting sites were in operation in these cities as of 2002. These composting operations were often carried out on vacant plots within the communities. Studies have documented practice in other LEDCs, for example Lardinois and van der Klundert (1993) in Brazil, Kinobe et al. (2010) in Uganda, Enayetullah et al. (2006) in Bangladesh, and Jaza (2005), Jaza (2008) in Cameroon.

UNEP (2005) reviewed waste reduction in Africa and also in Nigeria and reported that in addition to home composting, community composting has been in operation in Benin, Cameroon, Kenya, Ghana and South Africa. In Nigeria, Jaza (2008) recounted that subsistence farmers have usually depended on community composting and livestock manure to improve soils. For instance the Ibo's use tree branches for

mulching, apply goat or cow dung to individual plants, and have been composting household waste since the 1970s.

8.2.1.3 Reusable bags

A reusable shopping bag is a type of bag which can be reused numerous times and used as a substitute for single use plastic bags. It can be produced from a variety of materials such as canvas, jute, or heavy plastic which are stronger than single use plastic bags. This type of bag is at times called a Bag for Life in the UK and their use is encouraged due to the numerous benefits that they bring (Future Centre Trust, 2010). Guidelines on how to safely use these bags and prevent the contamination of food products have been developed by the California Department of Public Health (CDPH) (Undated) while similarly Williams et al. (2011) recommends that the public are educated on the proper use of reusable bags. Literature has shown that an average EU citizen uses about 500 plastic bags each year of which 92.5% are single use plastic bags (EC, 2014). The majority of European citizens (92%) agree that measures should be taken to reduce the use of single-use plastic items, such as shopping bags. According to Zero Waste (2016) over 100 billion single use plastic bags are utilized annually in Euro-centres and most end-up in landfills, incinerators or litter in communities and aquatic environments.

A number of nations and cities across the world have taken steps to lessen the use of single use plastic bags, including outright bans, bans on free provision, levies, as well as voluntary agreements. Examples include England, Hong Kong, Japan, Mexico, New Zealand, Sao Paulo in Brazil and South Korea (Strange, 2011). Some EU countries such as Italy (since 2011), France, Denmark, and Spain have already banned the use of single use plastic bags in preference for reusable plastic bags.

In LEDCs there are numerous examples of initiatives to promote the reduction of plastic bags. Iwuoha (2016) found that over 15 countries across Africa either ban or tax the use of single use plastic bags. For instance Rwanda in 2004 barred shops from giving out free plastic bags to their customers. The government introduced tax opportunities which inspired companies to recycle instead of manufacturing plastic bags. This created a new business opportunity for entrepreneurs to produce alternative shopping bags made from environment-friendly and biodegradable materials, like paper. In 2013, Mauritania banned the use, manufacture and import of plastic bags, and anyone who manufactures plastic bag could be jailed for up to a year (Iwuoha, 2016). Similarly in 2015, Senegal's National Assembly totally prohibited the production, import, possession and use of plastic shopping bags. Iwuoha (2016) stated that Yaounde in Cameroon charge 100 Francs (8 pence) for single use bags. Guinea-Bissau, Mali, Ethiopia and Malawi are among countries that have limited the use of plastic shopping bags, and are encouraging the use of reusable bags in its place. In Kenya the ban on use, manufacture and importation of plastic bags took effect on August 28th, 2017 (Akwei, 2017). It is the third initiative

Kenya has taken in ten years to reduce bag use. In both 2007 and 2011 policy focused on reducing the thickness of the bags. However this was not very successful and problems with plastic bags impacting on the environment continued. Kenya's 2017 Environment Manufacturers and Co-ordination Act stipulates that a culprit faces not less than a year in prison or a fine of not less than Shillings 2 million (\$19,305) with the government vowing to enforce the law to ensure that the ban is fully implemented.

There has also been much lobbying of governments. For example Environment Watch in Botswana called upon the government to enforce a levy on plastic bags. It urged the government to use the proceeds to fund environmental activities in order to create a cleaner Botswana, while reducing the use of plastic bags. The "Kicking the Bags Out" campaign in Zambia pushed for a plastic bag ban across Zambia principally due to the impact plastic bags were having on blocking drains (Zero Waste Europe, 2015).

The promotion of reusable bags would present Jos with a low cost opportunity to increase diversion of waste from the waste stream and also to address some of environmental challenges posed by plastic bags in the community.

8.2.1.4 Eco-Schools Programme

The Eco-Schools programme is referred to as Green-Schools in Nigeria and some other countries (Elusoji, 2015). It is recognised by United Nations Educational Scientific and Cultural Organisation (UNESCO) (2014) through the award of certificates to thousands of schools around the world. Through Eco-Schools students, teachers, parents, and the local community learn how to improve and safeguard the environment (UNESCO, 2014). The National Wildlife Federation (NWF, 2016) has enumerated the many benefits of Eco-Schools. The scheme educates in order to protect the environment and the people who live in it, including the communities who depend on it, the businesses that profit from it and the ecologies which rely on it. Eco-Schools is an important initiative to inspire young people to get involved with the environment and address environmental challenges and extends from nursery schools to universities.

Across the world Eco-Schools engages with millions of students from 49,000 schools in 64 different countries, making it the biggest environmental schools programme in the world, (Eco-School, 2016). It was launched in 1994 in response to the 1992 UN Rio Earth Summit and is operated by the Foundation for Environmental Education (FEE) who partner with UNEP and UNESCO.

The Eco-Schools programme exists mostly in MEDCs. For example in England the Eco-Schools programme supports schools to deliver effective environmental education for sustainability, as well as acting as a catalyst for positive behaviour change that flows out beyond the confines of the school, into pupils' homes and the

wider community (Eco-Schools England, 2013). It introduces environmental topics into the National Curriculum in schools and helps to develop a creative learning environment for all learners involved. It also helps the pupils to understand the ways in which different issues are linked together, for instance the connections between transport and pollution and climate change. An important element is waste and ways in which to reduce waste and recycle.

When FEE became an international foundation in 2001, its scope increased to outside of Europe. LEDC countries that became part of Eco-Schools programme include South Africa and Kenya in 2003, Uganda in 2009, Ghana in 2014 and Tanzania in 2016. In South Africa, the Wildlife and Environment Society of South Africa (WESSA) are responsible for the programme, and since 2003 more than 10,229 schools across all nine provinces have participated, reaching 400,000 students and 16,000 teachers (WESSA, 2017). The Kenya Organisation for Environmental Education (KOEE) manage the initiative in Kenya with 210 schools involved. In Uganda 377 schools are involved and the scheme is operated by Conservation Efforts for Community Development (CECOD).

It is a widely held view that children and young people's participation in Eco-Schools can have a positive contribution to the school and community in a number of ways (Department for Children, Schools and Families (DCSF) 2008). For instance Grodzinska-Jurczak et al. (2003) conducted research on the impact of a school waste education programme on students', parents' and teachers' environmental knowledge, attitudes and behaviour. The focus was on primary school students aged 11– 13 in Krakow, Poland and lasted for four months. At the end of the programme the students together with their parents and teachers were surveyed using questionnaires. Findings generally revealed that the programme improved student knowledge and awareness of municipal waste management, with three quarters of the students sharing their learning outcomes with their parents. The majority of parents (84.5%) testified that the programme was very valuable and confirmed frequent family discussions which often led to a change in household attitudes and improved waste management practices in their homes. Teachers also evaluated the programme positively, recommending its implementation in school curricula at all stages of education as an ideal solution to the national waste management problem. Ballantyne et al. (2001) had made such similar discovery.

There is evidence that the approach can have wider societal benefits. According to UNESCO (2017) a school in Uganda worked on the Water Theme of the Eco-Schools programme. As part of the programme they received a grant from Denmark, allowing them to buy large tanks to collect rainwater. This helped to improve the sanitary conditions at the school, so that the girls could have showers. Moreover the school acted as a hub for the community with excess water being made available to families in the community, thereby reducing the need to source water from the local

river, typically undertaken by women. It is estimated this saved these women 2 hours per day thereby allowing them additional time to work or make crafts to sell. The parents in surrounding community were inspired and set up an Eco Parents Association and began building and installing water tanks at homes. In 2011 only 25% of girls continued schooling after the age of 11/12 years but now 75% continue their studies and this has been largely attributed to the actions resulting from Eco-Schools (UNESCO, 2017).

There are limited examples of the Eco-Schools programme in Nigeria. The Caleb British Academy, a privately owned, co-educational day and boarding Christian School founded in 2009, held a day of action as part of the Green Schools Programme, in conjunction with the Lagos State Ministry of Environment (Elusoji, 2015). The theme for the event was 'Preserving our green heritage' and featured a variety of presentations, drama, songs and a quiz on climate change. The event launched 'The Anti-Litter Police Squad' which is an initiative to tackle the waste problem in the community. Caleb British Academy's vision is to empower children everywhere to live sustainably and in an environmentally conscious manner. Unlike in other countries the author understands the Eco-Schools programme in Nigeria is decentralized, there is no overall coordinating body, and this was a barrier to finding more examples of the scheme being implemented.

The Eco-Schools programme when adopted in Nigeria could result in improvements to students' and parents' attitudes and behaviour towards the environment. The involvement of parents in discussing environmental issues with their children could encourage them to take a more active role in their children's environmental education, hence contributing to the development of long-term environmental awareness and concern (Meucci & Schwab, 1997; Palmer et al. 1999).

8.2.1.5 Public awareness campaigns on waste prevention

One tool commonly used to stimulate behaviour change is public awareness campaigns (United States Government Accountability Office (USGAO), 2010). A public awareness campaign has been defined as a comprehensive effort that includes multiple components (Bouder, 2013). It is about explaining issues and disseminating knowledge to people so that they can understand and make their own decisions. Usually, a campaign strives to raise awareness about key issues, and induce desired positive behavioural change (Coffman, 2002; Zacho & Mosgaard, 2016).

Waste prevention depends on changes in the attitudes and behaviour of households and businesses and on new paradigms in industrial processes and product design (EC, 2012). Therefore, public awareness campaigns targeted at individuals and businesses could bring about a positive change to waste prevention. This research shall focus on campaigns that target individual behaviour, with the aim to prompt individuals, including those in positions of authority, to change their knowledge,

attitude and practices in relation to SWM. Changes in behaviour could contribute to embracing waste prevention, thereby reducing waste levels and safeguarding the public from the impact of solid waste on the environment and public health. However, public awareness campaigns can sometimes be limited in scope and impact – they might not reach all parts of the community. Therefore Barr et al. (2013) and Fell et al. (2010) support the use of stiffer actions such as fiscal and regulatory measures.

Public awareness campaigns have been used globally to help people understand waste prevention and to reduce the generation of specific types of waste. For instance public awareness campaigns can be used to change people's mind set and attitude from waste disposal towards waste prevention. A wide range of approaches and tools could be adopted as part of a public awareness campaign. For example radio jingles, television commercials, stories on the news, public service announcements, leaflets, and stands in public spaces, social media, face to face engagement and freebies.

In the UK in 2009, a one week high profile campaign by Gloucestershire Zero Waste focused on the reduction of waste. During the challenge residents reduced their waste to landfill by an average of 3.8 kg per household, with most residents achieving a 50% drop in the amount of waste they produced (Defra, 2013). This was achieved with a campaign budget of around £25,000. It was projected that if this were to be replicated by all households in the county it would have the equivalent effect of Gloucestershire meeting their 2020 60% recycling target⁴⁹. Public awareness campaigns to reduce waste generation are already operating successfully in Europe and abroad (EC, 2016), hence it is sustainable. The Helsinki Metropolitan Area Council in Finland used a range of measures such as waste prevention education and public awareness campaigns, as well as low-cost incentives to reduce waste from households, businesses, and local authorities. The results of the investigation show that the campaign helped to change attitudes towards waste and increased behaviours with respect to waste prevention (EC, 2016).

In LEDCs there are examples of public awareness campaigns on waste and environmental issues per se. The African Youth Union (AYU) is a Pan-African youth organisation that has the largest youth representation in Africa, and it launched the AYU Green Campaign in 2014 (African Youth Union, Undated). It provides young people with knowledge to protect Africa's natural resources and environment. For example waste management can locally impact of public health but also have global implications through climate change. It is vital that youths are empowered with knowledge to take action and inspire their fellow youth to be agents of positive change in their communities in order to save and protect the climate. The Green

⁴⁹ Reduced residual waste levels would increase the proportion of waste being recycling.

Campaign has increased the number of climate change literate people in Africa and has inspired people to *go green*. Currently over 30 African countries with 12 recognized chapters are involved in Green Campaigns.

A study of the perception on domestic waste disposal in Ijebu Ode, Nigeria by Banjo et al. (2009) revealed that public awareness campaigns through radio and television were the most obtainable, accessible and the most effective sources of environmental information. Their study exposed the effectiveness of mass media in creating awareness about public health and environmental issues. The study found that radio and television have extensive geographic coverage and at a relative low-cost. Ojelede (2016) and Rada (2016) suggest that public awareness on the environment should be increased through public campaigns and education so that public participation in SWM will improve.

8.2.2 Focus groups

The five shortlisted interventions were considered for more in depth evaluation using focus groups with PEPSA representatives and householders from within the study area community. The focus groups were facilitated by the author and the methodology adopted is presented in Chapter 4.2.8.2.

The first group with PEPSA had eight people in attendance. The participants were selected based on their relevance and knowledge of the subject and all the participants had been staff of PEPSA for at least 2 years. The session was held on Thursday the 21st of January 2016 at the office of PEPSA and it lasted from 2.00-4.00pm.

The second focus group discussion was held with residents who are householders from the study area on 23rd of January 2016 at Wakili School of Business Studies in Tudun Wada. This group had seven people in attendance, and were identified and recruited by the pastor from ECWA Church Tudun Wada. The session was held from 5.00-7.00pm.

Both focus groups started with the author welcoming the participants and thanking them for coming to the meeting, thereafter introducing herself and giving the participants' time to introduce themselves. The author went on to introduce the topic of discussion and explain the reasons for the discussion. The participants were presented with a list of 5 waste prevention initiatives; each of the initiatives were introduced and explained. In addition the waste composition from the study area was introduced and displayed as it partially formed the basis on which the stakeholders were going to make their choices. Thereafter participants were requested to ask questions or seek clarifications on areas that they did not understand. The participants were requested to examine the list of waste prevention opportunities that had been presented and placed before them, and give their views and opinions on each initiative. Ketso and SWOT were integrated into the focus groups (see Chapter

4.2.8.2). Participants were asked to determine the strengths, weaknesses, opportunities, and threats (SWOT) of each waste prevention initiative with each theme recorded on different coloured paper: green for strengths, yellow for weakness, blue for opportunities and red for threats. The results were collated and analysed.

8.2.3 Results

A summary of the key points raised for each initiative are presented in the sections below under each SWOT and illustrated in Figure 57 to Figure 61. Where applicable statements or information from individual participants are included and coded FGDWPIP – from the PEPSA focus group and FGDWPIH from households with the number denoting the participant number. Each of the initiatives is discussed in the sections below with each theme considered. Points made by each participant are included in full in Appendix 7.

8.2.3.1 Home composting

Figure 57 provides a summary of the responses given by the participants who took part in the focus group discussion.

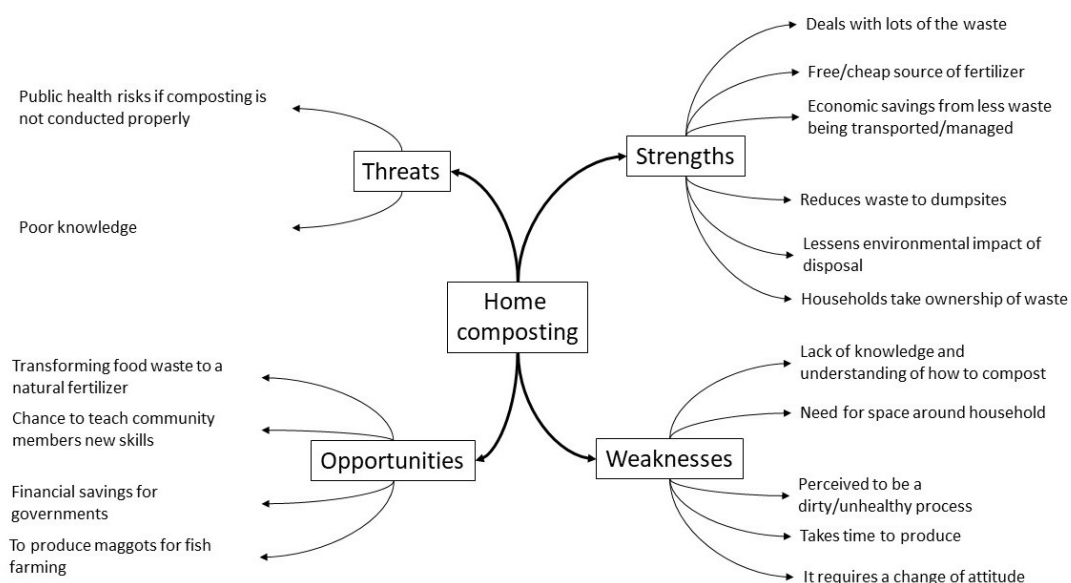


Figure 57 SWOT feedback on home composting from the focus groups

Strengths

15 people participated in this focus group discussion out of which 7 participants were of the opinion that home composting was the best initiative for low income areas (FGDWPIP 001, FGDWPIP 002, FGDWPIP 003, FGDWPIP 005, FGDWPIH 002, FGDWPIH 003, and FGDWPIH 007). A range of strengths were identified by all participants – the main strength raised by participants was the composition of the waste stream being conducive to composting.

A reoccurring theme was the number of participants that mentioned the economic benefits of composting. They stated that the handling of waste this way can result in economic savings for the municipality of less waste will need to be managed. This is also more convenient for the household as they will have less waste to get rid of. For instance a member observed:

“If I am to do home compost more than half of the waste coming out from my house will go into it and my bin would be half empty so I do not have to look for where to dump waste every day”. (FGDWPIP 003)

Similarly residents commented that compost was an affordable replacement for chemical fertilizer, it is practically free as it involves householders transforming their own waste to a resource. FGDWPIP 001 added that he got a WhatsApp message from a friend informing him of how fruits, vegetables and crops produced with natural manure⁵⁰ are better than those produced with chemical fertilizer. FGDWPIH 002 stated that he would go for compost if given the opportunity because a bag of fertilizer now costs between NGN7, 500 (£15) and NGN9, 000 (£18).

Other strengths mentioned by participants was that it reduces the quantity of waste that goes to dumpsites thus reducing the need for dumpsites thus lessening the environmental impact. It is a better way of handling decomposable waste, it encourages householders to take responsibility for their waste, and it does not require any technical expertise since it is on a low scale.

Weaknesses

Three main weaknesses were identified by participants. The lack of knowledge and understanding of how to compost and the need for space around households for composting were common concerns raised. It was also perceived as being a dirty process, and participants were concerned it could spoil the aesthetic beauty of the environment, be smelly and attract pests like flies, spiders, rats and dogs, thereby posing potential public health risks. Other weakness mentioned were that it takes time to produce compost which may discourage participation from householders. It requires residents to change their attitude and behavior and if they do decide to compost time and effort is required which might deter participation. For instance they need to embrace the habit of saving compostable wastes that they would have ordinarily thrown away (FGDWPIP 005). An issue of lack of acceptability was raised by a participant (FGDWPIP 003) of compost being used in place of chemical fertilizers for growing food – people would be skeptical it would work.

⁵⁰ In this context this would include compost.

Opportunities

The main opportunity identified was transforming food waste into a natural fertilizer. Also composting would increase awareness of waste issues the community and facilitate skill development. It provides an opportunity for government to save money since the waste is diverted so less resources needed for collection – these resources to be used to help fund composting. FGDWPIP 001 stated that the composting process could be used to produce maggots as feed for animals and fish (see Threats below).

Threats

A key threat expressed by focus group members was that if home composting was not carried out properly there could be health and environmental risks. A range of impacts were mentioned: it could attract rats, flies and vectors – impacting on public health, composting could make the environment dirty and strong poor smell, poor composting could contribute towards greenhouse gases or potential pollution if materials were not properly separated and sorted before composting (FGDWP001).

It was clear some participants had a poor knowledge and understanding of composting – this was identified as being a key threat. For example as alluded to above FGDWPIP 001 stated that composting was a good opportunity to produce maggots which could be feed for fish in the community. However a good performing composter should not attract flies. Some households could lack the will to participate even though much of their waste could be composted - there would be the need for proper education on how to compost.

8.2.3.2 Community Composting

Figure 58 summarises the responses of the focus group participants.

Strengths

10 people out of 15 participants strongly opined that community composting was the best option for the study area. (FGDWPIP 001, FGDWPIP 003, FGDWPIP 004, FGDWPIP 005, FGDWPIP 006, FGDWPIP 007, FGDWPIP 008, FGDWPIH 001, FGDWPIH 003, and FGDWPIH 004). It should be noted that community composting shared many of the identified strengths as presented for home composting, however most of the participants preferred a community based approach. A principle reason for this was the space limitation around households in the study area makes community composting a more desirable option. As with home composting, the waste stream is conducive for community composting, and it reduces the quantity of waste that needs to be managed.

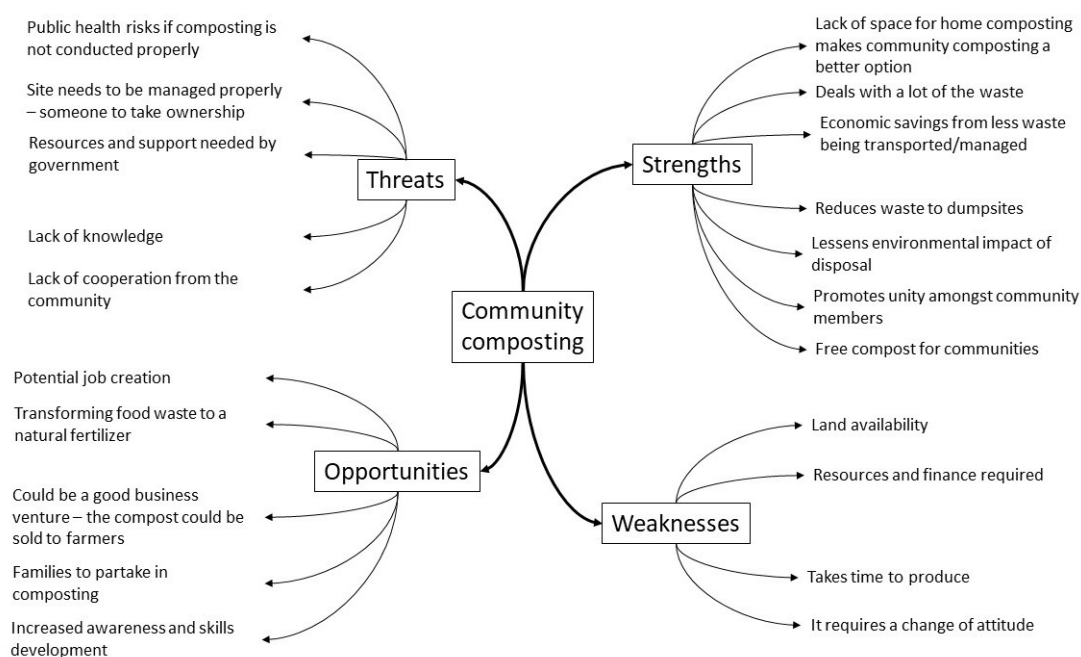


Figure 58 SWOT feedback on community composting from the focus groups

Participants mentioned the community element of this approach as it promotes unity among community members. For example (FGDWPIP 006, FGDWPIP 005 and FGDWPIH 003) believed that community composting encourages cooperation and develops cohesion. Households may hardly know or interact with their neighbors, but being engaged in the same venture in the community fosters a good working relationship. Organic waste generated in the community would be composted and used for the benefit of the community (FGDWPIP 001, FGDPIH 005, 006).

Weaknesses

The weaknesses of community composting are similar to home composting, however some additional weaknesses were identified. The key issue was the availability of land within the community and if spaces would be available and conducive to the community approach. Moreover when composting on this scale participants were concerned regarding the resources required and that financial support from government might be required.

The timescales for composting were also identified – if it takes too long to compost residents/farmers may prefer to use cow dung/animal manure. If excess compost is produced this could potentially be sold to farmers in rural areas. However participants (FGDWPIP 001, 003, FGDWPIP 004, FGDPIH 006) stated that cost of transporting compost from the urban center to rural areas could be an added cost.

Opportunities

The larger scale production of organic fertilizer, compared to home composting, was seen as a significant opportunity. When composting on this scale participants mentioned the potential provision of jobs for unemployed youth to collect waste from households to community compost sites and produce the compost. As touched on above there is the opportunity to sell excess compost to farmers, therefore helping to fund this approach. It provides opportunities for families to partake in composting and for the wider community to increase awareness of composting.

Threats

The key threat mentioned by participants was the concern for potential impacts to public health and the environment when composting on this scale. Participants listed the threats of air and water pollution plus odour. The sites could also attract flies, rats and vermin. Therefore participants were insistent that a community composting site needs to be managed properly otherwise there could be multiple detrimental impacts.

Another threat mentioned by five participants was that unlike home composting where residents might be comfortable handling their own waste, in this community approach those working on the site would be handling materials from multiple sources hence this potentially increase the risk of infections from inappropriate materials being taken to the site.

An important threat was the resources required for a community site for example provision of land and funds for equipment. Lack of financial support from Plateau State Government could hinder the success of community composting as the community may not be able to supply these resources themselves. For instance a member (FGDWPIH 004) observed that the fertilizer blending plant in Bokkos failed because of non-commitment and support from the state government. The member emphasized that: *“government does not promote compost production because government itself is not practising it”*.

Insufficient knowledge on compost and its benefits is also a threat to compost production. Finally participants observed that the success of any community composting scheme was reliant on the cooperation of community members.

8.2.3.3 Reusable bags

Summary of the responses provided by the participants with regards to reusable bags is presented in Figure 59.

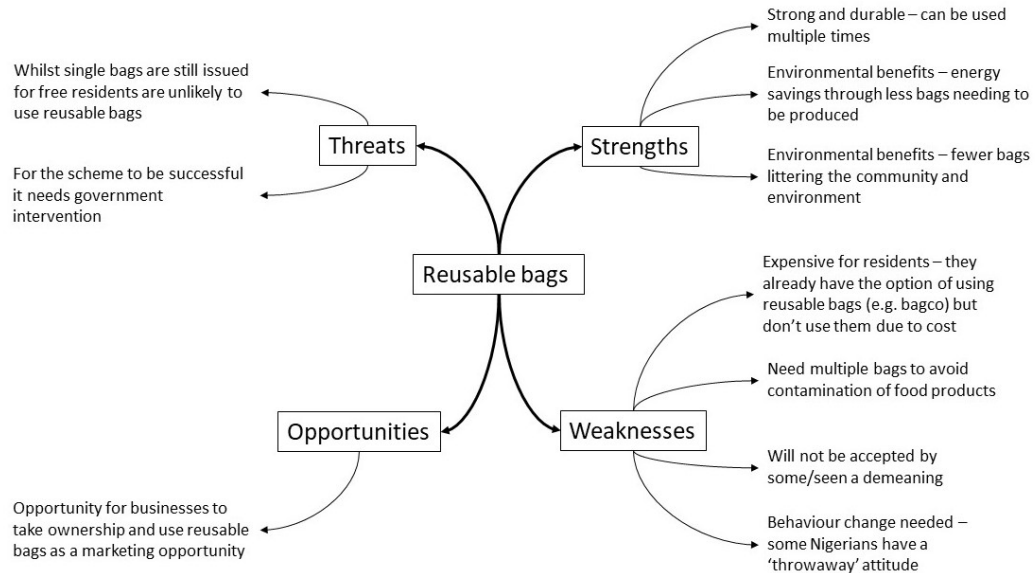


Figure 59 SWOT feedback on reusable bags from the focus groups

Strengths

Generally participants agreed that reusable bags are in principle a good idea, and could reduce impact on the environment. Reusable bags were observed by participants to have an advantage over single use bags as they are strong and durable and can be reused many times, thus saving energy in production in addition to reducing the number of bags that could be thrown into the waste bin or littered (FGDWPIP 007, FGDWPIH 002). FGDWPIH 002 stated that he uses reusable bags because of their concern for the environment and consider it the right thing to do.

Weaknesses

A major weakness of reusable bags as mentioned by participants is that they can be expensive, and could be easily misplaced or stolen. For instance FGDWPIP 007 mentioned that bagco bags⁵¹ in Nigeria cost NGN50 (10 pence) each which puts people off from using them. Most participants stated that they do not use reusable bags because they are expensive, and besides single use plastic bags are freely given out. Another weakness is the need to have at least two reusable bags for food products and non-food items, in order to avoid contamination or spoilage. For example putting fresh produce such as spinach, tomatoes in the same bag as other products such as matches and clothes could lead to problems as the water from the

⁵¹ A reusable bag already available in Nigeria made from hessian.

fresh produce could spoil other items⁵². Having to buy multiple bags was seen as a weakness. Some of the participants view the use of reusable bags as demeaning, hence they want to use only single use bags (FGDWPIH 002). Participants stated that some Nigerians have the attitude of use once and throw away.

Opportunities

A key opportunity mentioned by households is that companies could use logos on reusable bags to increase awareness of their brands as a marketing strategy. For example Dangote rice, Dangote cement or Dangote salt are sold in reusable bags and have aided in their product promotion – citizens reuse the bags over and over again (FGDWPIH 002).

Threats

The main threat mentioned was that single use plastic bags are issued freely in shops and all over the markets in Nigeria thereby discouraging people from buying reusable bags. Therefore for any scheme to succeed it would need the intervention of government to implement a policy, and this was unlikely.

8.2.3.4 Eco-Schools programme

Responses from participants during focus group discussion concerning eco-school programme is presented in Figure 60.

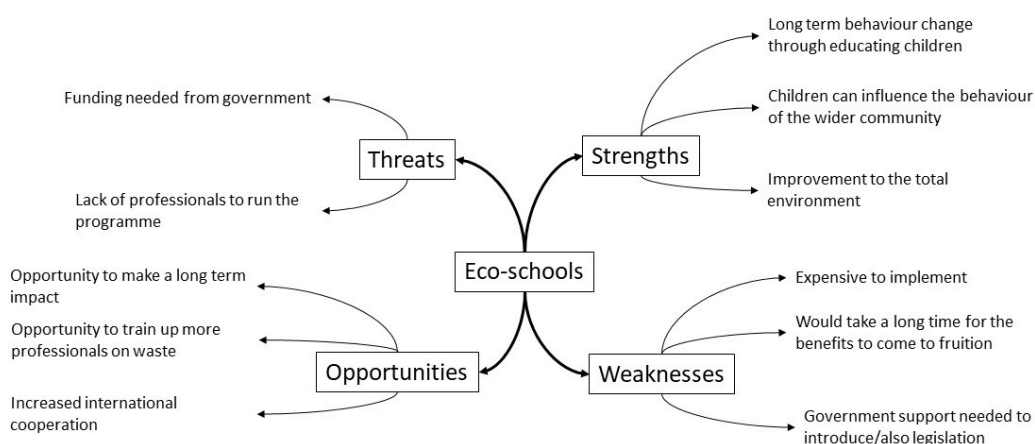


Figure 60 SWOT feedback on the Eco-Schools programme from the focus groups

⁵² It is important to highlight in Nigeria much of the food is purchased without packaging and therefore a higher risk of contamination than in MEDCs.

Strengths

All participants agreed that Eco-School is a good and needed idea. A key strength of Eco-School programme was that educating children early in life on waste management issues benefits many: the children themselves, the parents, the community and the wider society. The programme encourages and supports the development of children with interest on the environment (FGDWPIP 008) and it improves children's awareness and knowledge of the environment. The children are empowered to drive change and improve levels of awareness influencing change amongst parents, communities and the general public (FGDWPIH 004). The long term benefits would be reduced quantities of waste generated and reduced impact on the environment.

Weaknesses

The general perception of participants was that the Eco-Schools programme is expensive and that it takes years before the effects are felt or seen. FGDWPIP 008 noted that it requires government support and legislation for it to succeed.

Opportunities

Participants were of the opinion that Eco-Schools encourage and support the development of children with an interest in the environment leading to long-term change in behaviour. Participants observed that children are provided an opportunity to learn new skills and empowered to lead change in order to safeguard the environment (FGDWPIH 004, FGDWPIP 008). Participants also agreed that opportunities exist for training more professionals who would work and teach the students in these schools. In addition Eco schools being international programmes creates opportunities 'for developing national and global contacts.

Threats

A major threat recognised by participants to Eco-School programme is the need for support from government in terms of funding. Members mentioned that funding is vital in order to support delivery and that legislation is needed requiring schools to comply with the programme, otherwise it might fail (FGDWPIP 008). Another risk could be lack of professionals to teach the children about the environment.

8.2.3.5 Public awareness campaigns

Figure 61 gives a summary of the responses from participants during focus group discussion.

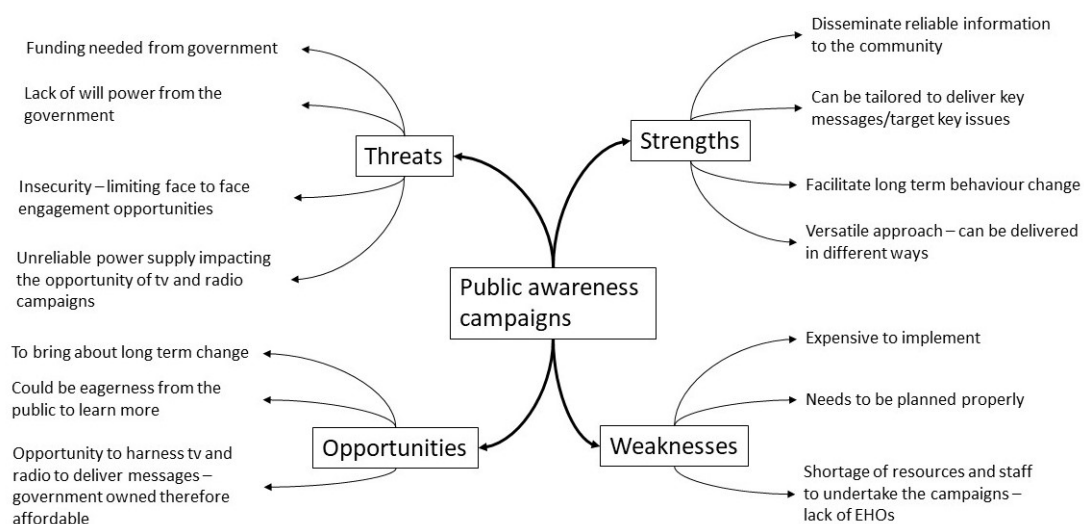


Figure 61 SWOT feedback on public awareness campaigns from the focus groups

Strengths

A key strength of public awareness campaigns is that they disseminate reliable information to members of the public in order to help them understand issues so that they can decide on the actions to take (FGDWPIP 002, FGDWPIH 006). For instance public awareness campaigns on waste prevention could provide information about the significance of waste prevention to themselves and the environment, after which they could decide to take positive action hence limiting the impact of waste.

Another major strength recognised by participants is that public awareness campaigns help to bring about a long term change of attitude and behaviour in response to the messages received (FGDWPIH 001, FGDWPIP 006). It can also encourage people already practicing waste prevention and pro-environmental behaviour to do more. The approach is also versatile and can be designed to deliver key messages.

Weaknesses

A key limitation of public awareness campaigns as mentioned by participants is that it can be expensive because of the resources required (FGDWPIP 002, FGDWPIH 001, 006). It requires adequate planning, finance and logistics for it to be successful (FGDWPIH). Another issue was that no matter the methods used for communication, the campaigns could still be ineffective if the key points are not

planned and addressed properly (FGDWPIH 001, FGDWPIP 006) and it takes time for its effects to be felt.

Another significant limitation identified by participants is lack of support from government, institutions, policy makers and political leaders – this would be needed for a campaign to succeed. The shortage of professional manpower (EHO's) to deliver key messages was also seen as a weakness (FGDWPIP 002).

Opportunities

SWM is a challenge for low income households, therefore some participants felt that the community would be eager and willing to discover things that could help them to reduce the quantity of waste generated from their home. Participants noted that there are different ways of educating the public on waste prevention, however FGDWPIP 006, FGDWPIH 001 stated that less expensive methods such as radio and TV can be used. Public awareness campaigns bring about long lasting changes in behaviour and attitude of the general public, and generate fresh perceptions on waste prevention (FGDWPIP 001, 006).

Threats

A key threat to public awareness campaigns is lack of funds for executing and sustaining the project. In addition lack of will power from government to support public awareness campaigns' could lead to its failure. Inadequate staffing is also a threat, currently there is an embargo on employment (FGDWPIP 002). Insecurity as currently being experienced in Jos limits face to face engagement therefore other communication approaches would be needed. The lack of reliable power can limit communication options – the community could go for long periods without power and this would impact on accessibility to campaign ran on television and radio.

8.3 DISCUSSION

The sections below reflect on the feedback from the focus group discussions. It was apparent to the author that the knowledge of the participants on the waste prevention interventions discussed was limited and therefore there were further points not addressed by the participants. In the discussion below the author integrates additional points which are pertinent to reflect on when discussing the viability of the initiatives.

8.3.1 Home and Community composting

There was overlap in many points raised for home and community composting therefore for brevity they have been merged under one heading.

Home and community composting were the preferred waste prevention interventions for the study area based on the strengths and opportunities identified in the focus groups. They were both popular amongst the focus group discussion members. The

strengths identified support previous research conducted in Nigeria stating that composting is the most sustainable way of managing the biodegradable waste stream (Harir, et al. 2015; Sridhar and Hammed 2014; Taiwo, 2011). Composting is also acknowledged by Cointreau (1982), Hoornweg et al. (1999), and Ali (2004) to be a cornerstone in the sustainable management of waste in LEDCs.

An opportunity for home composting mentioned by some participants was that the compost produced could be used in their small vegetable gardens. Some households from the study area had gardens situated near stream sides or water channels not too far from their residence (an example of this can be seen Figure 29), where this compost could be used. Composting at home was an opportunity for parents to teach their children how to compost thereby developing their awareness for environmental values.

Whilst home composting was a popular intervention, focus group members identified weaknesses and threats. A key issue discussed in the focus groups was the lack of space around homes which may make home composting very difficult. Many people live in compounds and there may not be the required space, and there could be conflict between the occupants. This reaffirms results from questionnaires undertaken in Part A of this research where lack of space was perceived to be the biggest barrier by 43.7% of respondents to composting at home.

A further concern was the lack of awareness of how to compost and the negative impacts this could have on the community through poor composting practice which could cause odour and attract vermin. Moreover some focus group members perceived composting as being dirty and unhygienic and therefore it might be a challenge to get buy in from residents. Lack of knowledge on composting was seen as another barrier to composting by 30.0% of respondents to the questionnaire in Part A.

From the questionnaires and focus groups it was clear there was a low understanding of composting in the community. This is a key threat as people might be opposed to composting due to these concerns regarding perceived odour or vermin problems, or compost wrongly thereby creating these problems. For composting to be successful it would need to be supported through public awareness campaigns to ensure the community has a good knowledge of what composting actually is, and how to actually compost safely and properly. Research by Banjo et al, (2009), Rada, (2016), and Sitra Studies (2015) have established that public awareness campaigns have been helpful in stimulating behaviour change thereby leading to positive attitude towards the environment. Once households are properly educated on the importance of compost and how to produce it, they would hopefully embrace it.

Given the spatial challenges and the low base understanding of composting, a community approach was seen as more favourable by focus group participants. This could be supported through land allocation within communities for community

composting as observed by Slater et al. (2010). WRAP (2017) also specifically encourages community composting where home composting is not viable due to space constraints. However given the nature of the community with animals moving about freely, any composting site would need to be secured.

The view of the author is that churches could play an important role in helping promote community composting in the study area. Some have the availability of land which could be used to trial community composting and they could also manage the operations. Moreover they could act as a catalyst to educate community and church members on composting and enhance co-operation. This community approach could address some of the waste awareness and educational challenges that are key barriers to developing a successful compost programme.

Church organizations have for years worked on composting project such as in St Lucia in Spain where the Laborie Catholic church is participating in a community compost project (Edinburgh, 2009). Similarly there are examples in the UK including St Peter's and St Luke's Churches in Brighton (BHCC, 2017). An example from LEDCs is a mothers' union (Eagle) in Uganda made up of members from both the church and wider community who set up a community composting project (Parish Magazine, 2017). These schemes have been of great success and could be used as a template to help address the challenges in Jos. Other community based organisations (CBOs) could come together to run local community composting projects.

A further option considered by the author was community composting sites being located at schools in the community. As highlighted in the questionnaire in Part A, in 34.5% of households children were responsible for managing the waste. If sites were located on school grounds, children could be encouraged to take waste with them to school to compost. Moreover composting could be integrated into the curriculum. As with the church approach, the school would need to take ownership of the site. However based on how schools function in the community there are some barriers which could hinder the viability of this approach – see the information on Eco-Schools in Chapter 8.3.3.

A weakness for community composting identified by participants was finding land close to the community to set up a site. If a site was long way from where residents live this could make taking waste for composting difficult for households involved, and therefore they would not participate. However if sites were located by churches, residents would be visiting them as part of their daily activities⁵³.

The compost produced from community composting could be used by the church and the community for local food production, and in the study area churches typically have farms for the pastor. The compost could also be given away to

⁵³ Anecdotal evidence from the author suggests that community members visit churches at least 3 times a week.

congregation members as an incentive to encourage them to bring their food waste. Extra compost could be sold to farmers. Again resources would be required which may depend on government support for provision of the initial starting funds and equipment, and additional land for non-church led sites.

8.3.2 Reusable bags

The adoption of reusable bags was ranked joint 1st after applying the assessment criteria when screening the long list. Waste composition analysis indicated that single use plastic bags formed 10.2% of the waste stream and the questionnaires from Part A showed that only 24.0% of residents questioned were reusing bags – hence this approach had some opportunities to address the waste problem.

Focus group discussion members were generally supportive of the reusable bag approach however a range of weakness and threats were identified which led many to question the practicality and impact of this intervention without government involvement. Participants raised the point that reusable bags were already available to buy in shops, however due to the charge take up of this was low, and also due to the abundant supply of free single use plastic bags from all retailers.

In most countries where successful bag reuse schemes have been adopted, normally it is in tandem with policy on single use bags, the government has played an important role (BBC, 2015). Often government policy has been influenced by initiatives previously introduced by businesses or communities – the UK is a case in point where many bag reuse schemes are in place before the charge on single use bags. A weakness in the Nigerian context is the lack of political will from the Nigerian government to address this problem (Abutu, 2018)). Moreover it is the view of the author that it is unlikely that Nigerian businesses and retailers would take a lead to implement their own initiatives.

Overall globally literature has shown the importance and benefits of using reusable bags (BBC, 2015, Future Centre Trust 2010) and the environmental impacts of badly managed plastics on the environment (Biginagwa, et al. 2016; Cole et al. 2013; Gall and Thompson, 2015; Li et al. 2016; Rochman et al. 2013; and Zero Waste, 2015). These issues have been the principle drivers for the adoption of policies on reusable bags in many countries, however the understanding of these issues in Nigeria is at a low level, and without government intervention it is unlikely that a reusable bag scheme, on a large scale, would be successful. However there is the opportunity for community organisations to develop their own small scale projects promoting and providing subsidised bags.

8.3.3 Eco-Schools programme

The Eco-Schools programme, in principle, was perceived to be a good idea by participants. Its prominent strengths were stimulating long term behaviour change amongst the youth, and the potential impact on wider society

However some weaknesses and threats were identified by focus group participants – however in some instances the author questions the validity of the points raised. There was the perception that in order for the Eco-Schools programme to be introduced it required government support through legislation, but follow up research from the author found this was not the case. Participants also mentioned that the programme could be expensive and complex, requiring the training of professionals to teach these topics and take a long time to succeed. However the role of promoting Eco-Schools in other countries running the programme is normally fulfilled by existing teachers who have an interest in the environment.

At present in Nigeria the majority of the schemes running an Eco-Schools programme are private; the author was unable to find any examples of the initiative running in government schools which are those found in the study area. It is important to note the precarious nature of government schools in Nigeria: some remain closed for months due to strike action due to non-payment of salaries and pensions to retired staff members, and the lack of promotion opportunities. Therefore the success of Eco-Schools could be a challenge in these circumstances due to lack of motivation amongst staff which is critical for a scheme to succeed.

A further weakness of the current approach is that setting up Eco-Schools takes time in order for it to succeed as it goes through a series of processes. The model adopted in South Africa consists of seven stages starting with developing an eco-committee and finishing with an Eco-School report documenting the changes made at the school which is used to assess if the school gets the award. This entire process could take a minimum of five years (WESSA, 2017)⁵⁴.

The way in which the Eco-School programme works in Nigeria also presents boundaries to schools in the study area participating. Fabe International (2017) runs the scheme and sets out guidelines for participation. For instance the scheme requires online registration – however the schools in the study area do not have internet access. Internet access in the study area is non-existent and in the wider community internet access is low. Even at the University of Jos internet access is extremely limited. Further the criteria required to join the scheme is ambiguous: *“ensuring that the school is clean, hygienic, disease free, and presentation of a fumigation certificate”*. Due to the way Eco-Schools is set up in Nigeria it is difficult to come across schools that meet all of these conditions, hence the limited number of schools involved in Nigeria, let alone the study area.

Overall given the circumstances it would be challenging to implement an effective Eco-Schools programme in the study area. There is an option of developing a

⁵⁴ The example of South Africa has been used in this instance due to the lack of information for Nigeria.

localised version which aims to increase awareness of waste issues within schools, but again this will be down to the motivation of key individuals.

8.3.4 Public awareness campaigns on waste prevention

The key strength of public awareness campaigns is that it is a versatile approach which can encompass a range of key messages promoting waste prevention activity. In this study the key waste streams have been identified, hence participants stated that awareness campaigns can be tailored to fit the waste constituent of concern and run in-conjunction to complement specific waste prevention interventions. For example public awareness campaigns have been used worldwide to address specific types of waste such as food (Sitra Studies, 2015; Wigmore & Lee, 2010), plastics (Zero Waste, 2015) and junk mail (EC, 2016). Participants mentioned that if campaign messages are geared towards waste prevention, then the general attitude and behaviour of the people would change in favour of waste prevention, thus individuals would be encouraged and confident in engaging in waste prevention. The opportunities in public awareness campaigns include long lasting effects on behaviour and attitude of people which could lead to better waste management practice in the community.

A range of weaknesses and threats of public awareness campaigns were identified. Rejection of campaign messages by households could be because of lack of understanding. To address this it is important to make sure a clear plan is developed before embarking on any public awareness campaign making sure there that the core message is simple and clear for all to understand. Developing a clear vision setting goals, assessing the resources available, and setting priorities is imperative. It is important that community leaders are engaged with at an early stage to help get buy in into the campaign. This would be followed up with using most appropriate method to delivering the message be it through media, public events, passive approaches or working directly with communities. The final stage is to evaluate the campaign, and see what worked and what did not work which would help to inform future strategy.

A threat expressed was the issue of finance and resources. In Nigeria, where the economic and political structures are in disarray, where there are no dedicated funds to address climate change, it is pertinent to wonder how well the core messages entrenched in waste awareness can be spread. However this could be addressed by adopting more community based interactive approaches – thereby long term investment in people rather than resources. Longer term the lack of will power by government to support public awareness campaigns could be dealt with through lobbying. The impact of public awareness campaigns cannot be measured instantly, but can be felt on the long run.

8.4 RECOMMENDATIONS

On the surface it could be viewed that it is easy and straight forward to implement waste prevention initiatives. However as highlighted in this research, there are many challenges and factors that need to be considered in order to implement an effective waste prevention strategy. After reviewing existing waste prevention interventions, and gaining the views of the focus group stakeholders on the five shortlisted waste prevention initiatives, the author recommends the following to promote waste prevention in the study area:

i. Pilot community composting

As identified from the study, community composting was the preferred option over home composting, due to limited space around households of the study area, and the low level of understanding of how to compost. This community approach requires the availability of suitable land within the area, which may not immediately be possible and would require time since land has to be sought for, by the state or local government. Government could however seek possible collaboration with churches, and community based organizations (CBOs) with an interest in the environment that could provide the land. Moreover the church and CBOs could act as a facilitator for change to educate the community, and encourage residents to participate by bringing feedstock. These groups could also help oversee the running of the site and compost production plus providing training. The resulting compost could be donated to those participating in the project as a way to get buy in and as an incentive for continued involvement. It is recommended that an initial pilot study is conducted with a church to evaluate its viability and impact. If this succeeds, then the project could be replicated with other churches.

ii. Pilot home composting – following the successful implementation of the community approach

A weakness and threat to composting was the lack of understanding from residents on what composting is, and how to compost. Therefore householders need to be trained on how they can safely compost. In the short-term the recommendation is that the focus is on a community composting approach through which community members can develop an understanding of how to compost, and gain confidence in composting. If the community scheme is successful it is recommended that home composting is piloted in those households which have suitable space, or land where they currently farm.

iii. General awareness campaigns

In order to influence people's behaviour there needs to be a carefully planned engagement strategy. This needs to focus holistically on increasing awareness of waste issues, the importance and ways of preventing waste, plus information on how to compost and the benefits. A suite of engagement approaches need to be adopted in order to maximize exposure.

As per the recommendations in Part A, the government has a key role in television and radio broadcasting in Nigeria. Being state run these stations have minimal broadcasting costs, and an effective strategy could be developed for disseminating information to the public on waste issues. Given the paucity of the waste management system in Jos, it is important that the campaign encourages initiatives and behaviour in which the community can actively engage in.

iv. Training of volunteers to support communities

As mentioned in other recommendations it is imperative that in order for composting to succeed that residents understand how to compost properly. To advise the public and support their composting efforts, and general waste prevention behaviour, mechanisms need to be put in place. Given the current situation in Jos it is unlikely that EHOs will be able to fulfil this role hence a community based approach would be more suitable. Community volunteers need to be trained, similar to the Masters of Composting scheme operating in Flanders, to support waste prevention efforts.

v. Engagement with community leaders in all initiatives

For waste prevention interventions to be successful, and to obtain buy in from the public, there has to be a careful plan for engagement. Research has identified that the behaviour of households and communities are heavily influenced by ward heads, chiefs and church leaders. In the light of this, government is advised to consult with the community leaders of the study area in order to seek the cooperation of communities in embracing waste prevention. The leaders could help identify churches in the study area that could be used to pilot community composting, and work with residents to increase awareness and encourage participation in the scheme. Further ward heads and chiefs are part of the government administration and could help government in their communities with the development of waste prevention awareness campaigns.

vi. Funding to support projects

Any scheme being implemented will require funding. This could be for the composting units - as in other scheme pre-fabricated units could be purchased or the units could be produced in the community harnessing local resources and facilitating job creation. Other costs include training, public engagement, and for community composting projects the funds for the preparation of land, and monitoring of the impact. Government could seek financial support from donor organizations such as UNEP, UNDP, Banks and other financial bodies in order to cover these costs.

vii. Longer term strategies

Reusable bags could help to address the problems associated with single use plastic bags. However the practicality and success of implementing reusable bag initiatives on a large scale without government intervention is uncertain. In countries where reusable bag schemes have been successful, government policy has been influenced by initiatives previously introduced by businesses or communities – the UK is a case in point where many bag reuse schemes were in place before the charge was introduced by government. A weakness in the Nigerian context is the lack of political will from the Nigerian government to address this problem. Moreover it is the view of the author that it is unlikely that Nigerian businesses and retailers would take a lead to implement their own initiatives. Hence this is unlikely to succeed in Nigeria. However, longer terms could be an option – and indeed other African countries have introduced similar measures which might facilitate the Nigerian government to act.

The Eco-Schools programme was perceived by participants as a good idea, but its feasibility is questioned because at present in Nigeria no government school are involved in the initiative, and all schools located within the study area are government schools. Schools operating the scheme in Nigeria are private and they have the necessary resources to develop the programme. Moreover as previously explained there is a lot of disruption in government schools due to non-payment of salaries and schools remaining closed; hence it is a challenge for these schools to be part of Eco-Schools programme. There is no doubt that educating children in waste management issues is imperative and could lead to long term behaviour change. Given these circumstances a more appropriate approach would be churches and CBOs running localised awareness schemes targeting the youth.

8.5 LIMITATIONS TO THE RESEARCH IN PART B

For the waste composition analysis, due to time constraints this study did not look at seasonal variations such as rainy or dry season changes in waste variation, but it is well understood that season affects waste generation in Nigerian cities, as well as other countries (Afon & Okewole, 2007; Ezeah, 2010; Gidarakos et al. 2006; Roberts et al. 2010, Sha'ato, 2007). The study was carried out between November 2014 and January 2015 which is a dry season and coincides with the harvest period of many fruits and vegetables, and this could directly impact household waste generation. Further sampling taking both seasons into account could overcome this limitation.

Waste composition analysis was based on the primary classification of waste into broad categories such as dense plastics and plastic films/bags. These broader categories do not truly reflect the composition of the waste stream and present *useful* results. For example there are many types of dense plastic – some of which have high value, other have little to no value on the secondary market. Similarly plastic films/bags were grouped together and these should have been classified into more detailed secondary classes like plastic films, plastic bags, and water sachets. To overcome this problem the author used anecdotal evidence to calculate the level of plastic bags, however ideally data would have been collected during the composition exercise. Similarly food waste was not broken down into avoidable and unavoidable food waste, rather it was lumped together as food waste.

Previous waste composition analysis studies on waste in Nigeria have used differing definitions and categories therefore making it hard to make accurate comparisons between studies. Consistent guidelines for undertaking analysis should be developed for Nigeria therefore helping to improve the usefulness and comparability of the data.

Questionnaires from the sample households showed that 68.7% of the participants recycled while 77.6% reused recovered waste materials. Typical examples of the items they recycled include metals, plastics, paper and glass, while items they reused or gave out to others include clothes, plastic bottles, food waste, electrical and electronic waste – this activity would therefore influence waste levels. In spite of the instructions given to householders to deposit all the waste generated in the plastic bags provided, limited recycled materials were seen in the waste stream. This could have been because most recycled materials were held back for sale to the informal sector. It is therefore reasonable to say that the result of the waste classification study do not show the total quantities of wastes being generated.

The number of people in the household was derived at the beginning of the waste composition analysis. It is also important to note in Nigeria household size is

transient therefore the number of people staying or visiting could vary over the week and this could influence the results.

A limitation was the subject of waste prevention itself. From the focus group some of the stakeholders' did not quite understand what it was, hence the author had to do some explanations. Having limited knowledge of waste prevention responses from the focus group discussion with stakeholders did not give as much information as desired by the author, hence limited data to work with. On reflection the author would have given more time for the focus groups, or conducted them in two parts giving the participants the time to digest the information, and reflect on the relevant merits of each intervention.

8.6 SUMMARY

Waste prevention is accepted and practiced in some LEDCs; however in Nigeria it still has a long way to go in order to achieve its potential in helping to address the significant waste management challenges faced. A long list of waste prevention initiatives was developed and screened down to five using five criteria. The short list was further assessed with stakeholders in order to determine the most viable prevention initiative for the study area. After which the selected initiatives were discussed and recommendations made. The final chapter presents the conclusions from both Part A and Part B.

9 CONCLUSION

9.1 CONTRIBUTION TO KNOWLEDGE

Following a detailed mixed method approach this research has identified a complex range of challenges that are impeding on the development of an effective waste management system in low income areas of Jos. The research has developed a set of recommendations to address these challenges with detailed evaluation on the potential role of waste prevention.

This research is timely as it addresses the challenges posed through increasing waste generation, at a time when municipalities already face financial and infrastructural challenges to manage existing waste levels. The consequences of poor waste management impact upon public health and the environment, hence the importance of this research. The research is closely associated with the United Nations Sustainable Development Goals particularly Goal 12 to Ensure Sustainable Consumption and Production Patterns and the target to substantially reduce waste generation through prevention, reduction, recycling and reuse by 2030.

The empirical study has created a better understanding of the nature and characteristics of low income areas. Through the methods applied the research has contributed to existing research on barriers to waste management in LEDCs and the numerous challenges hindering the sustainable management of waste. The study has generated a wealth of quantitative and qualitative data contributing to the limited existing data on waste management in low income areas helping to inform policy and the design of further research.

The following conclusions can be drawn from this research:

- The existing system for managing household waste in low income areas of Jos is poor. The residual waste collection system relies on residents taking waste to communal containers which are meant to be emptied by PEPSA twice a week – however this rarely happens. For the entire city there are only 64 containers, this equates to 20,313 citizens per bin which is grossly inadequate. As a consequence, residents of the study area mainly managed their waste through burning (45.0%) and throwing into water bodies (31.1%) with subsequent environmental and social impacts.
- A key overarching challenge is that of resources: in addition to the lack of containers PEPSA have only 11 vehicles to collect waste in the entire city – some vehicles have been out of service for over a decade.
- There is no sanitary landfill in Jos, as a result if waste is collected by PEPSA it is taken to open dumpsites with no controls to mitigate impacts on the environment and public health.

- Impacts caused by the poor waste system were identified as groundwater pollution, air pollution, flooding, risks to public health, and conflicts between community members.
- Unsurprisingly questionnaire respondents rated the quality of waste collection service as very poor 67.8%.
- Whilst there is no formal recycling system in place reuse and recycling is prevalent. 77.6% of residents actively reused items and 68.7% recycled. Materials commonly recycled were metals (97.9% of those that recycled), plastics (84.3%), and paper (26.6%). Reuse was common including clothes (88.0% of those that reused), food (43.7%), plastic bags (31.4%) and electrical products (30.6%). As presented in Chapter 5.4.9 there are a range of stakeholders and entrepreneurs engaged in reuse and recycling in Jos.
- The research concludes there are twenty challenges impacting upon the development of an effective sustainable waste management system in the study area. These challenges were grouped under four themes: role of governance, solid waste management practice, resource allocation and the attitude of the public towards waste.
- 13 recommendations to address these challenges are proposed though some of them may be long term requiring changes to the governance structure and further resources.
- PEPSA have responsibility for managing waste in Jos but due to the current political system they do not have the autonomy to manage their own budget, recruit their own staff and buy their own resources. This directly impacts on service delivery – this is a key challenge that needs to be addressed.
- For the past 17 years there has not been any form of government led public awareness campaigns on waste. Reasons identified were lack of funds and insecurity in the state. A key recommendation is to increase education and awareness of waste amongst the population with community groups having an important role.
- The socio-demographics of the study area are complex. Results show that households have between 2-15 persons, with an average of almost 6 people. Whilst the area was perceived to be low income, 30.6% of residents were middle to high income earners. Within the study area it is common for businesses to be based at home, in turn this will influence the types and levels of waste generated.
- From composition analysis the waste generation rate from the study area was estimated to be 0.47 kg/capita/day, corroborating findings from other LEDCs.
- The main components were food (29.2%), ash/unburnt wood (18.4%) and plastic films/bags (13.6%). The waste components belonged to 3 categories: biodegradable (65.2%), recyclable (13.2%), and residual (21.6%). The

implication of this is that the majority of waste is suitable for composting and recycling – there are resources in the waste stream that could be utilised.

- Community composting should be prioritised as a waste prevention strategy, however this needs to be complemented with an effective waste education and engagement programme. Due to the composition of the waste stream composting has the potential to play an important role in the development of an effective waste system for the study area. 94.8% of residents in the study area were not composting despite the high biodegradable component of the waste stream. Their main reason was lack of space (43.7%) and don't know how to compost (30.0%) – as such a community based approach could be effective in overcoming these challenges.
- For an effective system to develop stakeholders need to come together. In the short term the study contends that households and communities in low income areas have to take responsibility for their waste since government waste collection services are already insufficient and unless there is a radical change, politically and in terms of funding, are likely to remain for the foreseeable future. However as noted the challenging conditions in low income areas make introducing seemingly simple waste prevention interventions complex and any interventions would need careful planning, effective community engagement and the necessary resources.

9.2 RECOMMENDATION FOR FUTURE WORK

The research has highlighted the prevalence of small businesses based at home in the study area. Business activity significantly influence the types and quantities of waste being generated. This was touched on in this research, but there is the opportunity to research the role of small businesses and their impact on waste levels in more detail.

Waste composition analysis in this research was based on the primary classification of waste. Including secondary classifications would help to develop a deeper understanding of the waste stream, for example the breakdown of different plastics which have varying value. This particular study only considered the composition of waste during the dry season, further work could establish the variations in waste levels during the wet season.

Given the poor waste management system in Jos, the wish of the author is that this study is not *wasted* but is applied leading to practical benefits to the community. Further work would be to follow up on the key recommendation from this study, and evaluate the feasibility and effectiveness of a community-composting site in Jos. This would include identifying potential sites, stakeholder engagement to develop the project, setting up the logistics of collecting and processing the waste, evaluating the quality of the compost, yields and markets.

Reuse and recycling was prevalent in the study area. It is recommended that further research be conducted to determine the quantity of waste being managed through these routes and the wider social, environmental and economic benefits.

Further studies need to be carried out in order to calculate actual municipal solid waste arising in Jos in order to develop an effective waste management strategy, and the capacity needed to handle waste. Moreover there is a lack of formal maps of the study area – further work could be undertaken to map these areas using GIS helping to identify potential bin locations, opportunities to improve accessibility.

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