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Towards
Integrated Sustainable Solid Waste
Management in Nigerian Cities

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PhD

2022

Towards
Integrated Sustainable Solid Waste
Management in Nigerian Cities

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of the requirements of the
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Abstract

Municipal solid waste (MSW) management in Nigeria has been a persistent problem for many decades, with sustainable waste management seemingly a long way off. MSW is often seen piled on roads and open spaces, and in water bodies, contributing to environmental pollution and human health problems. Most of the previous studies have focused on proposing technical solutions to the problem however, promoting stakeholders' involvement in the management is important. The assumption is that increasing stakeholder involvement in MSW will result in significant improvement in MSW.

To this effect, 17 interviews were conducted with government agencies on waste management in Ibadan and Lagos, Nigeria, together with households and private contractors and 2 focus group discussions with the waste pickers at the dumpsite. Thematic analysis was used to examine stakeholders' perceptions of problems, analysis revealed that there is currently no significant collaboration between the stakeholders and authorities, householders and private contractors have differing views of the problems. The analysis outlined poor governance, poor enforcement strategies and inadequate infrastructure, lack of awareness, public attitudes and households' behaviours, inappropriate technologies and untapped waste value as the main factors impeding collaboration among the MSW stakeholders in Nigerian cities. These empirical findings were used to develop an Agent-based model as a tool to assist in creating an integrated sustainable waste management system suitable for Nigerian cities.

The model simulations indicated that poverty is a factor in the dumping, but the hygiene consciousness of households plays a crucial role in disposal decisions. It shows residential area cleanliness influences the disposal behaviour of households and revealed that more effective and regular monitoring by waste officers across the city reduce waste dumping by approximately 55% compared to when officers' monitoring is irregular.

Insights gained from the empirical data analysis and the ABM identified the key drivers for achieving stakeholders' inclusive approach in MSW in Nigerian cities.

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Dedication

I dedicate this PhD to Almighty Allah, who protect and gave strength to my body. He is God, the one, the absolute. He begets not, nor was He begotten. There is nothing comparable to Him.

Also, to my father Engr. Ganiyu Adesola Shittu, who passed away few weeks after my successful defence of my thesis. In which my wish and his desire to attend my graduation ceremony vanished all at once. May Allah forgive him all his shortcomings and grant him Jannatul Firdaus.

Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is my own work.

Any ethical clearance for the research presented in this commentary has been approved.

Approval has been sought and granted by Northumbria University's Ethics Online System on 11/09/2017

I declare that the Word Count of this Thesis is 39,358 words

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Date: 23/09/2022

1 Introduction

Industrialization and urbanization are on the rise in world cities, and one of the most important by-products of an urban lifestyle is municipal solid waste (MSW), which is growing faster even than the rate of urbanization Onibokun (1999). In 2012, the global prediction of waste generation is estimated to be 1.3 billion tonnes per year however, it was 2.01 billion tonnes in 2016 and the expectation is that global annual waste generation will increase to 3.40 billion tonnes by 2050. (Hoornweg and Bhada-Tata, 2012a, Kaza et al., 2018). Sub-Saharan Africa generated 174 million tonnes of waste in 2016 and this is expected to increase by three times by 2030 (Kaza et al., 2018). This will exacerbate the current capacity constraint in MSW management practice in most African cities (United Nations, 2009). Solid waste management in Africa has been very informal with poor management practices (Nwosu and Chukwueloka, 2020a) and most governments in African countries are unable to keep up with the level at which waste is being generated in their cities (Onibokun, 1999). In Africa, the annual average waste collection rate is approximately 55% and the average waste collection rate in sub-Saharan Africa is estimated at 44% of the total waste generated. Notably, almost half of all solid waste generated in Africa remains within the cities and towns. It is dumped into storm water drains and rivers, footpaths, streets, highways, open fields and uncompleted buildings and is often followed by open burning (Godfrey et al., 2019).

This thesis investigates how an inclusive approach can be developed, via encompassing social, environmental and regulatory factors as well as purely technical issues in municipal solid waste management in Nigeria. This study argues that increasing stakeholder involvement and participation in the waste management process will facilitate a sustainable waste management practice in Nigerian cities.

1.1 Research Background

Nigeria is the most populous country in Africa, having a population exceeding 170 million (WorldBank, 2016) and one of Africa's emerging economies. Correspondingly, there has been an alarming increase in the rate of MSW generation in the country. However, the actual amount of MSW

generated in Nigeria is not specifically known due to poor data management, some researchers have estimated MSW to be around 32 -42 million tonnes annually (Chinedu et al., 2018, Nwosu, 2020, Nwosu and Chukwueloka, 2020b).

In Nigeria, there is no rigorous legislative structure to control waste, and only a small fraction of the MSW generated in each state in Nigeria is collected by the waste authority in the state in collaboration with private-sector participation (PSP) waste collectors (Bioenergy Consult, 2016, Nwosu, 2020, Nwosu and Chukwueloka, 2020b, Nnaji, 2015). PSPs are small to medium-sized waste collection businesses; the size is determined by the number of trucks each possesses in order to carry out their operation. They are licensed by the waste authority of each state and operate along with an authority for collecting and disposing of MSW in the cities (Aliu et al., 2014).

However, the rest of the waste, which is not collected, is disposed of directly in the streets, burned in back yards, dumped in water bodies or left on uncontrolled dumpsites by the generators (Anestina et al., 2014, United Nations, 2009). The current waste management practice being carried out by the authorities is the collection, transportation and disposal at dumpsites through PSPs and government-owned vehicles. Even though this collection practice exists in every state in Nigeria, it does not cover all cities and towns in each state, nor is it effectively carried out (Emmanuel, 2013).

Waste containers such as bins for storing waste at the household level are not available in every area across Nigeria. This means that households tend to manage their waste based on whatever means they have available. For example, in low residential density areas, with an average of 5,478 inhabitants per km² and with relatively medium-high income residents, waste handling is quite well-organised. Each household in these areas has a bin, pays fees for collection and their waste is collected regularly by PSP contractors. However, open burning, open dumping and informal collections of waste by cart-pushers characterize the middle and high-density residential areas, with averages of 18,864 and 28,838 inhabitants per km² respectively (Aliu and Ajala, 2014, Ajibola et al., 2012). These areas represent the low to very low-income sectors of the population.

At the dumpsites, there is a form of informal waste sorting by waste pickers. They sort recyclable materials such as paper, PET bottles, metals and other plastics, while some of the waste pickers dismantle electronic devices into recyclable fractions. The waste pickers sell these materials to

middlemen through an informal transaction, and then the middlemen transport and sell these recyclables to the recycling process facilities across Nigeria. The effort of the waste pickers contributes immensely toward recycling waste. However, their working conditions are often unsafe, and their earnings are very uncertain (Mbah and Nzeadibe, 2017).

It is apparent that multiple stakeholders are involved in the waste management chain, including households, public and private waste collectors, formal and informal recyclers and regulatory authorities. Achieving sustainable solid waste management requires stakeholders to work hand in hand to supplement each other's efforts and form a consensus on achieving change (Zurbrügg et al., 2012, Storey et al., 2015). However, this is not the case in Nigeria at present as the stakeholders do not work in a coordinated way; it is, therefore, clear that the attainment of sustainable solid waste management is a major task.

1.2 Problem Statement

Solid waste management is a global concern. Challenges to tackling waste generation and management in the city are highly relevant to economic, social, political, and environmental issues at hand in the country (Singh et al., 2014, Anschütz et al., 2004). These challenges vary widely between developed and developing countries. For example, many countries in the Global South are striving to improve public health and this remains the main driver for waste management in these developing countries. On the contrary, in most of Europe, improving public health is an issue of the past and is no longer a major driver; the main focus here is on waste-to-resource and zero-waste management (Wilson, 2007, Singh et al., 2014, Oloruntade et al., 2013, Anschütz et al., 2004, Wilson et al., 2013). The alarming rate at which waste is being accumulated in developing countries that have relatively underdeveloped infrastructure requires serious attention (Nnaji, 2015, Godfrey et al., 2019, Godfrey et al., 2018). Large numbers of people in developing countries are exposed to hazards created by polluted air, soil and water every day, and poor solid waste practice is a contributing factor, among others. There is a need to find consensus in the world regarding how to solve this persistent problem of waste management in developing countries.

Copious research has been carried out on solid waste management with respect to developing countries such as Nigeria. Many researchers have tried to identify factors that contribute to poor MSW management. In the literature, factors such as inadequate institutional and legal frameworks, ineffective environmental policies, a low level of public awareness and participation, high population growth and high levels of poverty, poor funding of infrastructure and unplanned urban developments have been underlined as major factors (Ezeah and Roberts, 2012). However, studies on the approaches to developing effective stakeholder collaboration on sustainable solid waste management are rare in the literature.

1.3 Research Aims and Objectives

The overall aims of this research are to obtain insight into the factors responsible for poor stakeholder involvement and collaboration in solid waste management practices in Nigeria and to investigate how an inclusive approach for MSW management in Nigerian cities could be developed, via encompassing social, environmental and regulatory factors as well as purely technical issues.

Research Questions

- 1) Can stakeholder collaboration promote sustainable municipal solid waste management in Nigerian cities?
- 2) What are the barriers to a stakeholder-inclusive approach in solid waste management practices in Nigeria?
- 3) Is the Integrated Sustainable Waste Management (ISWM) concept achievable in Nigeria?

Research Objectives

The main objectives of the study are:

- 1) Identify barriers and explore possible explanations for barriers in MSW management in Nigeria from the stakeholders' point of view.
- 2) Examine how the existing MSW problems are interrelated and interdependent.

- 3) Identify the drivers for achieving a stakeholder inclusive approach in MSW management practices in Nigerian cities.
- 4) Determine the possibility of adopting the Integrated Sustainable Waste Management (ISWM) concept in Nigeria, based on the country's local conditions.

1.4 Structure of the Thesis

Chapter 1 presents a general overview of the global perspective of municipal solid waste, followed by background information on municipal solid waste management situations in Nigeria. Then present the perceived problem statement and research questions, and objectives to examine the problem.

Chapter 2 presents the review of relevant literature to this investigation. The chapter starts with an overview of the concept of waste, then a review of municipal solid waste in the research context, that is, Nigeria. As the research follow the inductive logic of inquiry, an extensive literature review is to support the empirical findings from the set of data collected from the fieldwork. This was followed by a review of social theories to give explanatory ideas and patterns that emerged from the data analysis and to support this research work's philosophical views. Also, this chapter includes the review of Integrated Sustainable Waste Management as the main concept of focus of this study. It identifies the gaps in the research that provides the rationale for conducting this study.

Chapter 3 explores the methodological framework within which research has been undertaken. It outlines the philosophical views underpinning the research process. Three different paradigms were used to frame the research process to enable the exploration of the research area, which is an engineering issue that is looked into through the social research approach. The chapter presents the research approach of case studies for the thesis with different methods pragmatically adopted to gather data.

Chapter 4 explores a social simulation model with qualitative evidence as a potential sustainable tool to generate virtual representatives of the interdependencies between stakeholders' actions in municipal

solid waste management and to assist in creating an integrated sustainable waste management system suitable for Nigerian cities.

Chapter 5 presents the qualitative research data analysis employed in this investigation, the findings gathered from the empirical data collected for the study and presents the model outcomes of different types of scenario interdependencies among the stakeholders. This is followed and presents the combined discussion of the quantitative and qualitative research methods findings. This section presents the discussion of the insights gained from the fieldwork and application of the designed sustainable tool to enable stakeholder inclusive approach in the MSW in the cities.

Chapter 6 outlines discussions of the original contribution to knowledge and conclusions. It highlights the limitations of the study and makes recommendations for future research.

2 Literature Review

This chapter presents an overview of the previously published works on solid waste and MSW which is the main focus of this study. The nature of the knowledge that this study is seeking is to gain insights from each stakeholder's views of MSW and to understand the factors responsible for poor stakeholder involvement and collaboration in MSW management practices in Nigeria, the logic of inquiry needs to be clarified before commencing the research. (Blaikie and Priest, 2019, p.115) explain that choosing a logic of inquiry to answer research questions requires the researcher to understand the capabilities and the relative strengths and weaknesses of the logic to be considered. With this in mind, the logic of inquiry in this research was assessed and chosen to be inductive logic. The inductive approach implies that this research set out the research questions from the beginning and began the research with the collection of empirical data from the case study cities. The collected empirical data is analysed to gain the general ideas and patterns that are embedded in the data and then the literature review was carried out. Because of this, the literature review for this study does not come from one direction of literature but it is covering the theoretical perspectives that are most related to the identified ideas that emerged from the data analysis of this study. This approach is different to the common and conventional literature review, this approach is to look at the intersection of these theories reviewed. This chapter started with a review of the broad theoretical perspectives of solid waste and MSW that relates to empirical data. This is followed by discussions on the symbolic interactionism theory, phenomenology theoretical perspective, social institutions, social practice, place attachment and the tragedy of the commons which are identified as the main theories underpinning this study. Then, the literature review is expanded on integrated sustainable waste management as the core concept to adapt to in addressing the general ideas and patterns that emerged from the analysis of the empirical data. The last section of this chapter highlights the gap in existing knowledge that has shaped the point of inquiry in this study.

2.1 Defining Waste

Waste is broadly defined as any substance or object which is no longer suited for its intended use (Orhorhoro and Oghoghorie, 2019, INTOSAI, 2022). The definition of waste is primarily a case-by-

case decision, for example, a by-product of a product can be regarded as non-waste whilst another similar by-product is regarded as waste. This decision of determining what is waste and non-waste is by a country's national waste regulation and it is generally tied to the concept of disposal as stated in the following definitions of waste by international organisations.

Article 5 of the Basel Convention: “ ‘Wastes’ are substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law”.

OECD: “Wastes are substances or objects, other than radioactive materials covered by other international agreements, which: i) are disposed of or are being recovered; or ii) are intended to be disposed of or recovered; or iii) are required, by the provisions of national law, to be disposed of or recovered”.

EU Waste Framework Directive: “‘Waste’ means any substance or object which the holder discards or intends or is required to discard.”

Waste is classified into two main categories as non-hazardous or solid waste; and hazardous waste as shown in Figure 2.1 based on the distinct legislation and policy instruments. The Hazardous waste category is usually regulated at the national level, whilst most non-hazardous regulation is usually a local (municipal) level of affairs. The types of solid waste are grouped based on the source, composition, and toxicity nature of the waste and they are classified as MSW, agricultural waste, construction and demolition waste, industrial waste, wastewater (sewage sludge) and Mining waste (INTOSAI, 2022, (Baker et al., 2004, Pizarro, 2014) report a comprehensive overview of waste-related issues, causes, effects and any possible solutions were developed through analysing the most recent data source across the continents. In their report, solid waste was categorised into different types depending on their sources, composition and toxicity. They classified solid waste into MSW, industrial waste, agricultural waste and hazardous waste (Baker et al., 2004, Pizarro, 2014). Baker et al. (2004) describe solid waste management as a way in which waste that is generated within the city is handled and treated through the collection, sorting, transportation, recycling and incineration or by landfills.



Figure 2.1: Classification of waste into categories (INTOSAI, 2022)

2.2 Municipal Solid Waste Management

MSW is the term generally used to describe solid waste that has not been categorised as hazardous in the waste identification process. MSW is categorically referred to as the various solid wastes generated by towns and cities from different types of household activities alongside similar waste from markets, street trash, commercial centres, institutions and offices (Millati et al., 2019, Pizarro, 2014, Andreescu Nicoleta and Edit, 2017, Bourguignon, 2015a). Medical waste and agricultural waste can be considered MSW if the municipality oversees their collection and disposal (Hoornweg and Bhada-Tata, 2012b). Conversely, Pizarro (2014) outlined industrial processes, construction and demolition debris, sewage sludge, mining waste and agricultural waste as not included in the MSW based on the origin of the source.

Per capita waste generation in sub-Saharan Africa is generally lower than the developed countries, it ranges from 0.09 to 3.0 kg per person per day, with an annual waste generation of 174 million tonnes. Whilst the developed countries generate 572 million tonnes of solid waste per year and per capita, generation ranges from 1.1 to 3.7 kg per person per day. MSW collection rate varies widely from country to country, and it is highly influenced by income level. In the World Bank data, collection

rates range from a low 41% in low-income countries to 98% in high-income countries (Hoornweg and Bhada-Tata, 2012a).

MSW composition consists of recyclable and non-recyclable materials, organic matter and toxic substances and the common treatment methods are landfilling, incineration; open dumping, open burning, recycling and composting (Bourguignon, 2015b, Millati et al., 2019) MSW management is an enormous task, it involves a routine of activities associated with the generation, storage, collection, transportation, treatment and disposal and these activities are to be carried out the most economically, socially, and environmentally as possible (Sharholy et al., 2007, Hoornweg and Bhada-Tata, 2012b) Previous researches highlight that the management of solid waste is typically one of the local government authority's responsibilities to its residents (Hoornweg and Bhada-Tata, 2012b). However, management is always associated with the largest budget from the city's annual finance, and this is most particular in developing countries. Improper collection and uncontrolled disposal is usually the leading contributor to local flooding and water pollution, particularly in developing countries (Orhorhoro and Oghoghorie, 2019). In general, open burning and dumping of MSW are contributing to environmental pollution and human health problems and it is of great concern locally and globally (El-Haggar, 2007, Hoornweg and Bhada-Tata, 2012b, Babayemi and Dauda, 2009). MSW is a complex issue that has manifested in difficulty to manage in many regions of the world and the rapid rate of uncontrolled and unplanned urbanization in the developing nations of Africa makes MSW harder and more complex to manage in developing countries (Onibokun, 1999).

2.3 Municipal Solid Waste Management in Nigeria

Having identified the emergent patterns from the empirical data, the understanding of the existing relevant knowledge in the literature on the MSW situation in Nigeria is essential for this study. This study expands the literature review on current MSW practices situation in Nigeria, to serve as possible sources of explanatory general ideas and patterns in the empirical data. The review of MSW in Nigeria was conducted under the following MSW management processes.

2.3.1 Waste Generation

The quantity and rate of solid waste generation in Nigerian cities have become increasingly problematic as the emerging market economy is happening in the country. The consumption patterns and lifestyles of people in the main cities have been changing in the last few decades; modern food and drink packaging has replaced traditional food packaging material (polythene bags). Modern packaging uses materials such as plastics, paper, polythene, metals and wood and all have been contributing to the increase in waste generation in Nigeria (Nnaji, 2015). The use of electronic devices such as mobile phones, computers and other smart devices has been seen as the new consumer behaviour, thereby contributing enormously to the quantity of e-waste generation in the country. Nnaji (2015), conducted a study on solid waste status in Nigeria through an extensive literature review and field study in 31 Nigerian cities. The author concluded that the population density, economic status, citizens' lifestyle, commercialization and level of public awareness of proper waste management practices in each city are major factors that contribute to the quantity of waste that is being generated day to day in every city. The available data from the previous studies have managed to estimate the solid waste generation per capita per day in Nigeria as between 0.58kg – 0.91kg (Babayemi (Babayemi and Dauda, 2009, Aliu et al., 2014) and estimated annual solid waste generated in Nigeria to be more than 32 million tons (Bioenergy Consult, 2016). Whilst Chinedu et al. (2018) in their study to examine the problems and prospects of solid waste management in Nigerian cities using the mixed method of data collection estimated MSW generation in Nigerian cities at the rate of 0.65-0.95 kg/capita/day and at an average of 42 million tonnes annually. Previous research highlights that organic waste represents 52 - 60% of the total MSW that is generated across the country every year, which indicate similarity with the estimate of organic waste in sub-Saharan Africa as shown in Figure 2.2 (Chinedu et al., 2018, Ogwueleka, 2009, Abila, 2014, Wilson et al., 2012, Godfrey et al., 2019). Nwosu and Chukwueloka (2020b), (Nwosu and Chukwueloka, 2020a) review of secondary data on waste management across various parts of Nigeria found that organic waste constitutes up to 50 per cent of the overall MSW in Nigerian cities. In their study they underlined the dysfunctional nature of MSW practices in Nigerian cities as the manifestation of a huge number of organic resources ends up

being burnt or dumped as a way of disposing of it, thereby leading to various environmental problems.

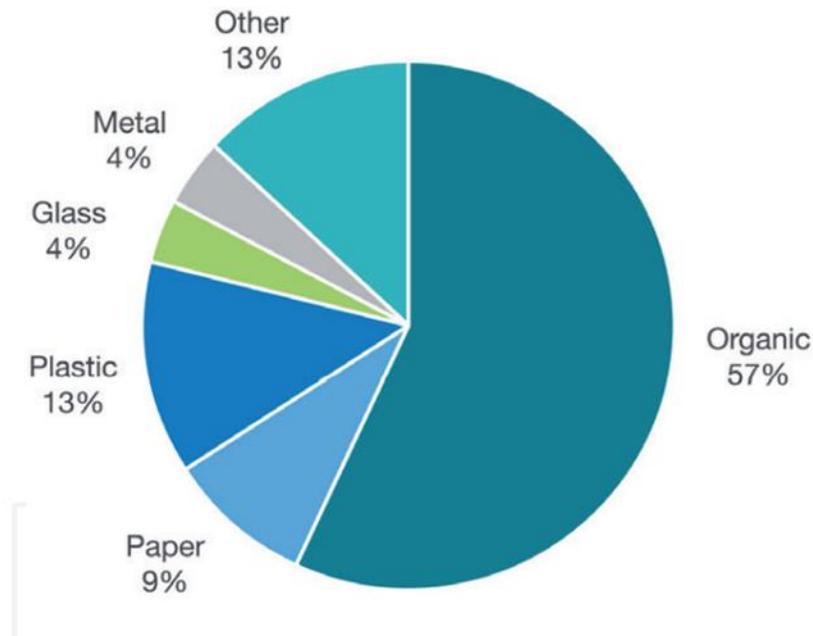


Figure 2.2: MSW composition in sub-Saharan Africa (Godfrey et al., 2019)

2.3.2 Waste Storage

Ideally, all garbage, rubbish or waste should be stored properly in waste containers such as a bin or a dumpster prior to collection, as proper waste storage makes collection easy. However, this is not the case in all cities in Nigeria (Nnaji, 2015). A waste bin is seldom found in residential houses except for high-income areas where the aesthetic value of their streets and areas is of high interest. In middle to low-income areas, solid waste is usually stored in sack bags, plastic bags and other containers available for households to use (Kofoworola, 2007). This waste is piled up at one corner of the house or on the street for many days before either being burned or given to the wheelbarrow pusher at an affordable fee who will wheel the waste away and dump it somewhere in the city. The households themselves can dump this waste in stormwater, especially during the rainy season (Manus and Adrian, 2010).

2.3.3 Waste Collection and Transportation

The collection of waste should be considered the most important aspect of MSW management due to the great impact the dumping of waste has on both the environment and public health. However, many cities in developing countries found collection services as the most expensive aspect of solid waste management. According to the study carried out by Hammed et al. (2016), through a literature review and key informant interviews alongside an on-site observation checklist to collect data, it was found that local governments in developing countries use 77-95% of their revenue on solid waste collection, transportation and disposal. Conversely, previous studies indicate nearly half of all MSW generated in Africa, remains within the cities and towns, dumped onto sidewalks, open spaces, and water bodies (Godfrey et al., 2019). Nnaji (2015) highlights that about 30-60% of MSW generated in Nigerian cities is not collected, this waste can either be dumped or burnt in the neighbourhood. Another study by Hammed et al. (2016) attributed the cause of poor collection to a lack of institutional policy, financing, inadequate transportation facilities, inadequate law enforcement and a lack of monitoring of MSW activities in the city. This study further highlights funding as being the central problem whereby many cities are struggling to carry out their responsibility in terms of MSW collection (Manus (Manus and Adrian, 2010, Hammed et al., 2016). The analysis of the quantitative research survey conducted by Babayemi and Dauda (2009) revealed that every city in Nigeria has waste collection services, however, these are mostly in partnership with private waste collection services. These private waste collection services charge certain monthly fees to collect waste from each house alongside other places such as markets, schools and offices. They then transport and dump the waste into controlled dumpsites designated by the city authority.

2.3.4 Waste Treatment and Disposal

Waste treatment and disposal are considered to be the final stage in the linear waste management practice. However, the global effort is striving toward minimizing the number of waste people dispose of and the world is also looking into embracing a zero-waste strategy. Hammed et al. (2016) argue that Nigerian cities have a long way to go in terms of adopting sustainable solid waste practices; these include waste minimization and the conventional solid waste treatment practices used around the

world. The failure of the city authority to implement proper waste treatment and disposal methods has manifested in promoting and encouraging people to dump their waste anywhere in the city, including water bodies (Nnaji, 2015). The common solid waste treatment methods that are practised in Nigerian cities as revealed in the literature review for this study are explained as follows.

2.3.4.1 Reuse and Recycling

Recycling is defined as a series of processes that convert materials reclaimed from waste into a more useful form (Manus and Adrian, 2010). In 2018, the world recycled 68 million tons of MSW (EPA, 2020). Kofoworola (2007) explains that MSW recycling in Lagos, Nigeria is in the preliminary phase and the progress made has been very slow and rudimentary. Waste recycling has not gained enough attention, both from the government and the citizens. The government's focus is on collection and disposal at the dumpsite and individuals are willing to dispose of their waste recklessly with no concern as to where it will eventually end up. There is no government-owned material recovery facility (MRF) in Lagos state (which is the most commercialized and industrialized state in Nigeria), whereby collected waste can be separated and recyclable materials are made available for end-user manufacturers to buy. The first and only MRF in Lagos and Nigeria was built in 2015 and it is owned WestAfricaENRG; a private operator. The reuse of waste materials is common among some people, especially in rural areas in Nigeria. Where there some households feed their livestock and poultry with waste foods and reuse packaging materials for other household purposes (for example, using paint buckets to fetch water, using large paper cartons to pack household items and using wooden package material to make a fire for cooking). Drinking water bottles and clothes are also often reused, they are usually sorted out from the collected MSW, clean and sell to traders who are selling second-hand things. In both urban and rural areas, waste pickers sort waste from dumpsites in an attempt to find something they can use or sell to make the end means. However, Manus and Adrian (2010) emphasise that there is a risk of contamination from reusing materials that have been sorted out from dumpsites without proper sanitizing of such materials before being reused.

2.3.4.2 Biological Solid Waste Treatment

The largest percentage of solid waste composition in Nigeria is organic waste (Nnaji, 2015), commonly referred to as a category of bio-waste. Recycled bio-waste can be used as compost and to produce biogas; a renewable energy source (Babayemi and Dauda, 2009). One of the global benefits of processing bio-waste is that it will help to lessen landfill environmental problems. Despite the huge amount of organic waste in the MSW generated in Nigerian cities, there is no information in the existing literature about where in Nigeria this opportunity has been utilised maximally to produce compost that can be used as fertilizer to enhance farming or to create biogas to use as a source of energy (Kofoworola, 2007). All indication from the literature is that organic waste continues to be dumped into open dumpsites or openly burnt in Nigeria and this has been contributing to environmental pollution through the release of particulate matter and harmful gases into the atmosphere (Kofoworola, 2007). Also, the leachate from the decay of food waste on dumpsites flows into streams and groundwater resources, thereby contaminating water supplies to the public (Leton and Omotosho, 2004).

2.3.4.3 Incineration

Nigeria has no functioning incineration facility; the two incineration plants built in Lagos state in 1976, have never been used (Kofoworola, 2007). This is due to inappropriate technological adoption from the developed countries which rendered incineration incompatible with the level of moisture in the wastes that were being generated in Nigeria, thereby eventually turning incineration uneconomical (Ogwueleka, 2009). No other incineration facility has been identified in the research so far apart from the two mentioned. In *UN-Habitat* by Manus and Adrian (2010), it was highlighted that cities in developing countries can achieve improved solid waste management systems through the adoption of appropriate technological options that are designed to meet the varying needs of each city. It is very expensive to build an incineration facility; waste burning in the incineration produces hazardous air pollutants and it requires a huge operational cost to implement the environmental controls needed to mitigate air pollution (Kofoworola, 2007).

2.3.4.4 Landfill

According to the empirical observations collected in this study thus far, there is nowhere in Nigeria where an engineering landfill can be found. The controlled open dumpsites are generally referred to as landfills in Nigeria, however, the common features of the sanitary landfill are absent and there is neither leachate management nor pollution control mechanism inbuilt on the site. In Lagos state, there are three major landfill sites that are currently serving all the metropolitan areas: Olushosun (the largest dumpsite in Africa), Abule Egba, and Soluos-Igando and whereby Agege and Iyana-Iba landfills were no longer in use (Oladapo et al., 2013, Kofoworola, 2007). The landfills in Ibadan are: Lapite, Aba- eku, Agakanga and Awotan and these were located on the outskirts of Ibadan city initially, however, the city is growing and moving ever closer to these dumpsite locations. All the landfills receive a huge amount of unsorted waste from the city on daily basis. The common management routine on these dumpsites is that waste pickers sort out recyclable materials from the dumped waste and then sell them to recycling middle dealers. These dealers are usually present at dumpsites so they can buy the recyclable waste from the waste pickers straight away. Alternatively, the waste pickers can take the recyclable materials to a junk shop to sell. After a few days of multiple waste dumping by waste collection trucks, the recyclables are sorted out by the waste pickers, however, the waste-pickers (or even the dumpsite manager) will often set fire to the waste in an attempt to discourage fly breeding or to control the insects and rats, and to reduce the volume of the waste (Kofoworola, 2007, Manus and Adrian, 2010).

2.3.5 Waste Hierarchy

The disposal of solid waste wholly in landfills implies a loss of valuable resources that could be reintroduced back into the economy. The waste hierarchy is a tool that is used as a strategical framework to promote waste prevention, reuse, recycling and recovery at the hierarchical level over waste disposal as shown in Figure 2.3. The ugly truth is that disposing of waste in a landfill is generally cheaper than recycling it or recovering energy from it. However, adapting to a waste hierarchy strategy is globally perceived to have environmental and human health benefits and promotes the safeguarding of the planet's finite raw materials for future generations (Levine, 2018).

Wilson et al. (2013) in their analysis of a set of data collected from twenty cities on all six continents, found that the developing world (including cities in Nigeria) is still a long way from adapting to a waste hierarchy strategy.

Their analysis illustrates that developing countries only recycle 20-30% of their solid waste generated, mainly through the informal recycling sector (waste pickers). Nwosu and Chukwueloka (2020b) highlight the importance of stakeholders in waste generation in terms of incorporating a reducing adapting strategy alongside the importance of establishing adequate waste characterisation as being key to a successful waste minimisation strategy. Governments are responsible for raising the awareness of both the public and businesses about the importance of reducing waste generation, by assisting businesses and industries with policies and regulations that will help them to properly manage and reduce the quantity of waste generated from their business activities. Citizens are responsible for reducing their daily waste generation and their local governments are responsible for providing the proper management services for MSW within each city and town. The optimal aim of waste reduction is to move to a more resource-efficient economy (EEA, 2020).

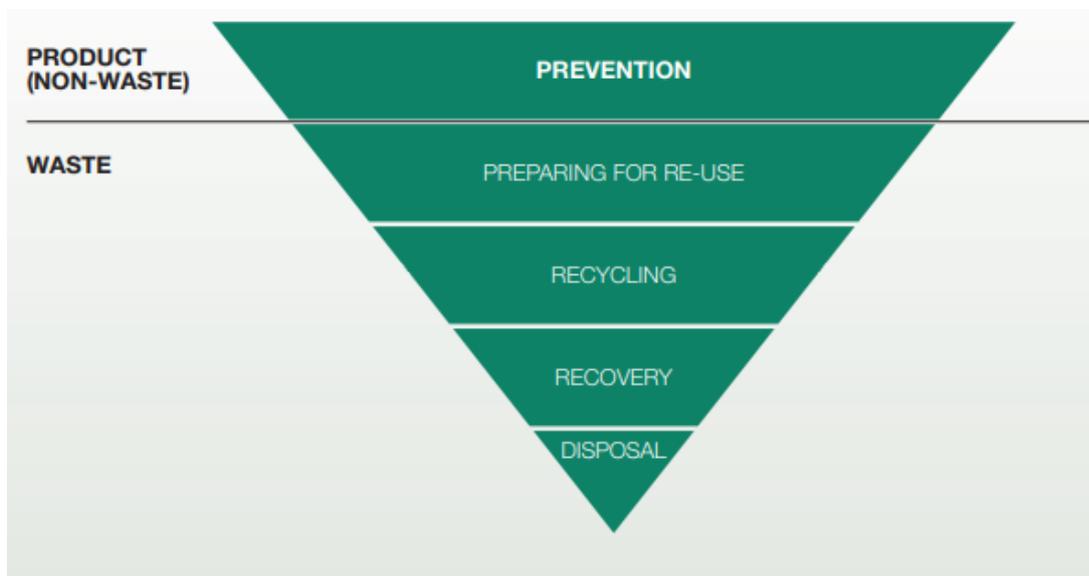


Figure 2.3: The waste management hierarchy (UNEP DTU Partnership, 2015)

2.4 Poor Waste Disposal Practice

Waste disposal remains the most crucial problem in developing countries due to the high investment and operational costs involved in maintaining proper waste management practices (Wilson et al., 2013, Aparcana, 2015). Poor waste disposal activities expose the environment and humans to pollution and health problems. Nwosu and Chukwueloka (2020b) emphasize that Nigeria is in a struggle to combat improper waste management and improve disposal behaviour among its citizens. The authors express that there are a number of factors that contribute to poor waste management in Nigeria, including the lack of waste management awareness, educational status, the amount charged for waste collection services and the efficiency of the services provided by the collectors. It concludes that all these factors have contributed to the improper waste behaviours that are seen among the people of Nigeria.

2.4.1 Open Dumping

Open dumping is the most common disposal method in many Sub-Saharan African countries. Open dumping of MSW in dumpsites legally or illegally dumping in drainages, along the streets and roads and in water bodies are common practices in Nigerian cities and it is usually the conventional final stage of MSW management in the country in most cities (Orhorhoro and Oghoghorie, 2019). All waste that is collected in each state goes to dumpsites which may be continuously on fire, either by the natural occurrence or via human-induced processes.

2.4.2 Open Burning

The main common method to control the volume of waste in the open dumpsite in Nigeria is through burning without air pollution control (Orhorhoro & Oghoghorie, 2019, Nnaji, 2015). Open burning of waste generates toxic air pollution which impacts human health and contributes to changing climates (Godfrey et al., 2019). A review of the scientific literature indicates that open burning produces a considerable amount of black carbon (known as soot) and other particulate matter. The research from Imperial College London estimates that black carbon emissions from open burning of waste could

contribute to between 2-10% of global CO₂eq emissions and have greater global heating potential than carbon dioxide. However, although it has a relatively short lifetime in the atmosphere, the inhalation of soot and other particulate matter can cause human health problems (Natalia Reyna-Bensusan et al., 2019, Ferronato and Torretta, 2019).

2.4.3 Littering

Littering streets and open spaces is also a common behaviour among people and it seems to be an acceptable way of life among many Nigerians (Orhororo & Oghoghorie, 2019, Kofoworola 2007). However, littering varies greatly from area to area, in high-income areas, littering is curtailed to a certain extent as waste is often put inside the appropriate container in these areas. In middle-low-income areas, littering is predominantly the order of the day. Fly-tipping is very common in these areas as many residents of these areas consider the street to be an appropriate place for dumping rubbish and domestic waste. On the other hand, Nnaji (2015) attributes littering and indiscriminate dumping to poor waste collection performance in Nigeria.

2.5 Waste and the Environment

The current MSW collection services in most Nigerian cities are completely inadequate also, the main implemented waste treatment and final disposal systems which is open dumping and open burning are not environmentally friendly and not sustainable treatment methods. The aftermath of open dumping and open burning results in pollution to the environment, including the freshwater and marine environment (Ferronato and Torretta, 2019, Godfrey et al., 2019).

In the same way, the indiscriminate dumping of waste in the cities creates risks of disease (such as cholera, malaria, typhoid fever, dengue fever and Zika), flooding and soil contamination and environmental pollution. Furthermore, open dumping generates leachates that are not controlled, diseases carrying vectors, odours and greenhouse gas such as methane, which is a powerful greenhouse gas, estimated to be responsible for approximately one-fifth of man-made global warming. Likewise, the open burning of waste produces significant air pollution and black carbon in

the environment and significantly impact human health and contributes to changing climates (Godfrey et al., 2019).

2.6 Challenges to Waste Management

MSW management is a challenge for the authorities in many developing countries. The challenge is becoming more alarming day by day due to the continual increase in population in the cities; something which inevitably increases waste generation. In Nigeria, the MSW management challenges have been a long-term battle, including in megacities such as Lagos and Ibadan city (Adeoti and Obidi, 2010). Poverty levels, inconsistencies in government policies, inappropriate government technological adoption and inadequate public awareness have been long-time barriers to functional MSW management in Africa (Guerrero et al., 2013, Henry et al., 2006).

2.6.1 Poverty

Poverty is one of the global challenges. The number one UN sustainable goal is to eradicate extreme poverty for all people everywhere in the world by 2030 (SDGs, 2021, Wilson et al., 2015). Nigeria, the giant of African countries, is characterized as having a high rate of poverty (Dauda, 2017). A large proportion of Nigerians are dwelling in poverty; a living condition characterised by a lack of social and economic infrastructure (for example, waste collection services) alongside a lack of education and awareness that will make inclusive MSW management very hard to achieve (Abbas et al., 2005). According to Adeoti and Obidi (2010), the income level of a household is assumed to be a variable that has a negative influence on household behavioural attitudes and solid waste management. In their study, they assessed households' preferences for improved solid waste management in a city in Delta State, Nigeria. They used a well-structured questionnaire to collect data from 115 households in the city. The analysis of their collected data shows that households in poverty have a negative likelihood of choosing proper solid waste management options. They concluded that the poverty status of a household is one of the factors that dictate households' behaviours and attitudes toward solid waste management in a city.

2.6.2 Poor infrastructure

Many cities in Nigeria (including Lagos and Ibadan) lack the adequate infrastructure required for efficient and sustainable MSW management. According to the World Bank Group (2017) report (2017), Ibadan is a city with a population of around 3.4 million which has 70 waste trucks. These were not enough to carry out the proper waste collection in the whole city and, also, these trucks were without lifting mechanisms and rear-loading packers; something which makes it harder to ensure proper waste collection without littering refuse along the streets during collection. Even in Lagos, the most populous and popular city in Nigeria, the problem of not having enough waste trucks for collection is a big issue (Agbesola, 2013).

Moreover, many of the roads in Lagos are in very poor condition, therefore the waste trucks cannot be used in every part of the city. Vehicles often break down during operation, thereby resulting in irregular collection services. Dumpsites are usually located far from the city area and the conditions of these dumpsites are very bad for both the environment and humans. Household bins or street dumpsters to store waste that will help the collection to be more efficient are not evenly available in every area in Nigerian cities. Metcalfe et al. (2012) highlight that waste bins are the central element of waste infrastructure, therefore achieving proper waste collection should begin with the good provision of waste containers across the city.

2.6.3 Poor Governance

MSW management is a major responsibility of the state and local authorities (Ogwueleka, 2009). According to Wilson et al. (2015) report on pioneering work for UN-Habitat's solid waste management in the world's cities, waste governance comprises inclusivity of stakeholders, financial sustainability and sound institutions/ proactive policies. During the planning and decision-making stage, authorities should allow stakeholders to contribute and benefit, both as service users and service providers. Financial sustainability should be considered as a range of quantitative data points available to use in developing the solid waste budget to ensure that solid waste management services and activities are both cost-effective and affordable. The third aspect of waste governance that was

mentioned in the report is sound institutions and proactive policies which are allowing separate assessment and comparison of the national and local institution framework in the cities.

Ezeah and Roberts (2014) indicate in their report that good governance is absent in the cities' waste management in Nigeria and this lack of good governance has impacted negatively on the general solid waste management system in the country. The current lack of interest taken by private companies' involvement in solid waste management is driven by the failure of good governance to provide adequate infrastructure, effective policies, regulations and monitoring to support such investment. In Nigeria, private participation in waste management has not been a successful business model because company profit is driven away by operational costs due to the absence of monitoring and regulation by the government.

Onibokun (1999) pointed up the inefficiency and ineffective governance in Nigeria persist because of the lack of a clear conceptual and strategic framework to empower the citizens organizationally and institutionally. The author elaborated that the governance in Africa has been insufficiently informed by the practical problems of service and structure needed altogether, which has resulted in poor governance. The government needs to ascertain where the problems really lie and what can be done to address them.

2.6.4 Lack Environmental Awareness

Sustainable municipal waste management is an inclusive process. To achieve this aim, cities need to increase the environmental awareness of waste issues to facilitate change in the behaviour and attitude of the citizens and to encourage an increase in public participation in waste minimisation, recycling and composting initiatives. Ifegbesan (2010) stresses that promoting awareness and a change of behavioural attitudes toward waste generation and management is critical in the effort toward solving the waste management challenges in Nigeria. Desa et al. (2012) examined the attitudes, behaviour and practice concerning solid waste management among first-year students at a Malaysia University. This was achieved through a questionnaire survey which revealed that the level of consistency between environmental consciousness and behaviour is determined by a person's knowledge and awareness of environmental issues and the individual's sense of responsibility. Their study highlights the lack of

awareness and knowledge among the Malaysian community regarding solid waste management issues, and how this ignorance has manifested into improper waste management which has, in turn, worsened the waste problem in Malaysia. Awareness-raising among school pupils is very common in Nigeria compared to adults or the general community, however both schools and communities should be effectively targeted.

2.6.5 Stakeholders Engagement

MSW management is a complex social phenomenon that involves multiple stakeholders, both service providers and users. Storey et al. (2015), identify (through the quantitative data and qualitative information derived from their field experience with MSW in four cities in Asia) that there are diverse stakeholders in waste management. Their study investigates all activities involved in the day-to-day generation and management of waste in these cities, with the aim of developing an effective partnership between stakeholders to support waste-to-resource initiatives. In the study, households and communities, government (national and local), non-governmental agencies and waste collectors (formal and informal) can be identified as stakeholders in waste management and their conclusion emphasises that effective waste management practice depends on good collaboration among these stakeholders. Wilson et al. (2006), emphasise the importance of the role of informal actors (waste-pickers, waste pickers) in solid waste management; something which has not been fully recognised by the formal sector. However, informal actors have been at the centre of waste recycling and re-use across developing countries and their actions need to be acknowledged. The effective integration of informal actors in waste management is needed for sustainable waste management in the cities. Ogwueleka (2009), summarises the characteristics that define MSW in Nigeria and concludes that inefficient and insufficient coverage of the collection system and improper disposal choices are the bottom lines of the poor waste management practices in Nigeria. The study outlines the involvement of many stakeholders in waste management and the different drivers behind each action in waste management. The study further stresses the disadvantages of developing countries adopting developed countries' waste management methods as developing countries differ from developed countries in

terms of institutions, various political, social and economic circumstances and waste composition. For example, inappropriate technology adoption was the main reason behind the three incinerators being built in Lagos in 1976, one of which was eventually converted into a civic centre in 1989, while the others were dismantled because of too much moisture content in the waste; something which made it hard to maintain the facilities. Nigerian cities are heterogeneous in nature, therefore taking an inclusive approach that factors in all these differences may be the only solution.

Uwadiogwu and Chukwu (2013) address the problems emanating from solid waste management in their study. They used data gathered from pre-coded questionnaires, structured interviews and direct observations carried out with 310 respondents from three residential densities (Low, Medium and High) in Enugu, a south-eastern part of Nigeria. The study highlighted that the only way to ensure sustainable waste management in Nigeria is to develop a comprehensive, coordinated policy, alongside good governance in combination with adequate funding, functioning infrastructures and technologies and public involvement.

2.7 Waste-to-Resources

The world is working to promote the reduction of global waste generation while encouraging product design that will facilitate recyclability; waste is now regarded as a valuable resource. With the advancement of technology and innovative ideas, values are being extracted from the management of municipal solid waste operations, thereby minimizing waste sent to landfills.

2.7.1 Waste-to-Energy

Waste-to-energy (WtE) is the process of generating electricity or heat from the treatment of solid waste. It is a practice that has been used for many years in many cities of the Global North and the most common type of WtE technology is incineration. However, the European Union (EU) is gradually turning away from WtE incineration as the EU had assessed WtE to be an approach to waste management that has not contributed to the EU's sustainable goals of achieving carbon neutrality by 2050 and that waste incineration is a carbon-intensive process that is undermining the EU's efforts to decrease carbon emissions (Vähk, 2019). Any city in Nigeria that wants to adopt this method of

MSW management needs to re-assess the values of adopting WtE as a treatment to manage waste will have on the global effort on mitigating climate change.

2.7.2 Reuse and Recycling: a circular economy view

With the global competition for resource use intensifying and resources gradually becoming ever more scarce and costly, there is a greater global concern about the rate of the extraction of natural resources to support human needs which are being carried out unsustainably. Lacy and Rutqvist (2016) state that businesses are looking for ways to protect recapture and reuse the embedded resources in their production outputs and waste. The reuse and recycling business model is a new look for the company to pursue, where value is not only considered for the outputs alone but also for all material streams in the business operation. The company is to exploit technology and innovation to make everything that used to be considered as waste in their production and consumption systems revived for other uses – the view referred to as a circular economy and blue economy. INTOSAI (2022) defines a circular economy and the blue economy as a regenerative systems in which resource input and waste, emissions and energy leakage are minimized by slowing, closing and narrowing energy and material loops through investing in the development of innovation and technology. Velis (2018) explains that some basic challenges are impeding transforming a city towards a more ‘circular’ use of material resources. Further explains that adopting a circular economy into MSW management will reduce the pressure on the environment by eliminating pollution and ensuring the supply of raw materials while also creating new jobs. It further explains that the concept of a circular economy has started to gain traction, both in the public and academic environment. However, there is a concern about whether it is doable when there are major systemic failures in our cities that are not addressed, such as the failures in the Nigerian system (Godfrey et al., 2019, Nnaji, 2015).

2.7.3 Compost for Agriculture

Composting is a sustainable method of treating the putrescible part of MSW. It is a process whereby organic wastes such as food, garden waste and other decomposable materials are allowed to

decompose under carefully controlled conditions. Compost is a rich nutrient-filled soil useful for farming (as plant nourishment) and it can be used in place of inorganic fertilizers. Baker et al. (2004) Wilson et al. (2013), describe composts as being a source of organic matter and key nutrients for the agricultural value chain which is important to soil vitality and food security. They emphasize that composting is a very valuable strategy as it reduces the amount of waste going into landfills and reduces the methane emissions from landfills.

2.7.4 Empowerment

Tapping the embedded resources in the different waste streams can be a way of creating empowerment and jobs for the citizens. The informal recyclers also known as waste pickers are the only set of individuals that engage with the recycling value chain in MSW. Waste pickers are involved in sorting and collecting recyclable materials from MSW and selling them to middlemen who then clean and sell the materials to the industry. Kaza et al. (2018) describe the waste pickers working conditions as precarious; they handle hazardous waste without any physical or social protection and the income obtainable from their activities is very low. The authors emphasize the need for the government and corporations to improve waste pickers' income prospects through government regulations that will ensure fair prices are paid by the middlemen to the waste pickers. They further state that the government can help waste picker cooperatives to establish direct contacts with large buyers of recyclables, for example, bottle and packaging manufacturers. More importantly, there is an urgent need for the integration of informal waste pickers into formal municipal waste management operational plans to contribute to the success of any recycling initiatives in developing countries.

2.8 Theoretical Perspectives

The theoretical views underpinning this study are rooted in examining some social theories and economic concepts and solid waste management concepts that researchers perceive as a lens through which thoughts and ideas in the study are viewed. Theories provide a basic understanding of human

behaviour in their contemporary environment and expand the research view in the analysis of the social-economic and environmental aspects of MSW in the cities.

2.8.1 Symbolic Interactionism Theory

Symbolic interactionism is a theoretical perspective in sociology that has been developed to allow an understanding of the social process from micro-level interactions between (or among) human beings. Symbolic interactionists hold the view that human beings act towards things based on the ‘meanings’ they have for them and that these meanings arise out of the social interaction that one has with one another (Blumer, 1969). Meaning is regarded as one of the major elements in understanding how humans will behave and interact in any social process (Jeon, 2004). Human behaviour is an explicit manifestation of the inner conversation a person engages with as part of a constant process of meaning-making. George Herbert Mead (1863 – 1931), known as the founding father of Symbolic Interactionism, redefined human behaviour as being a response to the meaning individuals attach to things in their environment rather than a set of environmental stimuli (Charon, 2007). In understanding the meaning of behaviour, a researcher needs to actively interact with the people being researched in order to understand the situation from their point of view. This should be conducted in their natural settings in order to give the most reliable analysis of the phenomenon (Blumer, 1969, Jeon, 2004). The focus of this study is to understand the perspective each stakeholder has on MSW management in Nigerian cities. This study involves interacting with the set of key stakeholders in waste management in Nigeria to understand and make sense of their attitude and behaviour that is shaping their waste disposal decisions.

2.8.2 Phenomenology

Crotty (1998) describes phenomenology as a ‘simple enough concept. It is a theoretical approach that aims to reveal how individuals make sense of the world around them and what role human awareness plays in the creation of social action. Phenomenology suggests that, if we allow self-absorption into a phenomenon, we will gain the prevailing understanding of the phenomenon and revisit our immediate

experience with the possibility of new meanings emerging that will enhance our former meaning. Phenomenologists attempt to see social reality from the actor's point of view; they think about what they have seen, then interpret and attribute meaning to the interpretations in order to get a clearer understanding of the actor's behaviour (Crotty, 1998 pp.78-79, Bryman, 2016) p. 27).

2.8.1 Social Practice

Social practice is a theory within psychology that seeks to determine the link between practice (social phenomena) and context within the social structure. In psychology and sociology, it is explained as activities that are carried out on a daily, constant and repeated basis and the way these are typically and habitually performed in a society (Georg, 2014). Higginson et al. (2017) stressed that according to social researcher Reckwitz (2002), practices are shaped by the many elements that are interconnected to one another, thereby, comprising the conditions of existence for a practice. These elements include: 'forms of bodily activities, forms of mental activities, things and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge' as outlined in Reckwitz (2002p.249). The central idea of Reckwitz (2002) in his book was later translated into a conceptual framework by Shove et al. (2012). This framework has three elements: 'Meanings (which include symbolic meanings, ideas and aspirations)', Materials (which include objects, infrastructure, tools, hardware and the human body)', and Competences (which include the practical knowledge of the practice, and the skills to execute the practice)'.

They highlighted that all three elements shaped the process of interaction in social practice. Higginson et.al (2017) explain further that the way an individual is carrying out the practice is determined by the nature of the practice. The authors believe that influencing the elements can lead to altering the practice and consequently change the behaviour of large groups of people.

2.8.2 Social Institutions

Social institutions refer to the rules that govern behaviour within a given community. Institutions are mechanisms of conduct that are embedded with a social purpose and permanence; transcending

individual lives and intentions which govern their day-to-day behaviour (Hodgson, 2006, Steven F. M. et al., 2012). In the field of sociology, the social institution is broadly classified into five main institutional canopies: the family, government, economics, education and religion. This study thinks four of these canopies influence citizen behaviour and action in the management of MSW across cities in Nigeria as set out below.

Family stands as a structure that creates a sense of identity, tradition and connection for individuals in society. This identity is passed down between generations and tends to be a mental model of identity in an individual's life, thereby, it can have a strong impact on an individual's behaviour and choices (Kaufmann et al., 2018). MSW handling and disposal choices are in proximity to individual family settings and communities' attitudes, and this form of behaviour can be passed down from generation to generation.

Government is the umbrella for all these social institutions. MSW is typically the local government authority's responsibility. Government is responsible for developing and deploying a good and functioning waste management system in a city and they should ensure proper monitoring and enforcement strategy are all in place (Kaza et al., 2018). However, the government of most cities in Nigeria have apparently failed to provide satisfactory conservancy waste services to its residents and, thus, they are continuously failing to discharge this responsibility. Ezeah (2013) associates the poor MSW experiences in Nigerian cities with the government's failure in the country. Their analysis of the existing literature on solid waste governance in Nigerian cities suggests that there is a need for an urgent rethink of Nigeria's current top-down approach to waste governance which has unwittingly discouraged most residents of the cities from cooperating toward achieving sustainable waste management.

Another institution that governs human behaviour is economic status. The income level of an individual is a driver of that individual's waste disposal choice. High-income households tend to conform to proper waste disposal methods and often pay for their waste to be collected from their residence. Low-income households have money that is hardly sufficient for their livelihood and have

no means to pay for their waste to be collected; they look for alternative means to dispose of their waste. Haywood et al. (2021) report show that low-income dwellers often use improper waste disposal practices including burying, burning or dumping waste in the streets and open spaces; this is a common practice among economically disadvantaged communities.

Education plays a vital role in ensuring that the public has good knowledge of the matter. Education creates an awareness of the benefit of proper waste management, and it empowers people to make the correct waste disposal decisions. Apart from the government's failure in MSW management in the cities, the situation is compounded by low levels of public awareness among the citizens (Ezeah and Roberts, 2014). Globally, there have been relentless efforts to create sustainable waste management awareness among the people as a means of promoting behavioural change to a more sustainable waste management practice within the cities (Baker et al., 2004).

2.8.3 Place Attachment

Place attachment is a concept in the social and behavioural sciences that emphasises the emotional bond between individuals and place (Raymond et al., 2010). Manzo and Perkins (2006) examined and synthesized how the concept of place attachment has been used in the previous literature across disciplines in an attempt to develop a framework for understanding the psychological dimensions of people's interactions with their community. Their observation from examining the literature revealed that place meaning and attachment can play a pivot role in people's involvement in the development planning process. The author specifically believes that the physical setting in which the community is planned and the social capital on assets that they share within a neighbourhood have important implications on the residents' action to collaborate to help address environmental problems in their neighbourhood. Manzo and Perkins (2006) assumed that place attachment can help to understand why people resist or support efforts to improve their neighbourhood. Moreover, it can provide evidence to support what mobilizes people, and what feelings about a place, do people have as a basis for their reaction. However, the authors stress many studies have ignored place-attached emotional ties to

neighbourhoods, they see place attachment as a basis for community power and collective action.

Kyle et al. (2004) describe place attachment as an emotional bond that individuals consider an important factor because of its functional value such as amenities and recreational settings, which can facilitate desired experiences and pleasure for the residents.

2.8.4 The Tragedy of the Commons

The tragedy of the commons is an economic concept that is relevant to the subject of this study. This concept mirrors the dumping and burning behaviour and attitudes found among many individuals. Our environment represents a common space; one which is readily accessible to everyone without any barriers and thus prone to misuse, overuse and free riding, whereby eventually, this freedom depletes the resources available. This is a concept identified by Garrett Hardin (1968) as the “Tragedy of the Commons” (Ansari et al., 2013). Open spaces and water bodies are common and non-excludable, that is, people could easily dump waste on commonly owned or public open- spaces, as long it is not in their backyard, and they can get away with it. Open burning and dumping as forms of waste handling that are prevalent activities across the Global South are possible because our environment is a shared resource from which all the people may benefit, regardless of whether they have contributed to its creation or not. This behaviour continues to pollute the environment and threatens the health and well-being of billions of people worldwide, particularly the poorest people in the world (Velis and Cook, 2021). Crucially, this is a cumulative effect of the failure to consider proper waste management in our environment, therefore this is a social phenomenon developed as a result of the tragedy of the commons. The tragedy of the commons is a social problem that has no technical solution but requires an individual moral obligation to address it.

2.9 Integrated Sustainable Waste Management

Integrated sustainable waste management (ISWM) is a concept that involves considering waste management from three different angles in relation to sustainability. The concept was coined in the mid-1990s by a group of waste management practitioners in collaboration with the World Bank Solid

Waste Working Group. This framework was developed in an attempt to describe, theorize, postulate and fundamentally provide a basis to address the persistent problems with waste management assessment and planning in developing countries (Anschütz et al., 2004). ISWM recognises waste management solutions revolving around three important dimensions in waste management: 1) stakeholders or actors; 2) waste elements that include collection, transfer treatment or disposal and 4Rs: reduce, reuse, recycle, recovery; and 3) waste aspects, which well-functioning ISWM system would allow co-operation between the physical components of waste, which are public health, environment and resource management, and the governance strategies, which involve inclusivity, financial sustainability, sound institutions and pro-active policies. The model illustration of the three dimensions described by Anschütz et al. (2004) is shown in Figure 2 below.



Figure 2.4: Integrated sustainable waste management (ISWM) model (Anschütz et al., 2004)

However, this is not a straightforward exercise for benchmarking waste management; a successful model should be built on the existing strengths of the city. Tremendous efforts have been made in the

previous research to assist the cities in the Global South to assess the needs that will help them in achieving ISWM. For example, Wilson et al. (2013) examine the underlying factors for ISWM in developing countries using data collected from their study in 2009. They used 20 cities as their case studies to examine how cities in developing countries are tackling their solid waste management problems for the *UN-Habitat* book. The results from their involvement and engagement with these cities and the interpretation of the MSW data collected from the case study's cities give a consensus that viable and sustainable solutions for solid waste management in developing countries are possible provided that the specific local circumstances and conditions of the country in question are considered during the assessment and planning stage. Anschutz et al. (2004), analyse and summarise what to do and how to perform an ISWM assessment in order to arrive at a fully integrated performance of the waste management system in the city. They conducted action research with nine cities over the course of eight years to assess the process of how ISWM can be adapted in urban waste management according to the needs of the city. From their experiences within these cities, practical tips were written out which can be used to strengthen governance and improve urban waste services. Their report established seven steps for the city to follow when implementing ISWM. These are: 1) Initiate and start the process, 2) Set up the organisational framework, 3) Stakeholder mobilisation and the establishment of the working group, 4) Memorandums of Understanding (MoU) processes, 5) Capacity building, 6) Data collection, analysis, reporting and reviewing and 7) Identification and prioritisation of key issues. However, the authors stress that the city does not have to follow these steps to the letter or, indeed, in this order. However, the steps have been developed to provide helpful and reliable guidance for any city that wishes to implement ISWM. The overall conclusion of the authors is that good and adequate solid waste management in a city will always come into being as the result of a deliberate intervention of the stakeholders in waste management in coming together to make changes. In the report developed by Kaza et al. (2018) for the World Bank group discussions on the challenge of urbanization in developing countries, it was highlighted that action is required to engage numerous stakeholders to actively collaborate in the policy development and planning stage for city waste management. The report stressed that the MSW is the responsibility of every citizen, government, business and city. Nwosu and Chukwueloka (2020) reveal in their study that the absence

of full integration and collaboration of all the stakeholders is one of the underlining problems surrounding the collection and transportation of solid waste and which impedes sustainable waste management in Nigerian cities. Hammed et al. (2016) research, which assessed the challenges associated with solid waste collection and transportation activities in Ibadan, Nigeria, revealed that there is a wide communication gap between waste management actors and other stakeholders. They identified an important point stressed by their interview respondents whereby if effective communication on solid waste management could be promoted, it would provide a long-lasting solution to waste management problems in the city. The findings from their assessment show that other stakeholders such as community people were not involved in MSW management in Ibadan due to ineffective communication between the waste authority and these people. The authors conclude that, for a city's solid waste management efforts to be successful, holistic approaches to communicating solid waste management policies and strategies plans need to be developed to encourage the involvement and participation of the citizens. They recommend the integration and collaboration of all the stakeholders through broad-based sensitization and the communication of effective and sustainable waste management in Ibadan.

Notably, previous research has identified the need for stakeholders to be actively working together in solid waste management in a city, however, the achievability of its stakeholders working together for the same goal of sustainable solid waste management is unclear. More studies are required to address this important dimension in the ISWM process, especially in developing countries where poor economy and governance have been detrimental to the process of achieving the goal of sustainability.

2.10 Gaps in Literature

Waste management is a social, economic, and environmental problem facing all African countries. If the 2030 Agenda for sustainable development is to be achieved, sustainable waste management approaches must be an environmental and public health imperative deserving of political priority.

Current MSW practice in Nigeria is very poor and it is not environmental, economic and socially sustainable. In reviewing the literature, different factors and different stakeholders that impact the

effectiveness of solid waste management have been highlighted and discussed. Among the major factors identified is poor access to infrastructures (such as good roads), a lack of waste facilities and a lack of technical know-how, land-use planning methods and the wide gap between practical waste management and the waste management policy and legislation. The fast-growing use of technological innovations and technological devices that has swift to higher usage among Nigerians, for which there is no existing e-waste management capacity in place is another contributing factor to poor solid waste management practices in the country. However, there are gaps in the literature regarding how to develop a framework for efficient collaboration among the stakeholders and how to motivate stakeholders to work together to solve these identified problems and collaborate to promote sustainable solid waste management in our cities. Although achieving sustainable solid waste management is never an easy task, it has always required a good platform for stakeholders to work together to hit a common ground on the policy decisions, planning and implementation process. With this in mind, a strategic approach to achieving sustainable solid waste management can be developed by adapting to a framework, called the Integrated Sustainable Waste Management framework (ISWM) concept. This framework encompasses social, environmental, political, technical and financial aspects while emphasising the critical role of involving various stakeholders in the approach to achieving sustainable solid waste management.

Notably, the way to achieve sustainable solid waste management is via all stakeholders in the waste management coming together in the assessment and decision-making process. However, at present, stakeholders in Nigeria do not work in a coordinated way. Crucially, achieving collaboration among the stakeholders is not a straightforward activity; there is a need for the city to figure out how to establish a collaboration solution through a low-cost system that Nigeria can afford.

This study looks into addressing the factors that are impeding stakeholders' collaboration in Nigerian cities with the aim of developing a sustainable tool to enable stakeholder inclusive approach in the MSW in the cities.

3 Methodology

The section outlines the methodology used during the investigation of research phenomena.

MSW management in Nigeria is a complex social phenomenon resulting from the interactions between human beings and the environment. The fact that human beings are very complex means that any research seeking the understanding of the underlying factors of social phenomena has to employ an appropriate research method (Mennell, 1990). The heterogeneous nature of this research suggests using a case study approach by focusing on two major cities in Nigeria. Due to the robust nature of the research, a qualitative research strategy was used to conduct the research. Data was gathered through different methods; this follows Bryman (2016) and Woodside (2017) who recommend using a combination of data collection methods (something which is referred to as “triangulation”) to develop a comprehensive understanding of the phenomenon (Olsen, 2004, Carter et al., 2014) and to make the outcome of research more credible, transparent and reliable.

3.1 Philosophical View

Understanding the philosophical view that underlies research serves as the foundation for the research assumptions, shapes the nature of the investigation and sets out how a study relates to the methodology and method employed in the research. What can be known depends on the nature of the reality we are seeking knowledge of, thus, determining what exists and its nature depends on what we know. In this sense, it is difficult to conceptual distinguish these two stances when discussing issues in social research, as they are mutually dependent and complementary (Crotty, 1998, Scotland, 2012). Crotty (1998) highlights four elements that can be used in the framework for social research: epistemology, theoretical perspective, methodology and methods. At the beginning of the research, a researcher needs to ask him/herself – “*What methodologies and methods will be employed in the proposed research?*” and “*How best to justify the methodologies and methods chosen?*” Answering these questions implies justifying assumptions about reality that are being generated in the study and the theoretical perspectives that are being used. Crotty (1998) emphasises these elements as being a clear-cut way to help researchers set the direction of the research and have a sense of stability as they proceed with the research. However, Crotty (1998) stresses that these elements should be related to as

‘scaffolding’ for a social research process and that it is not the only way of understanding and analysing the research process.

Having understood the importance of initiating the philosophical view of social research, this proposed study applied some social methods to investigate an engineering issue. MSW practice is an observable event within an immediate physical and social setting in which people live and interact, therefore MSW can be generally referred to as a social phenomenon and a reality. Cacciattolo (2015) refers to the social phenomenon as behavioural processes that are carried out by human beings, in which human beings interact and influence one another. The mainstream perspective is that waste accumulation is an inevitable consequence of the social interactions of human beings. According to Stewart (2011), waste management practices should be seen as interactions among actors that are linked to the operation of socio-technical systems and the infrastructure of society. In this sense, the appropriate pragmatic philosophical approaches to the nature of this research are taken from the perspective of critical realism- a philosophical approach associated with Roy Bhaskar (1944-2014) and constructionism - a view of knowing the reality that was developed by sociologists Peter L. Berger and Thomas Luckman (1967) alongside epistemology interpretivism – a philosophical branch that is often linked to the ideas of Max Weber (1864 – 1920). The underlying principle for these approaches was explained and made clear in a book by Crotty (1998) -*The Foundations of Social Research*. These philosophical approaches are used to justify all the assumptions taken in this research.

3.1.1 Critical Realism

“The aim of critical realism is to remove the rubbish that prevents us knowing the world”
–Roy Bhaskar (2017, p. 7)

Critical realism (CR) is a philosophical paradigm associated with Roy Bhaskar. It is a useful framework that seeks to explore reality in its natural setting through an interplay between ontology and epistemology stance surrounding reality. For example, when we see waste in a place where it should not normally be in our society, our mind starts to run through different scenarios to find out

why the waste is there. One might start to think that this is because people are wayward, and they do not want to do things right and one might then attribute certain causal effects to this observation. However, the cause may not be evident in all cases; there are always hidden causes to observe a phenomenon and they have a potentially significant impact, and which are not measurable. Social researchers should not consider what they have observed as being sufficient to provide them with all the information they need to know in order to arrive at reliable conclusions regarding the social phenomenon (Denscombe, 2010pp. 125-127). Thus, CR is a philosophical framework (iterative approach) used to establish an understanding and meaning in order to unfold the observed phenomenon. Critical realism is considered a suitable perspective to approach this research since MSW is a real-world observable phenomenon and its meaning-making of it needs to be conducted through an iterative approach.

3.1.2 Constructionism

“All knowledge, and therefore all meaningful reality as such, is contingent upon human practices, being constructed in and out of interaction between human beings and their world and developed and transmitted within an essentially social context” – Crotty (1998, p. 42).

This belief is referred to as constructionism. It holds the notion that social reality is not discovered, rather it is constructed by human beings as they interact with the world they are interpreting.

Constructionists argue that every existence of social phenomena stems from human action and that reality is the product of social processes. Generating meaning for social phenomena should be achieved through the process of interpreting and reinterpreting emergent reality. This argument centres on the process of obtaining an understanding of reality and not evaluating if the construction of reality is true or false because there is never any single true or valid interpretation of reality. What is important when evaluating reality is to arrive at a useful, fulfilling and rewarding interpretation of reality (Crotty, 1998). According to this paradigm, the inquiry into a particular social phenomenon is obtained through an interaction between researchers and actors in real-world situations as reality unfolds naturally used to generate a rich and detailed description of the social phenomenon under study (Antwi and Hamza, 2015). Adapting the constructionist perspective into a research process means the researcher is aiming to gain an understanding of the constructions of other individuals

toward observed reality and to reach a consensus of opinions among the individuals involved in the reality. Multiple individuals are involved in MSW, and their involvement varies widely. Therefore, there is a need to understand individual perspectives in order to reach a common ground whereby individuals can work together to reach a consensus that will yield sustainable MSW. This philosophical approach was adopted in this research as the researcher strongly believed that MSW is a socially constructed real-world phenomenon.

3.1.3 Interpretivism

“Different ways of viewing the world shape different ways of researching the worldthe understanding of reality needs to focus social inquiry on the meaning and value of acting persons and therefore on their subjective ‘meaning -complex of action ’” – Crotty (1998, pp. 66 -69)

Interpretivism is a paradigm that views social reality as something that is constructed within individuals’ interests and values. Interpretivism shares a view that the social sciences are fundamentally different from natural sciences and opposes the belief that social reality can be examined and understood through the assumptions and methodologies incorporated in the same way natural scientists use them to examine physical reality (Bryman, 2016), p. 26, Nelson et al. (2014). The German sociologist Max Weber (1864 – 1920) described sociology as ‘a field of science which attempts the interpretive understanding of social action in order to arrive at a causal explanation of its cause and effects’. The study of society and the understanding of social action has to be substantiated by empirical evidence (Crotty (1998 p.69). The perspective is that social reality emerges as the outcome of how people individually and collectively interact and interpret the social environment in which they live. The paradigm postulates social reality as a complex issue and that an interpretive inquiry through integrating human experiences and actions into the process of knowing will underpin the understanding of the complexity. Interpretivism recognises that there are a set of factors that may be influencing the meaning-making process in social reality (including political, cultural and social issues) and acknowledges that the process of meaning-making should not be set in stone at any point in the knowing process. The meaning-making that an individual attaches to their social environment may be revisited and reinterpreted in a variety of different and contradictory ways (Biesta et al., 2011). The main argument of interpretivism is that understanding is created through the construction

of multiple observations and interpretations, whereby interpretivism will use interviews and other qualitative methods to achieve this (Mallory, 2018). Notwithstanding, the fundamental concept of interpretivism provides too much uncertainty as this premise disallows meaningful generalizations to be drawn from interpretive research (Nelson et al., 2014, Guba and Lincoln, 1982). Also, the outcome of interpretive analysis usually only covers a specific account of the meaning of the real world. Interpretivism is employed as a framework to support and provide a standpoint for the assumptions, interpretive inquiry and the meaning-making from the data collected for this research. Embedding this philosophical approach into this study serves as a lens through which each actor in the MSW is viewed, understood and interpreted.

3.2 Perceptions from Paradigms

These paradigms highlighted in this study provide support and a standpoint for the empirical inquiry that was carried out in this study. The discipline of these beliefs moderates what is needed to be studied, how this research should be conducted and how the result of the analysis should be interpreted. The research gap identified in the existing literature on MSW management in Nigeria is that the absence of collaborative stakeholders' strategies has left a void for significant progress to be made in the MSW in the country. Nigeria has been struggling with MSW for many decades and, despite a number of studies alongside strategic and technical solutions being adopted, most of these efforts have ended up in failure or abandoned. It is common to find studies that have identified MSW problems and many that have proposed and developed technical solutions to the problems, however, the strategy for waste actors to adapt in order to utilize this knowledge has not been critically worked out. With this in mind, the proposition in this study is that a framework that can serve as a tool to promote stakeholders' inclusive approach in dealing with waste is essential in achieving sustainable MSW management in the cities. Without this framework being investigated in the MSW research, many developing countries (like Nigeria) will remain in the same status quo. These paradigms have provided the directions of the methodology approach and data collection that will help in understanding these observed stakeholder behaviours in MSW. Also, these philosophical views

underpin the research approaches that can promote collective efforts between stakeholders toward attaining sustainable MSW in Nigerian cities.

The underlining justifications these views have provided to this research and that have allowed more understanding of how research that involves human behaviour should be conducted are listed below:

1. Social action is constructed within individuals' interests and values; MSW disposal is a reality that requires a complex social action.
2. Research aiming to generate meanings from social action should consider using epistemological and philosophical approaches; however, an ontological view can also be adapted to provide a combined approach with the aim of achieving a rigorous research outcome.
3. Meaning and solutions to a social phenomenon should be achieved via the process of interpreting and reinterpreting emergent observations.
4. Research exploring interpretivism as a paradigm must take note of its uncertainty and ensure that the meaning of the reality obtained from the empirical evidence is not for generalization but, rather, for a specific account of the meaning of the real world.
5. The understanding from reviewing these philosophical stances is that there is no clear valid analysis of the observed social phenomenon, however, a reliable analysis is obtainable, and it depends on how the researcher has invested their time to interact with the people being researched as this will allow the researcher to understand the situation from their point of view.

3.3 Research Approach

The choice of the research strategy is primarily based on its suitability to provide an overall direction to the research. The nature of this research has its concepts and theories based on social research.

With this in mind, a qualitative strategy using the case study was adopted as the overarching research strategy for this study.

3.3.1 Inductive Approach

Understanding what is embedded in the collected qualitative data set, the researcher needs to find a well-systematic approach to analyse and interpret the information in the data. Inductive reasoning is mostly used as an approach to qualitative research, and it is a systematic way of exploring the phenomenon that is being researched (Lodico et al., 2006). It involves searching for the patterns or themes from the data and abstracting relationships between patterns and hence, propounding possible theoretical explanations for the observed phenomenon. Inductive reasoning which is often referred to as a “bottom-up” approach to knowledge has the ultimate goal as to generate meaning from the data set for reaching conclusions for the study (Saldaña, 2016 p.305) (Blaikie and Priest, 2019 p.92). This study uses the inductive approach to explore stakeholders' perspectives on MSW management in their social environment.

3.3.2 Qualitative Research Strategy

A qualitative research strategy is an inductive view of a research problem, it is employed to achieve an in-depth understanding of the problem a study is trying to solve (Bryman, 2016 pp. 31-36).

Qualitative research is an approach to social research that help researchers to access the thoughts and feelings of research participants and enable the researcher to gain an understanding of the meaning that people attached to their experiences. In this type of research data are collected to convey why people have thoughts and feelings which dictate the way they behave and to reveal the complexities and the richness of the phenomenon that is being examined. It is mainly classified as the inductivist, constructionist and interpretivist strategy that usually concentrates on the words from the research participants rather than the number of participants that are in the survey. The general perception is that qualitative strategy explores the relationship that exists between theory and research and elaborates research understanding by seeing things through the eyes of research participants. It is a strategy that is rooted in both branches of philosophy; it features an ontological position from the constructionism paradigm and fits into an epistemological position from the interpretivism paradigm (Bryman, 2016 pp.374-5). Having understood the usefulness of a qualitative research strategy, it is worthwhile to mention that the study using qualitative as an approach to understanding a real-world phenomenon

requires reflection on the part of the researcher, throughout the whole research process. As a way researchers reflect upon their position and subjectivities in terms of unconscious biases which it is possible to minimize but are unavoidable in this type of research. In this light, qualitative is not an attempt to generalize the research findings but an attempt to gain insights into the specific observed problem and which may in turn provide the basis for a future study (Sutton and Austin, 2015).

Bryman (2016) outlined the main steps that can be adapted to a study using a qualitative research process to address research questions. This research was carried out using these steps as highlighted in the flowchart in Figure 3.1

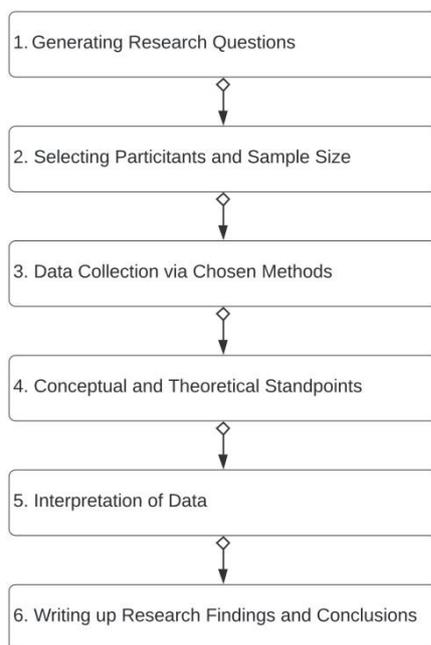


Figure 3.1: Flowchart of the research process

3.3.2.1 Case Study

A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context. Hence, a case study can help in achieving the set objectives of this research and is believed to enhance the credibility of the work (Wedawatta et al., 2011). Research seeking an understanding of underlying factors must include a thorough analysis through a rigorous research strategy methodology (Cacciattolo, 2015, Mennell, 1990).

Nigeria

Nigeria is located in the western part of Africa, bordered to the north by Niger, east by Cameroon, west by Benin and south by the Gulf of Guinea in the Atlantic Ocean. Nigeria is made up of 36 states, excluding the Federal Capital Territory (FCT) Abuja, with Lagos, Kano and Ibadan representing the first three largest metropolitan cities respectively. The population of Nigeria exceeds 170 million, the urban population was approximately 19.2% in 1963 and 50.3% in 2018 of the total population and urban areas have been estimated to have an annual increase rate of 4.23% indicating a fast alarming rate of urbanisation in Nigerian cities (Onibokun, 1999) (WorldBank, 2016, CIA, 2019). Lagos and Ibadan are used as case studies in this research due to the research timeframe and the researcher's familiarity with the part of the country. Figure 3.2 presents the 36 states and where each is located on the map of Nigeria.



Figure 3.2: Map of Nigeria showing 36 states and bordering countries (worldatlas, 2022)

Lagos

The Lagos metropolis is located in the southwestern part of Nigeria. It is a densely populated low-lying coastal area with a population estimated to be over 24 million inhabitants in 2015 (Lagos State, 2022). Lagos is the biggest city in Nigeria, the second-largest city in Africa, and it is currently the seventh-largest city in the world (Nkwunonwo et al., 2016). The land area of the Lagos metropolis is approximately 1,100 km²; a total of 455 km² of the 3,577 km² of the entire Lagos state land is water bodies, wetlands and mangrove swamps (Funsho et al., 2013). The state is bordered in the northeast by Ogun State, shares its western boundary with the Republic of Benin and to the south is the Atlantic Ocean. Figure 3.3 shows the location of Lagos state on the map of Nigeria. The Lagos metropolis is a mega-city and one of the cities in the world that is experiencing the highest rates of population growth (United Nations, 2004). It is a megacity and financial hub of Nigeria and west Africa countries, and the population is constantly growing. The metropolis is characterised by a lack of space for numerous human activities, resulting in muddled settlements, overcrowding, slum sprawling and environmental chaos (Nkwunonwo et al., 2016). The residential density pattern in Lagos encompasses low, medium and high with inhabitants averaging 5,478, 18,865 and 28,838 per km² respectively (Aliu and Ajala, 2013, Ajibola et al., 2012), with immense diversity in income levels among the inhabitants. Road networks are the best examples in Nigeria as a nation; nevertheless, there are still some areas with bad road networks, which limits vehicular access to these areas. Part of these areas is swampy slum settlements in which accessibility is mainly by canoe and boat. Municipal solid waste management practises in Lagos remain poor and this city is facing many challenges that are inhibiting the attainment of sustainable solid waste management (Amasuomo and Baird, 2017, Kofoworola, 2007). With the population persistently growing, the challenges with MSW management in Lagos city are compounded. However, Lagos is still one of the few states in Nigeria that provide waste collection services from house to house and communal collection points and some progress is being seen in terms of institutional capacity for solid waste management in the city (Amasuomo and Baird, 2017). The Lagos Waste Management Authority (LAWMA) is the government agency managing the day-to-day activities of MSW in the city and cooperation with the private sector.



Figure 3.3: Map of Nigeria showing Lagos location (Fawole et al., 2014)

Ibadan

Ibadan is the third-largest city in Nigeria, located in the southwestern part of Nigeria. It is Nigeria's largest city by geographical area, with a total metropolis area of 3,080 km² and an urban area of 6,800 km² (World Bank Group, 2017). It is 128 km northeast of Lagos and 530 km of Abuja, the federal capital of Nigeria (Onibokun, 1999). It is bordered in the northeast by Lagos State and shares an eastern boundary with the Republic of Benin. Figure 3.4 shows the location of Oyo state Ibadan on the map of Nigeria which is its capital city. The population of the metropolitan area of Ibadan is estimated to be around 3.4 million (World Bank Group, 2017). Ibadan city has no master plan, and this has led to uncontrolled urban growth and unsustainable settlement, poor transportation facilities and solid-waste and drainage managing systems (Onibokun, 1999). It features three types of residential density, low, medium and high, across each of the 11 local government areas in the metropolis. The inner-city core area consists of the oldest, the lowest-quality, and the highest-density

residences (slums) in the city. Most houses in the inner city are constructed of mud, with virtually neither sanitation facilities nor vehicular access (Makinde, 2012, Onibokun, 1999).

Moreover, most of the roads in the Ibadan metropolis are in very poor condition. House-to-house municipal solid waste collection has been in practice as far as 1988 and in the inner core, which is not accessible to trucks, the government placed dumpsters on the main roads for residents of the areas to dispose of their waste. Waste collection still exists in the metropolitan areas of Ibadan however, the collection is yet to be seen as an effective and efficient practice due to poor governance and infrastructure that characterized Ibadan (Onibokun, 1999).



Figure 3.4: Map of Nigeria showing Ibadan location (Wikipedia, 2022)

3.3.1 Reflexivity

Reflexivity is broadly defined as a self-reference in terms of how the researcher's background, values and attitudes may play a part in the research. This process is known as a reflection in qualitative research. Reflection, as its name suggests, is a state of mindfulness that involves searching questions on an issue that has never been asked before and bringing them out into the open in an attempt to solve them. Reflection is not a technique; it is a way of mirroring previous experiences to get into

what is missing and why is missing as this common says “*We do not store experience as data, like a computer: we story it*”- (Winter, 1998)(Bolton, 2018). Berger (2015) highlights reflexivity as a major strategy that adds quality to qualitative research and advises researchers in social phenomena to carefully self-monitor the impact of their own biases, beliefs and personal experiences on their research focus and understand their role in knowledge creation. The author stresses how important it is for the researcher to maintain the balance between their personal perspectives and the research respondents' views in order to minimize unconscious bias. Dodgson (2019) emphasizes the importance of reflexivity in the research process as it is one of the ways in which qualitative researchers can ensure rigour and quality in their work. The author refers to reflexivity as the gold standard for determining the trustworthiness of the entire research process and its outcomes.

Reflection is a journey that provides a powerful environment in which researchers can collect memories and organize thoughts from their experience of reality in real-world settings (Hughes and Purnell, 2008). Reflection can enable new inquiry into what we do not know and what we want to know, and it allows us to take into account the compounding factors of reality.

At the beginning of this study, I involved myself in a reflection to address any preconceived ideas that I may have had about MSW in Nigeria. I did this to avoid any unconscious bias in the research process. I looked back on my prior experiences as the starting point for the research process. I grew up and lived for more than two decades in Ibadan, one of the cities being studied in this research and as well visited and stayed in Lagos for months during my undergraduate days. It is very easy for me to recall all my experiences with MSW management in these cities. I initially devised the interview questions based on my experience of the MSW management situation in the cities and I also referred to the literature regarding what is currently known in terms of MSW management practice in Nigeria. I was aware that when interviewing my sample, I needed to be patient and remain neutral. I had to set aside my own views and reactions and listen mainly to the perspective of research participants without any interjection or moderation of their views. Throughout the research process, I was constantly aware of my prior experience and ensured it did not interfere with the research processes and the outcomes.

3.4 Data Collection Method

3.4.1 Participant Sampling

This research was conducted in order to produce a specific account of MSW management problems in Nigeria. According to Bryman (2016), where there is no accessible sampling frame for the population intended to be in the case study and the entire case study population is huge, it will be very difficult to create a probabilistic sampling frame, and neither would random selection be possible. The idea of using non-probability sampling for the study was influenced by this and, therefore, a snowball technique was chosen for recruiting participants for the interviews. A snowball technique is a non-probability sampling technique whereby participants are used to establish contact with further participants for the interviews. Thus, the sample grows until the amount of time and financial resources available to the researcher is exhausted.

3.4.2 Pilot Study

A pilot study is commonly recommended by many qualitative researchers as a desirable process to conduct before commencing with the main study (Majid et al., 2017, Bryman, 2016). Piloting interviews before the fieldwork will help the researcher gain an insight into how the main study will proceed. The researcher will be able to understand how interview questions are perceived by the participants and see where adjustments may be required. It can also be an instrument used to identify the main problem to be discussed in the interviews. More importantly, it enables the researcher to see whether the interview questions are appropriate enough to generate suitable data that can be used to answer the research questions (Ezeah and Roberts, 2012).

The interview was piloted in the UK with recently relocated Nigerians who retained clear memories of their experience regarding waste management practice in Nigeria. Snowball sampling was used to select participants for the pilot study. A total of ten UK-based Nigerian respondents were then selected. Five questions framed from the researcher's initial knowledge about the study were prepared for the pilot interview. Interviews were conducted at the interviewee's preferred location within Newcastle upon Tyne, United Kingdom. All the pilot interviews were recorded using a *Zoom H5*

Handy Recorder and the length of each interview was between 20- 30 minutes. Interviewees demonstrated different experiences and perceptions about MSW management in Nigerian cities. The audio recordings of the interviewees' responses were listened to and analysed to identify the interview questions that made no sense or that made participants unwilling to respond. This was done to ensure that the interview questions functioned well and would be suitable for gathering data for the main study.

3.4.3 Fieldwork

Fieldwork is a qualitative method that is concerned with understanding and interpreting the social interactions of social actors. It involves the collection of accurate data in the natural environment of a phenomenon while the researcher works ethically with the community of participants in ways that are of interest to them so they are willing to participate in the research (Rice, 2017). Phillips (2021) defines fieldwork as a first-hand experience of a phenomenon, which usually overlaps with other qualitative methods (such as interviewing and participant observation) with the focus being on understanding humans in their natural geographical settings.

Once the pilot study had been successfully carried out, the researcher embarked on a field trip to Nigeria to carry out the fieldwork for the study. The fieldwork was done in combination with interviewing MSW stakeholders in Lagos and Ibadan, Southwest Nigeria and participant observation. Field notes and photographs were included in the data collection process.

3.4.3.1 Interviews

Interviews involve asking participants a series of questions in order to obtain knowledge about an issue of interest. It has been a common practice among anthropologists and sociologists since the inception of their disciplines (Hamill, 2019). An interview is the most commonly used method of data collection in qualitative research when eliciting information about a phenomenon (King, 2019). In this research, semi-structured face-to-face audio-recorded interviews were conducted with waste management stakeholders in Ibadan and Lagos in Nigeria. Participant observation was also carried out

to permit triangulation of data collection. A total of 17 interviews and 2 focus group discussions were conducted within the five weeks of fieldwork in the cities. The choice of agencies interviewed in this study was based on their administrative management and involvement in the MSW management in the respective case study cities. Whilst, the interviewees were randomly selected from each agency based on individual roles in relation to solid waste management in the city. The stakeholders interviewed were: the Lagos Waste Management Authority (LAWMA), Lagos State Environmental Protection Agency (LASEPA), Lagos State Government Ministry of Environment & Water Resources, Oyo State Solid Waste Management Authority (OYOWMA) and Oyo State Government Ministry of Environment and Natural Resources. Other stakeholders contacted were households, private-sector waste management companies and traders. The focus group were carried out with two different groups of informal recyclers at Olushosun dumpsite in Lagos and Lapite dumpsite in Ibadan. The Olushosun dumpsite's focus group consist of thirteen informal recyclers all males and the Lapite dumpsite's focus group is made of eight informal recyclers of six males and two females. Information about what the interview entailed was communicated to the interviewees ahead of the interview date and the location for the interview was an open choice for the interviewee. Each interview was recorded using a *Zoom H5 Handy Recorder* and each interview lasted between 15 and 70 minutes.

Due to the large and voluminous audio recordings collected from all interviews, alongside the time constraint for the research, some portions of the interviews were not transcribed. However, these portions were closely listened to and any salient points from them were extracted to ensure that no new information would emerge from them. Nevertheless, it was kept in mind that the non-transcribed portions may contain certain data that might be useful at a later stage in the analysis, therefore, all recordings (including those that were not transcribed) were kept securely and could be readily accessed for further study. The idea to transcribe some of the audio interviews was influenced by Bryman (2016 pp.482-5) tips on transcribing interviews. Bryman highlights that it is wiser to transcribe only those portions of interviews that the researcher thinks are useful and relevant and to leave out those that are not illuminating. Also, Dilaver (2015) highlights that transcription of in-depth interviews may take a considerable amount of time, the author suggests listening to the audio records

of all interviews and taking notes of identified meanings emerging from the recordings is an alternative way of starting the analysis then the researcher can transcribe segments of narratives that are most informative. Transcribed texts were organised and coded on the NVivo 12. The process of sense-making from the data with regard to the research questions, as well as the reviewed literature and theoretical ideas, began in an attempt to extract core information that could illuminate the study. Sherratt et al. (2015) point out that qualitative researchers acknowledge transcribing interviews as the means that will permit a thorough examination of the interviewees' responses and will allow the data to be reused. In their study, they used coding from interview transcripts as a precursor to exploring their data through discourse analysis.

3.4.3.2 Focus Group

The technique of interviewing more than one participant at a time in qualitative research is referred to as a focus group. It is another data collection method that involves interviewing a set of respondents about a phenomenon that is of particular interest to them in order to generate primary data needed for a study (Boeije, 2009 p.64). A focus group was another method used in this research to gather raw data from a different set of stakeholders involved in the MSW practice in the case study cities. It was important to gain insights into how individual members of this group discussed the MSW issue and how they responded to each other's views. The strategy used for recruiting focus group participants was through a key informant recruitment approach; this means stakeholder organisations helped to gather participants for the interview (Bryman, 2016 pp.508-9). The office of the permanent secretaries in LAWMA and OYOWMA assisted in selecting staff to take part in the focus group interview. The WestAfricaENRG, a PSP operator in Ibadan, Oyo state assisted in gathering a group of waste pickers on the Lapite dumpsite in the Akinyele Local Government Area of Ibadan for the focus group interview.

3.4.3.3 Participant Observation

Participant observation is another widely used qualitative method for data collection, Bryman (2016 pp. 321- 9) describes participant observation as a social research method in which the researcher

engages in social settings for a certain period of time in order to observe the behaviours of social actors in the settings. This can include asking questions and listening to what is being said in conversations. Researchers participate in the actors' daily activities as much as possible in order to gather information during the direct observation of how day-to-day events unfold. During the fieldwork for this study, a series of observations from stakeholders' actions were documented from friendly talks in their workplaces and their homes to interactions with waste pickers on the dumpsites visited. At the dumpsites and material recovery facility (MRF), multiple insights were obtained via a tour of the facility and engaging in their daily operational activities. Observation revealed the challenges and predicaments that are facing the dumpsites and MRFs in these cities.

3.4.3.4 Field notes

Field notes are also referred to as observation memos. These are important materials used to describe observations made in the field and are helpful for formulating a reflective account of the entire fieldwork (Bryman, 2016 p. 440, Boeije, 2010 p. 70). It is essential to take notes of everything seen or heard during the fieldwork because of the frailties of human memory. A field note is a detailed summary of observations and behaviours experienced during the period during which the researcher immerses him- or herself in the natural settings of the phenomenon being studied. Notes are important materials as they may help to formulate a reflective account of the fieldwork (Bryman, 2016 p.440). Every day of the fieldwork, observations were jotted down in the form of brief descriptions of events and observed behaviours including the details of locations and dates. These were written in a small notebook to keep the memory of the events intact for writing up later.

3.4.3.5 Photography

Photography is an additional form of data collection that provides information that may be difficult to convey through written formats. Photography is particularly significant for the illustration of things found and it also helps the researcher to keep memories of the fieldwork (Bryman, 2016 pp.451- 3). Throughout the field investigation in both case study cities, numerous photographs were taken and preserved.

3.5 Data Analysis

3.5.1 Data Organizing via Nvivo

Understanding what is embedded in the collected qualitative data set is crucial and requires the researcher to find a well-systematic approach to analyse and interpret the information in the data collected. The primary data collected from the case study was organised in NVivo 12, a qualitative data analysis (QDA) computer software package used for the study of textual and audio-visual data sources. Hence, sense-making out of the data begins with verbatim transcriptions of the audio-recorded interviews. There is a degree of disagreement among qualitative researchers regarding the amount of data that should be coded when analysing transcripts. Some notable scholars (including Anselm Strauss) emphasise the worthiness of transcribing and coding every recorded interview. This is because there might be a significant insight into the data which could otherwise be lost if interviews are only partially transcribed (Charmaz, 2006). However, the majority of social researchers support the view that only the most salient portions of the collections that relate to the research questions should be given consideration in the coding process (Saldaña, 2016). Furthermore, novice researchers are warned of how time-consuming transcribing and coding can be during data analysis. Therefore, it has been suggested that it is good practice to transcribe only the parts of the data that seem more relevant to the research topic. By doing so, researchers will be able to save time on analysis (Alvesson, 2011, Bryman, 2016).

First cycle coding

The transcripts generated from the recorded interviews were organised in the NVivo 12 software programme and made ready for thematic data analysis. This process involves searching the transcripts for areas that will provide genuine insights that will, in turn, illuminate the research findings and conclusions. First-cycle coding is also known as *Open coding* or *Initial coding*, and it is the initial procedure that should be applied to transcripts. It means the transcripts were thoroughly read and reread in order to gain a sufficient understanding of the emerging information in the interview data. The coding of interviews is widely recognised by qualitative researchers as a common step in the

interview analysis process. However, there is no consensus among the experts of qualitative researchers on how this should be done and no universal agreement regarding a set of coding procedures that can be replicated (DeCuir-Gunby et al., 2011, Roberts et al., 2019). Saldaña (2016) and Woodside (2017) suggest coding line-by-line is the most suitable approach when analysing interview transcripts. This is because it displays data in a strategic way that can enhance credibility and trustworthiness as the analysis proceeds forward. Many scholars recommend open coding as the initial step to analysing qualitative data; they refer to open coding as the initial stage of making sense of the qualitative data. It involves segmenting the data into meaningful parts and naming these parts that will then be reassembled into categories of themes. Barney Glaser and Anselm Strauss are two famous sociologists supporting open coding; they refer to open coding as the initial stage of organising, conceptualizing and analysing the data that ultimately lead to the development of a theory called grounded theory (Saldaña, 2016). The transcripts and field notes are broken down into lines of words and supported with photographs that considered being relevant to the research questions of the study. The highlighted segments of the whole interview data set transcript are referred to as codes (Williams and Moser, 2019). The process of breaking down the transcripts into words or short phrases and labelling from the actual language used by the interview participants is referred to as “in vivo” coding; something which is particular to first-cycle coding (Given, 2008, Saldaña, 2016).

Second cycle coding

This is a set of procedures whereby the data is put back together in a new way after the initial coding has yielded a list of codes. This involves searching for the connections and relationships that exist between categories. In this procedure, the researcher reassembles the data that has been fractured during the initial coding in order to determine whether the list of codes developed to represent the insights in the data sufficiently or whether there is a need to assign a different code to code some data fragments properly to give coherence to the emerging analysis. The main purpose of second-cycle coding is to determine which elements of the data are the dominant ones, thereby giving insights into the observed social phenomenon. At the end of the second coding, the data set is reduced and

reorganised by selecting the best representative codes, crossing out the synonym codes and removing the redundant codes (Boeije, 2010 pp.108 -9). The social researchers Anselm Leonard Strauss and Juliet Corbin refer to this approach of further coding as *Axial coding* whilst sociologist Kathy Charmaz call second cycle coding *focused coding*. However, each of the preferred names all centres on discovering more from the data and making the most analytical sense from the coding of the data set (Bryman, 2016 pp.574 -5).

All codes generated in the open coding process were reorganized and reanalysed to develop a sense of categorical, thematic and conceptual organisation from the array of codes in the first cycle of coding. Codes were merged, based on their conceptual similarity, and they were then fitted into different categories.

3.5.2 Thematic Analysis

Thematic analysis is a widely used approach to qualitative data analysis; it is a systematic way of exploring the phenomenon that is being researched (Lodico et al., 2006 , Braun and Clarke, 2006, Bryman, 2016). It involves searching for the patterns (or themes) in the data and abstracting a relationship between these patterns that will provide possible explanations for the observed phenomenon.

Thematic analysis is a very flexible method for analysing contextual data, however, there is relatively little clear agreement among qualitative researchers about what thematic analysis is and how to conduct it. The work of popular thematic analysis qualitative researchers such as Braun and Clarke (2006), Attride-Stirling (2001), Dennis et al. (2013) provide a generic guiding set of principles for any study that wants to use thematic analysis as a research method. Bryman (2016 pp.584- 9) highlights the guiding steps to thematic analysis as follows:

Step 1: Familiarization –read through the materials to be analysed. Firstly, the researcher needs to become thoroughly familiarised with the materials (such as transcripts and field notes in this case) before starting to analyse the data.

Step 2: Coding –begin coding the materials. The researcher should develop their thinking about the data by highlighting sections of the text. This involves identifying various phrases from the transcripts and creating shorthand labels or “codes” to describe the content of these portions of text.

Step 3: Generating themes – to elaborate many of the codes into themes. In this step, the researcher seeks to reduce the number of codes by identifying common elements in the codes and then using them as themes. At the same time, the researcher will begin to write memos on what each theme meant.

Step 4: Reviewing themes – to evaluate the order of the themes. At this stage, the researcher may refer to the relevant literature to underpin the themes, so they adequately reflect the codes and are accurate representations of the data.

Step 5: Defining and naming themes – to examine possible links between the themes to depict what is known about the phenomenon that generates the data. The researcher states clearly what is meant by each theme and considers how it helps in understanding the data.

Step 6: Writing up –write up the insights to produce a compelling narrative about the data. It is crucial to link the emergent themes to the research questions and the reviewed literature.

These steps were strictly and carefully followed, and the researcher constantly asked self-questions: *Am I missing anything? How best to combine the codes to make them more useful and accurate? Are these themes really present in the data?* Through an iterative (repeated) reading of the data set and by comparing themes against the data set, the researcher made sure that emergent themes were useful and an accurate representation of the data. It is very important in the coding process to ensure that coding procedures are well-defined and relevant to the research questions in order to conform to the validity and reliability standards associated with qualitative research (Williams and Moser, 2019). The coding steps applied to the data set for this study are illustrated in Figures 3.5 and 3.6. These steps provide a transparent account of the process of reading through the transcripts and field notes that generated the codes.

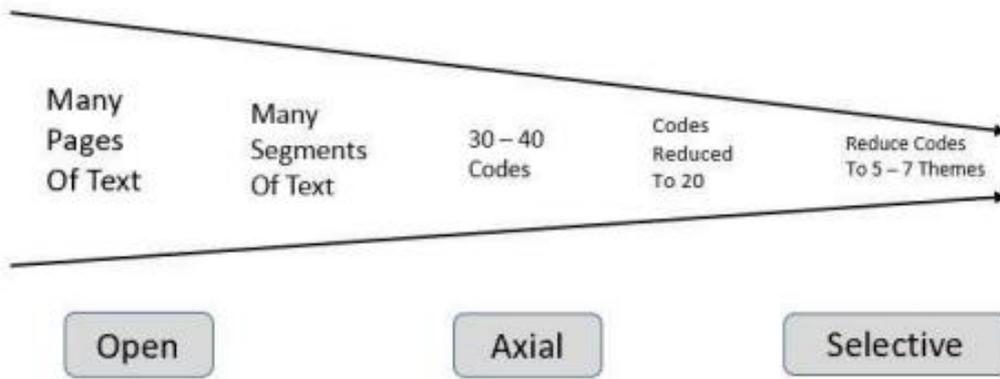


Figure 3.1: Overview of the coding process. (Williams and Moser, 2019)

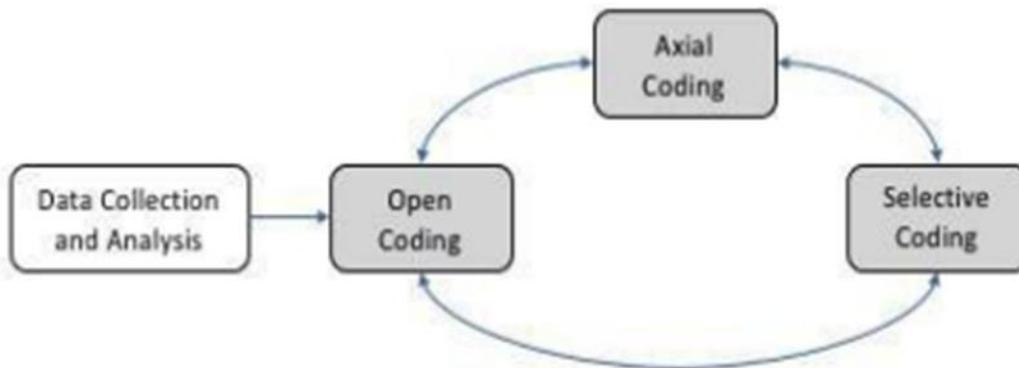


Figure 3.2: Illustration of the non-Linear process adopted. (Williams and Moser, 2019).

4 Agent-Based Modelling Method

In order to have an overall perspective of the MSW management situation in Nigeria, a modelling method is included to complement the qualitative method used. In developing countries like Nigeria, managing MSW comes with enormous challenges and complex problems. The management involves several stakeholders, and their involvement is not always in a collaborative manner. The complexity of this structure has made it a difficult task to study MSW performance properly using only conventional methods. Meng et al. (2018) stress that the notion of using the sociological methodology to address sustainability problems is inadequate. The management of waste in a given system is always based on a series of decisions made by agents, therefore, to achieve an effective assessment of solid waste management in a country, it is recommended to include a simulation method in the analysis.

4.1 Understanding Agent-Based Modelling

Agent-based modelling is a constructive modelling environment that has a significant transparency quality. The input parameters to build a model emanate from numerous lines of source code from the literature and empirical data (Polhill and Gotts, 2009). ABM allows the researcher to create a bottom-up approach that can be used to design a virtual replicate of target phenomena in a more transparent way compared to other traditional mathematical models (Galán et al., 2009, Polhill, 2015, Müller et al., 2014). Bandini et al. (2009) emphasise that a model should incorporate three basic elements: agents, interactions and the environment. Railsback and Grimm (2019) explain that a model should always be viewed as an iterating process that involves several loops of steps to perform tasks in an attempt to simplify assumptions that make up the model; these loops are referred to as the “modelling cycle”. The modelling cycle consists of “formulating a precise research question; assembling hypotheses for key processes and structures; formulating the model by choosing appropriate scales, entities, state variables, processes, and parameters; implementing the model in a computer program; and analysing, testing and revising” (Railsback and Grimm, 2019 p.12). One important thing to note is that this simulation technique can model systems composed of a collection of autonomous decision-making entities and it has the ability to handle a wider range of nonlinear behaviour than conventional

equilibrium models. Farmer and Duncan (2009) describe ABM as a computerized simulation of a number of decision-makers (agents) and institutions, which then interact through prescribed rules. Alonso-Betanzos et al. (2017) defined an agent as a computational entity that we can use as the basis for simulating social processes by which this entity interacts with other entities autonomously within a virtual environment. The authors emphasize that consumer compliance in a waste recycling scheme is not possible everywhere in the world like it is, for example, in Sweden today. The world needs to create alternative frameworks for the refinement of waste management strategies and policy implementation on waste generation reduction, alongside an improvement of recycling rates. They stressed that solid waste policies must take into account the sociological, demographic and economic facts about the households and other stakeholders involved in the MSW, to achieve sustainable change in waste management. Alonso-Betanzos et al, (2017) highlight ABM represents a promising alternative to traditional ways of understanding how social processes function over time. In addition, ABM is regarded as the most significant and potential technique for exploring dependencies among stakeholders involved in complex systems (Meng et al., 2018). In spite of the advantages ABM can offer, the use of ABM as a tool in analysing solid waste management studies is rare in the literature. Nevertheless, ABM had been used in a broad range of areas and disciplines including biology, ecology, economics and the social sciences (Macal and North, 2010). ABM has been used to simulate a more structured approach for resilience engineering in the analysis of sociotechnical systems in air transport, whereby interactions between human and technical system agents were simulated to develop an application for an advanced aircraft surveillance system (Stroeve and Everdij, 2017). One of the few solid waste management studies that use ABM as a tool is Meng et al, (2018), whereby ABM was used to provide support to the social survey questionnaire conducted on household behaviours in waste classification and recycling in the city of Suzhou in eastern China. Their study simulates the behavioural change of agents (households, recycling workers and authorities) in the system under different policy scenarios. The outcome of their simulations demonstrated that some policies could improve the performance of household solid waste separation behaviour and increase the collection rate of domestic recyclable materials. However, how households and other stakeholders work together with the effect of the policies' implementation was not elaborated on and, thus, were

not included in their study. This has provided a premise for this research to appraise ABM simulation and scenarios testing of stakeholders' inclusive approach in ISWM in Nigerian cities.

From the viewpoint of ABM potentiality, this study tests the application of a modelling simulation tool in providing clear insight and a demonstration of how stakeholders' actions can be collaborated towards achieving ISWM for the cities of Lagos and Ibadan in Nigeria. A model that has the ability to simulate the behaviour and interaction between waste agents (stakeholders) and the two other dimensions of waste management (the waste elements and the waste aspects as explained in the ISWM conceptual framework) is investigated in this study. The belief behind this research is that ABM can simulate scenarios for possible solutions for MSW management collaboration in Nigeria through virtual community behaviour interactions.

4.2 Agent-Based Modelling as a Tool

The focus of ABM is usually on developing simple and realistic complete representations of real-life processes. In this sense, ABM was applied in this study to develop insight into improving collaboration between the agents for the attainment of ISWM in the city. Another importance of ABM is that it facilitates systematic reasoning around the research interest and accommodates varying parameter settings which will enable researchers to experiment and compare multiple possibilities. This model was structured from variables and parameters from the empirical data and the interactions observed during the research fieldwork. The model was developed from coding step by step in an open-source, agent-based modelling package called Netlogo (Wilensky, 2015), (version 6.1.1). Netlogo is an easy-to-use interactive modelling environment which allows for an exploration of emergent phenomena by modifying switches, sliders, choosers, inputs, and other interface elements to vary the parameters (Skeldon, 2018, Skeldon et al., 2018). According to Bandini et al. (2009) a model should have three main basic elements: agents, environment and agents' interactions.

Environment - Virtual environment

Environments are the spaces in which agents exist. They capture all the structures and dynamics in a mode and execute the function of all agent actions and their effects (Klügl, 2016). The city of Lagos is

the environment for this simulation, and it is characterized as a city surrounded by water. Some areas in the city are not accessible by vehicles whilst others are accessible via road networks. The residential pattern in the city is heterogeneous therefore there is a wide difference in layout and waste management practices. Many unplanned land-use systems feature slums, and the dumping of waste is prominent in these areas.

Agents

There is no precise universal definition of “what is an agent”, modellers tend to agree on more points and disagree on another point. Generally, an agent is considered any type of independent component or entity with a range of behaviours from primitive reactive decision rules to complex behaviours. Entities should have the ability to sense their environment and change their behaviours in response. Some label agents as a component that has autonomous behaviour and the capability to make independent decisions (Macal and North, 2006). However, the consensus from a practical modelling standpoint is that agents should have certain characteristics summarized as thus: an agent is identifiable, autonomous and self-contained with a set of rules guiding its behaviour and decision-making. Klügl (2016) describes an agent as an entity situated in an environment where it functions independently or interacts along with other agents and its surroundings. An agent may have a goal to achieve and would only select an action that will yield the maximum outcome for its goals (Macal and North, 2006).

MSW consists of multiple agents of heterogeneous characteristics; they have diverse properties (variables) and attributes and exhibit a set of actions and interactions among themselves within their environment. In the empirical data gathered for this research, five types of agents are identified in MSW management in the city of Lagos, these being households, PSP (collectors), waste pickers, traders and the waste authority. However, waste pickers and traders are not considered in the model, in order to make the simulations as clear and easy to run and test. The properties of each agent of this model are enumerated as follows:

Households – waste disposal attitude is based on their income level, hygiene consciousness and residential area. Households' decisions can be to use proper waste collection services, open burning or dumping at random places in the city.

PSP (collectors) – collects waste, transports and disposes at authorised dumpsites, they carry out these actions based on receiving waste collection fees from households.

Waste authorities – monitor and enforce regulations; they go around the city to monitor the waste situation and promote waste awareness among the people through sensitization and advocacy.

Actions and Interactions

Actions and interactions constitute agent behaviour; they can cause modifications in their environment as well as in other agents that constitute the model (Klügl, 2016, Wilensky, 2015, Müller et al., 2014). Agents are dynamic; they move from place to place. Households move randomly within their residential environment and decide on the choice of disposal based on their state variables.

Collectors interact with households to collect their waste. Irregular waste collection services occur due to poor road accessibility or when households do not pay waste collection charges. The waste authority interacts with collectors by regulating their activities and interacting with households to encourage a change of attitude and commitment to proper MSW practices. Waste authority monitoring is carried out at a time interval and depends on the government's financial allocation; something which is usually not available most of the time.

4.2.1 Path Dependency

The patterns of behaviours that emerge from the empirical data suggest that households' actions tend to follow a set of certain ways as a result of the social environment in which they live in. These patterns evince the path dependence in household behaviours. Path dependence is a theoretical framework that is commonly used in disciplines like history, economics, political science, and sociology and it is classed as part of the school of thought of historical institutionalism (Trouvé et al., 2010). Bonoli and Palier (2000) appreciate institutionalism as being a particularly helpful theory that

gives account for the divergent outcomes observed in human society, they see it as a principle that explains the resistance of different structures to change through past commitments and referred to this as a path dependency. Path dependency proposition is that organizations and actors are part of institutions that structure their behavioural standards and activities along their normal paths. In particular, institutional paths shape the present choices of actors' actions (Trouvé et.al, 2010). The authors highlight the dependence on the path taken by actors as always in form of a historical dynamic and it is difficult to change it because the processes become institutionalized and are reinforced over time. They emphasize that reversing past institutions has become increasingly difficult because of the costs attached in terms of investment, learning and coordination. Thus, existing institutions are usually modified but not replaced despite their less-than-favourable nature. In general, Djelic and Quack (2007) article stress that there are different versions of the path dependency argument, and they are associated with varying perspectives on institutional stability and changes. However, the soft version of path dependency simply has to do with a historical focus of events in which general idea is that events that had occurred at an earlier point in time will affect the possible outcomes of the events that will occur at a later point in time. The inclusion of ABM as another method in this study will enable us to visualize the effect of path dependency that emanates from agents' interaction with their social environment.

5 Analysis and Results

This chapter presents the insights gained from the researcher's interactions and engagement with the stakeholders in MSW in Lagos and Ibadan in Nigeria. It includes interpretations of all observed situations and events as well as face-to-face discussions held during the researcher's stay in the case study cities. The data was generated through semi-structured interviews and focus group discussions and were then analysed and interpreted in order to make sense of all that had been said and seen. The analysis looks into the interplay between social, economic and environmental conditions that are impeding stakeholder collaborations in MSW management in these cities. Through the analysis, a list of barriers to a stakeholder's collaboration was identified from the research respondents' perspectives. The insights from thematic analysis of the set of data collected during the fieldwork for this research generated valuable contributions to the available knowledge on MSW in Nigeria. In the same way, it provides support for strategic thinking toward filling the current gaps in MSW management in Nigeria.

The photographs presented in this chapter were taken by the researcher during the fieldwork and informed consent has been granted for the facial recognition pictures used in this research.

5.1 Fieldwork Analysis

The review of the literature and the participant observation carried out by the researcher in this study revealed that MSW situations in Lagos and Ibadan city represent (to a significant extent) the waste management problems that exist across cities in Nigeria. Refuse is seen everywhere in the case study cities; MSW is indiscriminately dumped along the streets, roads, highways and water bodies. Street gutters in low to very low-income areas are predominantly filled up with solid waste and this prevents the easy flow of stormwater and wastewater along the streets. Instead, this water flows into the roads and impacts the accessibility of people moving in and out of these areas. MSW collection exists in some areas, particularly medium to high-income areas. However, the regularity of this service is questionable as many people are not satisfied with the service, they receive for the payments they are making for their waste to be collected. On the contrary, private waste collectors stressed that the bad condition of roads in the city was a major factor impeding the delivery of effective services. Even so,

the waste that is being collected is not treated in any form. Rather, it is collected and transported to authorized dumpsites. Waste burning to reduce the amount of waste is still a common practice among the residents and governmental authorities in these cities.

5.1.1 Coding and Thematic Analysis Results

The semi-structured interviews and focus group discussions were conducted with 19 respondents across all the stakeholders in MSW management in Lagos and Ibadan. These were: Lagos Waste Management Authority (LAWMA), Lagos State Environmental Protection Agency (LASEPA), Lagos State Government Ministry of Environment & Water Resources, Oyo State Solid Waste Management Authority (OYOWMA) and Oyo State Government Ministry of Environment and Natural Resources, households, Private-sector participation (PSP), informal recyclers (waste pickers) and market traders. The highlighted number of interviews conducted with each set of stakeholders is shown in Table 5.1 below.

Table 5.1: List of the participant stakeholders involved in the data collection methods in the case study cities

| Stakeholder | Case study | | Collection method |
|--|------------|--------|------------------------|
| | Lagos | Ibadan | |
| LAWMA | 2 | | Interview |
| LASEPA | 3 | | Interview |
| Lagos State Government Ministry of Environment & Water Resources | 2 | | Interview |
| OYOWMA | | 1 | Interview |
| Oyo State Government Ministry of Environment and Natural Resources | | 3 | Interview |
| PSP | 1 | 1 | Interview |
| Households | 1 | 1 | Interview |
| Waste pickers | 1 | 1 | Focus group discussion |
| Market traders | | 2 | Interview |

The construction of meaning which Holloway and Todres (2003 p.347) referred to as ‘thematizing meanings’ from the collected data set was achieved via familiarization with the entire data set and identifying the interesting and prevalence of elements that capture something important in relation to the research questions. The elements identified were collated and categorized into potential themes

that generate insights for this study. The analysis involves different steps of procedure which began with organizing the data set on the Nvivo 12 software programme and followed by the coding process.

5.1.1.1 First Coding Outcome

The iterative process of familiarizing myself with data that was generated from the interviews, participant observation and field notes serves as a precursor to analysis. The first coding revolved around constructing meaning from the data, due to the timescales of the research, and the exploratory nature of the work. The researcher was able to transcribe 72 pages of transcripts which were from the nine perceived useful and informative audio interview recordings from the total of 19 recordings of participants' responses in the case study cities, see Appendix A for copies of some of the transcripts produced for the thematic data analysis. The interplay between the researcher and transcripts and the rest of the audio that are not transcribed provided and enhanced the researcher's understanding of MSW management practice situations in Lagos and Ibadan. These data were coded line by line when something illuminating and interestingly related to research questions is emanating.

Through repeated reading, highlighting and identifying every interesting aspect of the data relevant to this study, in the back-and-forth familiarization process, a list of 48 codes were generated from the breakdown of data which formed the initial coding for the analysis. The process of generating the initial codes through a thematic framework is illustrated in Appendix B. The process involved the researcher systematically going through the entire data set, identifying interesting aspects in each data extract that are relevant to the research questions and giving each aspect a full name. Each name is coined based on the researcher's understanding of what each particular data extract is informing from the dataset. Following the naming of each aspect, a short memo is written to describe the insight that the researcher has retrieved based on the extract from the data. The compilation of the code names and descriptions is known as a codebook. The codebook of the 48 codes generated from the initial coding of the dataset with examples of the extracts that is underpinning the code is presented in Appendix C.

5.1.1.2 Second Coding Outcome

Larger numbers of codes can be too difficult to analyse and can reduce the clarity of the research findings. In order to get more specific information that corresponds to the aim of the study, the codes were further examined and compared for similarity through an intuitive sense of ‘what looks alike’ or ‘sounds like a similar point’ and then grouped into a selected category which forms a list of categories. The 48 codes generated in the first cycle of coding were rearranged into nine categories as Attitudes, Household behaviours, Poor governance, Poor infrastructure, Poverty, Monitoring and enforcement, Lack of awareness and engagement, Technology, and Waste value. These categories formed the major conceptual themes for the research focus and questions. Thus, the illustration of relevant and similar codes to form a theme is visually represented in Figure 5.1.

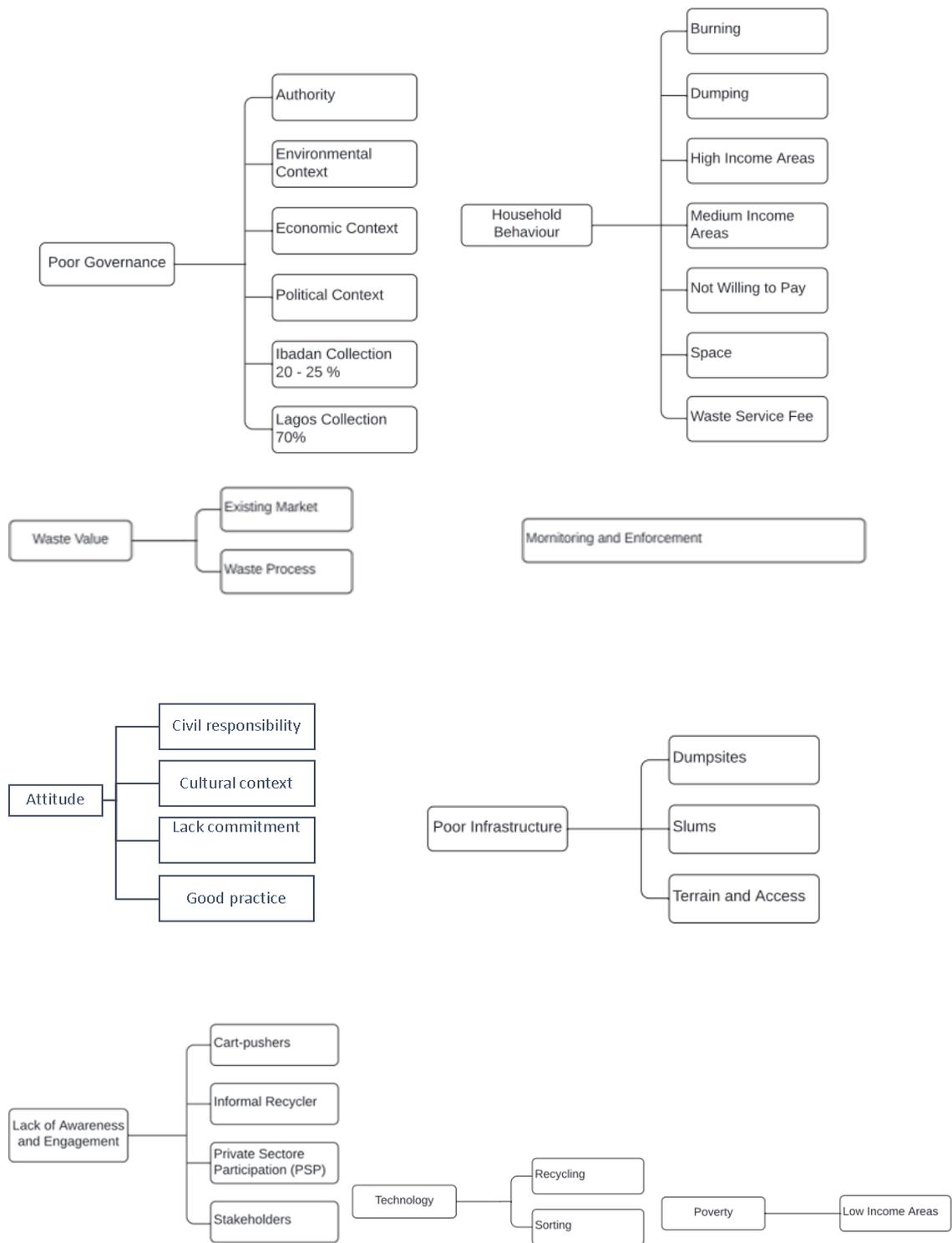


Figure 5.1: Axial coding: showing the relationship between codes and the emergent theme

5.1.2 Emergent Themes

It is important to outline the validity of individual emergent themes in relation to the entire data set in order to check if they accurately reflect meaningful evidence to support the research findings. In a like manner, identifying the essence of what each theme is about and part of the data each capture is a vital exercise and also leads to defining the theme. The following sections discuss the narratives that each theme is telling with evident data extracts from the interviews with the main stakeholders of focus in this research, the waste authority, the households, the PSP and waste pickers in each case study city.

5.1.3 Analytic narratives from Lagos

5.1.3.1 Attitudes

Authority

The Lagos waste authority claimed that the major MSW problem lies with the households' attitude to proper waste management practices. Government agents believed that, even with the poor infrastructure in the city, people could still make a difference if they cooperate to give their waste to PSPs and pay for their waste service. Authorities stressed that a positive attitude from the households will make a difference.

“The attitude of people to cleanliness is still poor. Compliance to dispose of properly, have waste bin, compliance to pay waste bills, is poor.”

“Somebody will bring the waste she generated at home to shop because she doesn't want to pay twice.”

“The thing with our people is that they are not just ready to do the right thing, is not that they don't know, I am very sure of that. People know the proper thing to do.”

“They are aware, the orientation is there, but the problem is just our mindset.”

“The Government Reserve Areas (GRA), Ikeja and the rest of high-income residential areas in Lagos, those one pays. The medium and high-income areas that one pays.”

“This mentality of our people that it's a social responsibility of government to pick and pack the refuse free of charge.”

Household

Households in Lagos are opposed to the authority's account of them, and householders do not want to do things correctly. Households show a willingness to cooperate with the government MSW management as long as it is reliable and continuous management and affordable.

“Government involvement in the waste management in our area then was just consistence for just two-three years continuously before it became inconsistent.”

“If we have communal dumpsters station close to our house, of course, we will dispose our waste into it.....where we lived before and during the government programme around 1995, we did put our waste in the dumpster provided by the government.”

PSP – Private sector participation

The PSP interviewed in Lagos highlighted that households' attitude to MSW management varies from neighbourhood to neighbourhood. Some households cooperate and manage their waste in line with government rules whilst many finds alternative ways to dispose of their waste with the city.

“A large number of the households still give their waste to cash pushers in many places in this Lagos and cart pushers had been banned by the government but they still operate illegally.”

5.1.3.2 Household Behaviour

Authority

Authorities claimed that households always find illegal ways to discard their waste. Currently, cart pusher waste collectors, burning, littering and dumping of waste were still common illegal practices among households, nevertheless, some still pay for waste collection services from PSP operators.

“Majority of the householders do not own a waste bin: ‘where your bin is?’ he will say ‘I don’t have any waste,’ ‘what do you mean you don’t have any waste?’ ‘I don’t produce any waste.’”

“We have communal facilities, by law, every household should have a bin, and do they have a bin? No, they don’t.”

“... the level of compliance is low in domestic waste generators. Households always find an illegal way to discard their waste.”

“I wouldn’t like to say Lagosian, for people generally, however, it is very difficult to make them do something. Some will tell you it very stressful to sort, how can I separate these, when waste gets there, go and separate it yourself.”

“You know a lot of things happened when there is a change in government and people always hide under that to say we don’t know that it is still going on, presently we are doing a lot of recovering waste debt from people that own us even when they know, they will still say we thought government say we are not paying again.”

Household

In spite of allegations made by the authority of household behaviours in waste disposal choices, the household interviewed in Lagos shows a desire for a cleaner environment and believes that if government carry out their functions appropriately, households will comply.

“It comes to a time these government waste officers don’t come regularly to pick the waste and still they still bring bills. So, we still have to use the Hausa which is tantamount to two payments, so we rather use Hausa alone.”

“.....there are Hausa’s people that come around with their wheelbarrow to collect your waste and we pay them.”

PSP – Private sector participation

PSP in Lagos think household behaviour is an individual thing and the government’s loopholes create an avenue for households to make illegal waste disposal decisions.

“It is just an individual thing, government has to play a big role, do their responsibility right, I’m sure people will comply.”

5.1.3.3 Poverty

Authority

The Lagos Waste Authority stressed the impact of poverty among the citizens in compliance with government plans on MSW management.

“Unfortunately, in our enlightenment and sensitization programme strategy, we have a problem and the greatest challenge is poverty because people believe that the government made them be poor and why should listen to the government that make them poor when they can’t put food on their table?”

“You know Lagos social classification of people; we have low, very low-income areas, the Badiya, the Ijora of Lagos’s world. If you expect anybody to pay for refuse collection in those areas, you are just wasting your time.”

“The slums and very poor areas where people can’t afford to pay for their waste, the government continues to pay PSP.”

Household

Household thinks it is a good idea that everybody pays for their waste to be collected and dumping should be stopped.

“Even in the new area we are now, we had stopped throwing the waste away because at one-time government came and start on the programme and prohibit throwing waste in the area.”

PSP – Private sector participation

PSP identified People with very low income have problem cannot afford to pay, on the other hand, household who lives in medium-high income areas are either pay for waste collection or dump waste in the spaces in the city.

“Household payment is based on property type and that is the type of measure we have.... There are low-medium, high-income areas and that one pays.”

5.1.3.4 Poor Governance

Authority

Political aspirations were said to influence waste management practices in public and marketplaces; this was clearly stressed by the authorized representatives during interviews.

“This is democracy, and the government are lenient because of political ambitions, maybe when the private sector comes to play, might be more forceful. You know the government are always careful because electoral positions, at they will be harsh, and the same time cool down and allow people to it wrongly.”

“Another issue is government policies is an issue, because a government will come in and bring new policies and when that goes, there is no continuity.”

“Our resources is not enough for a population of 23 million, the government needs to employ more health officers, WHO state that about one health officer is to 400 people. Lagos state present has one health officer to 7000 people.”

“Unfortunately, we have more than enough qualified health officers in the state that are unemployed.”

“The facilities for collection are not enough, is not adequate for us to completely clear all the refuse on the streets of Lagos daily, we need 1200 trucks and I think all that we have together is not even up to 200 trucks.”

Household

A household will like the government to do more to enable and promote commitment to proper waste management among the people.

“It comes to a time these government officers don’t come regularly to pick the waste and still they bring us bills.”

“Another thing which I think would be better is if the government can make available waste facilities at an interval on the roads, on the streets and so on. So people can see where to put their rubbish on their way, I think that will go a long way, aside from if it is possible to get a waste bin for every house even if the government is going to ask them to pay, most people will still comply as long it is consistent and the waste is picked regularly.”

PSP – Private sector participation

PSP believed Lagos is progressing with partnering with private sectors to carry forward an effective MSW management however, PSP thinks the legal framework for effective delivery is still missing.

“of course, partnering is on the ground, we just need the right administrative and legal framework to do it effectively.”

5.1.3.5 Poor Infrastructure

Authority

The waste authority in Lagos attributes the poor condition of roads in the metropolis as the major problem facing MSW management in their city. They highlighted the main waste handling processes (which involve the waste collection, transportation and disposal on dumpsites by PSP operators) usually come with a high cost due to poor infrastructure.

“Our facilities are not sufficient to handle all the waste generated in Lagos metropolis.”

“Terrain and access are a big problem in Lagos. There are areas where is not accessible by our bigger waste trucks, we have three-wheelers called Tata trucks for access to these areas.”

“Issue we have is the distance from the point of collection to the point of disposal. Somebody pick up refuse from where we are now to dump it at Ojota, Lagos (about 25km) is a big problem.

“Another problem is dumpsites, they are getting obsolete, they are getting filled up and they are even in the middle of the town”

Household

The residents interviewed expressed dedication to complying with government regulations on MSW management, however, the government is failing in to provide basic amenities that would make the compliance doable.

“We used to put everything in a bag and put it in the communal dumpster. After we moved to a new area which is still a developing area so what we did was just throw our waste probably on an abandoned land because there is no dumpster.”

PSP – Private sector participation

Lagos being densely populated with the vehicular volume on the road so high, it takes a long time and that affect the turnaround time, the time you should have used for two, three turns, you are still on one turn.”

“There is only one Transfer Loading Station and Material Recovery Facility in the whole Lagos metropolis.”

“You know infrastructure is the major obstacle here, bad roads, long miles, trucks are breaking down every day.”

5.1.3.6 Technology

Authority

The interview participant at LAWMA emphasized in one of the discussions that the government does not normally access the local conditions before embarking on (or adopting) foreign solutions to local context problems; therefore, adoption in most cases ends up being a setback rather than progress. The interviewee gave an example of the only material recovery facility for sorting solid waste in Nigeria that was commissioned in 2015. It provided two years of excellent performance before the facility's performance became crippled due to an irregular power supply and the high cost of fuel to power the facility.

“Foreign bring their technical skills but the local know the terrain better. So, the locals will help to fix the technology into our terrain. They too, the foreign will also learn by discovering that we are different, if it is not localized it cannot work. No foreign ideas, technology will work without the local content.”

PSP – Private sector participation

PSP claimed that they looked into what MSW management in the most advanced countries was using and borrowed the idea into the Nigerian context.

“We took the experience from what is happening outside there and try to adapt to our own local environment, and it has been working for Lagos.”

5.1.3.7 Lack of Awareness and Engagement

Authority

The separate interview with LAWMA and the Lagos State Government Ministry of Environment & Water Resources shows that Lagos has an ongoing awareness programme, and the city has been adapting to different frameworks to bring up the MSW management compliance level among the public. However, most of these programmes have ceased to continue due to regime-changing which usually involves the discontinuity of the predecessor's achievements.

“In the first two years of introduction of PSP in Lagos, collections were free, the compliance level was high and everywhere was beautiful, but at the time we bring then to realisation of keeping their refuse intact for refuse collectors and people cooperated and complied. Lagos won all the awards globally; we are the cleanest city beyond others.”

“Private sector is called PSP; they are companies that are registered under Lagos State Waste Management Authority (LAWMA) and we have over 300 of them across the Lagos.”

“Like almost 5- 6 years ago when we started with the recycling programme, monitoring and advocacy department go out on daily basis and there was a programme on incentive-based recycling, we asked people to bring their waste, even nylon, we weight it and pay them. There was a time we are also doing waste for food, maybe on children’s day, we asked the children to come with waste and return with food. We are even doing schools advocacy, where we can also talk to parents, we are having recycling clubs in public and private schools. So, at the point, we also collect PET bottles and pay for it, so that people begin to know that these things are useful, and they can be used to make money instead of just dumping it and people are forthcoming.”

“Then we are able to achieve a certain level of compliance at the point but now I don’t think it is still the same level. What I know is that we still do advocacy, and it is always in an interactive platform, where people can come and ask us anything they want to know. We do the advocacy with buses with megaphones moving from one area to another every day for general advocacy.”

“At the landfill, we have the informal waste pickers, and they do recycling, they do recovery of valuable fractions such as plastics, metals and cartoons, these are three main things they are looking for.”

“These waste pickers are registered on under our management and anyone that buying from the dumpsite must be registered with us as well so that we know them but the market, we leave the market alone to the waste pickers determine their best price, but you must be registered with us just to know what is going on and just to know who is recycling.”

Waste pickers

A scavenger at the Olushosun dumpsite in Lagos state said that he is doing the job of picking recyclable materials from the dumpsites because he cannot find any other work. He expressed his disappointment in the government for not providing a formal structure that could help waste pickers earn more from the job. However, he stressed that his interest in the job to get income did not involve any thought in regard to maintaining a healthy environment.

“There is no formal structure for our members, no recognition in the government structure.”
“We are here on dumpsite because we are jobless, poor people and we do this job to feed and support ourselves and our family.”

Household

Households show interest in getting more awareness and education on proper MSW management. The households believe that if the government try to educate people adequately, people will do the right thing.

“First thing is to educate people about cleanliness.”

PSP – Private sector participation

PSPs in Lagos are more concerned about promoting proper awareness among citizens, especially the households because they believe adopting a proper waste disposal choice stem from an individual’s mindset and it can be changed with the continuation of engagement and communication with this set of people.

“It is not about educational level, is about awareness and orientation because Surulere is one of the organised areas we have in Lagos metropolis and half of the people in Surulere are still not paying.”

5.1.3.8 Monitoring and Enforcement

Authority

LAWMA and the ministry of environment for Lagos state said proper monitoring and enforcement are going on in every corner of the Lagos metropolis, however, they acknowledge that there is not enough staff to carry out the enforcement effectively across the city.

“Even there is enforcement corps in Lagos KAI: Kick Against Indiscipline and the first state environmental force KIA in the whole nation. There are about 1000 staff, but the truth is that they are not enough considering population of the state of over 20- 23 million people.”

“I think complete enforcement can only prevent or curb these people from this habit and culture.”

Household

Households said government officers rarely come to their neighbourhood.

“I cannot recall when last I have seen these officers in my area.”

PSP – Private sector participation

Private waste collectors stressed the need for proper enforcement and more enforcement officers as a means to facilitate positive change in public behaviour in regard to waste disposal.

“The enforcement that is most important one...Is there any enforcement? No, any enforcement.”

“By law, every household should have a bin, and do they have a bin? No, they don't. Is there any enforcement? No, any enforcement.”

5.1.3.9 Waste Value

Authority

Authority affirms that there are resources waiting to be tapped from MSW management. Conversely, the current Nigerian legislation and policies do not provide any support to make that happen.

“Energy can be generated; gas can be obtained, and employment will be created. There are lot advantages and benefits from waste that everybody can be deriving from it.”

“It is a real fact, waste is valuable.”

“There are a lot of Nigerians, lot of Chinese and lot of Indian doing recycling business now as well and there is demand for it.”

Household

This household believes that there is value in waste

“Empowerment in waste”

PSP – Private sector participation

PSP encourage the government to do more to make MSW management lucrative.

“The management of waste is not profitable at all; the current financial and infrastructure we have in this country are not sustainable for waste business”

5.1.4 Analytic narratives from Ibadan

5.1.4.1 Attitudes

Authority

In Ibadan, authority emphasized that people are historically very stubborn. They tend to beat the system in their day-to-day activities in which waste management is not excluded. Authority in Ibadan believes that hygiene consciousness among Ibadan people is very poor, and this is manifesting in their attitude to waste disposal.

“At a time, the governor was on the emergency measure only, and then the waste collection was free. We are now six years later, Ibadan people are still saying that the governor said my waste collection is free, where there had been a change in the government. Er.... Ibadan people are very stubborn in memory.”

“The mindset that ‘why I’m to pay, why I have to pay, what is the government doing for me? It’s the government’s responsibility to do it for me.”

“‘Poverty’ because people believe that government made them poor and why should listen to the government that makes them poor when they can’t put food on their table?”

“There are lack citizenry attitudes, you know people themselves could have recognised actually this is my responsibility.”

Households

Households claimed that the government is not doing anything for them and that the government has failed them in difficult times. A large number of households believe the government should collect waste free of charge from all citizens.

“It’s more convenient for me to burn and dump waste, we have nearby space to dump them.”

“I can see payment as part of my problem indirectly but honestly to consider other people living in this area are struggling even to get food on the table. So, asking them to come and pay to dispose of their waste would be a kind of burden on them and no one is ready to do that. But to me, of course, if I say very good waste service, then I can also pay but now nothing. I know for a lot of people income will be challenging to pay for that kind of service may be a problem to subscribe to it.”

PSP – Private sector participation

This PSP took up MSW collection in Ibadan and Oyo state 12 months prior to the time this interview was conducted. Within a year of their engagement with the people of Ibadan, they realised that most households in Ibadan are less concerned with good waste management in their city.

“People in Ibadan are only worried about where to work tomorrow, they are not worried about the hospital bills next month, which they never see it coming and it is a very religious area. So, constantly, they will say God will protect, er...er, that is very fine, God protect it all, but it has in that mentality and cultural interaction to say this is my area, I must have pride in my area, I must keep it clean, I must pay for my waste bills and so on and on. In Ibadan in particular, have problems with that....”

5.1.4.2 Household Behaviour

Authority

The waste authority in Ibadan stressed that only a few households in Ibadan follow the government MSW management rules. Generally, households in Ibadan see no reason why they have to pay for their waste to be collected; they want everything to be free and do anything to beat the system.

“The problem is once somebody has a bin, everybody waste goes into that bin, they put the bin outside their house, and you come to wake up in the next morning, the bin will be overflowing.”

“Households burn their waste at their backyard, throwing it into canals, disposing on the highway or on the roads.”

“If we say to somebody where your bin is, he will say I don’t have any waste, what do you mean you don’t have any waste, he will say I don’t produce any waste.”

Households

The area where a person lives or has grown up has a strong influence, and the interview with a household in Ibadan confirmed this assumption.

“I grew up in the slum. It is a slum in the downtown of Ibadan. Yeah it is the core area in Ibadan I grew up there and there’s nothing like waste bins or collection trucks coming to that area, we dump our refuse onto the river, yeah.... In the river”

PSP – Private sector participation

PSP indicated that there is low compliance to proper MSW disposal among households and market people in Ibadan. They do not want to pay for their waste to be collected and use all available tactics to avoid paying. PSP also point out that small-scale businesses do not want to pay for their waste to be collected and that these businesses typically behave like households.

“They want to bargain with you, if ask for 1000 naira or 2000 naira for waste collection, they will say I give 1800 naira, this is not about bargaining because 200 Naira doesn’t really affect them, is almost that they need to, need to beat the system:”

“What I don’t understand about Ibadan markets people is that most of the markets women will pay more to the bullyboys to collect their waste and dump it into streams than what we will want to charge them.”

“Small scale commercials are almost the same thing as households, and they do not really care; they burn it or throw it into the environment in whatsoever.”

5.1.4.3 Poverty

Authority

Authority in Ibadan laments the extent poverty is taking its toll on people's behaviour in terms of proper disposing habits.

“We use to have bins inside major populated areas like dumpster bins and what was happening was that ‘I’m getting go down on the poverty, I’m afraid` the unfortunate situation is that people dispose their dead bodies in these bins and so on and it was not great.”

Household

Households are less concerned if their waste causes any human or environmental problems.

“.... see I’ve been in this area like this for decades, in my house I don’t think there is a year we have ever use bins before.... we just dump or burn.”

PSP – Private sector participation

PSP expressed that income level influences the willingness of the household to commit to proper waste disposal. The poverty level among people is very high, and complying might come at a too high cost to people in poverty.

“Poverty level is very high. People wonder and think ‘if I pay for my food, why do I need to pay for my waste, to get a grid of it?’”

“The concept of a long-time planning for someone in a high level of poverty is very difficult. They are only worried about where to work tomorrow, they are not worried about the hospital bills next month, which they never see it coming.”

5.1.4.4 Poor Governance

Authority

It was also claimed that politicians tried to be lenient with people in order to gain their favour in elections, thereby shielding wrongdoers from punishment. Moreover, it was claimed that the waste management budget is insufficient and there was a lack of continuity in policy and political will.

“Lot of these markets are the larger voting base or voter base if I can put it that way; so you cannot put too heavy-handed on them because they are very politic active.”

“One of the other challenges in Ibadan is that the majority of employers are working for the government, they are civil servants and we know the challenges when the system collapses, to pay civil servants wages, salary and so on will end up collapse.”

“We have now 70 PSP contractors around the whole of Ibadan, my view is that we are capturing 60% of the waste being generated.”

“Almost about four million people in Ibadan and we have 13 environmental officers in waste management.”

Household

Households in Ibadan think the government is not doing anything to change the dumping habit that is particularly among the people of Ibadan.

“The government is not enforcing anything here and you can do whatever you like.”

PSP – Private sector participation

PSP perceived the implementation of government policies and regulations as being very poor as it has given room for wrongdoers and has not encouraged private investment in MSW management.

“By law, every household should have a bin, and do they have a bin? No, they don’t. Is there any enforcement? No enforcement. “

“I don’t think is policy implementation issues that lead to failure in enforcement, I think is a resource issue.”

“Absence of political will and unplanned nature of government regulations have failed investment in the waste business.”

5.1.4.5 Poor Infrastructure

Authority

The waste authority in Ibadan stressed that the government in the current regime is doing everything in its power to improve road access and problematic terrains.

“The present regime in Ibadan has done the Ibadan master plan for 2036 and I see that look very positive. It takes the stress out on the central parts of the city, making a satellite town built around the city and that is a very good idea in my own view, and that will bring development and proper planning. It is not just about waste, is about all the utility; power, water, road and so on.”

Household

One resident of Ibadan stated that many areas are really bad in terms of access and that the people are living there because they do not have a choice, however, this household shows interest in living where is free of waste piling up in the neighbourhood.

“I can tell you there is some area that is quite bad than others. When you get to these areas where they are you will see a lot of bad waste piled up. Of course, you want to leave somewhere else but there’s nothing you can do to it.”

PSP – Private sector participation

PSP described Ibadan as an unplanned city and this structure issue has hindered any MSW progress plan that has been designed for the city.

“The structural issue is that Ibadan as historical as I know has no development planning whatsoever. Most of the growth in Ibadan has been unplanned, even in the plan area is very difficult to get vehicles in there to collect waste. So many of the roads could not fix for compactor trucks and if you cannot use compactor trucks, the major cost of operation will gonna go up and this has been the challenge there, this is structural issues around development planning and then physical planning is as well we go through here, that is one and it is a big issue.”

“We got to have to be careful, people in Beere [a slum in Ibadan], they don’t have proper housing, and how are we going to enforce proper bins?”

5.1.4.6 Technology

Authority

The interview participant at OYOWMA lamented a large number of abandoned waste trucks in their facility due to the fact that the spare parts needed to repair those trucks are not commonly available in Nigeria. Also, since the trucks were imported, there are no expert resources available in the country that can be used to repair them. Figure 5.2 shows abandon trucks at the OYOWMA facility, captured during a visit to the facility.



Figure 5.2: Abandoned trucks at OYOWMA facility in Ibadan

PSP – Private sector participation

PSP in Ibadan shows a great interest in generating energy from municipal waste using the available technology across the globe. In reality, they found these technologies were not appropriate for the current economic situation in Nigeria.

“We have done over study for waste to energy, we found, and we know it is viable, we can do technical but the economy at this moment that we do not see it coming. So, we are working on that. Presently we are looking into composing, composting biodegradable waste.”

“There is no concept of the sort at source; there are no waste process facilities at the Oyo state at moment, so we don’t them get to sort out.”

5.1.4.7 Lack of Awareness and Engagement

Authority

OYOWMA claims that they usually communicate with other stakeholders in MSW management.

It was also highlighted that the government is trying hard to make the engagement include as many people in the city as possible.

“We do enlightenment, where we do a lot of publicity campaign on radio, television, going out to the community, housing association, sitting with them explaining what we are doing, trying to communicate what we are doing.”

“We make waste management information and awareness on flyers and distribute it in each local government area in the city because we want to get the awareness across to grassroots communities’ people.”

Household

Households demonstrate a complete lack of waste management awareness. In the interview, this household admits that waste dumping can cause environmental problems, however, they seem not to be bothered with the problem.

“We don’t care about dumping, that's just the point. Everybody that lives in this area dumps their refuse so it is a normal thing. So when the refuse heaped up in a particular space, just one Samaritan will just come and burn it and it can be there burning for like weeks.”

Scavenger

The group of waste pickers at the Lapite dumpsite in Ibadan highlighted the difficulty they are facing in their day-to-day activities on the dumpsite. They talked about self-ignite fires that often occur on the dumpsite which usually prevent them from sorting waste and also expose them to toxic gases. This is illustrated in Figure 5.3 which was captured during a focus group interview with the waste pickers at Lapite dumpsite. They also expressed their disappointment with the Oyo state waste management authority for not keeping the promises they have made to them on several occasions. The promise to help them regulate their activities would make it more lucrative by setting out guidelines for the middlemen that exploit the waste pickers by buying from them very cheaply and then selling the recyclables at a far higher price to the recycling company.

“We want the government to assist us so that we can earn more income from our work on this dumpsite.... even if the government can employ us so we will be government workers and stable income.”



Figure 5.3: Waste pickers at OYOWMA dumpsite in Lapite Ibadan

PSP – Private sector participation

PSP in Ibadan is optimistic that people will comply and cooperate if a good waste management system is in place.

“We got to get the service right. I’m very convinced if we give good services to people, people will pay for it, and so we got to get the service right.”

5.1.4.8 Monitoring and Enforcement

Authority

OYOWMA claims that are doing regular monitoring of MSW situations in the city every week, carrying out enforcement and doing proper sanctions on anybody that violates the environmental rules.

“We do try to go and do enforcement on it on days to days. On Thursday we do have environmental inspections on the markets.”

“We have dedicated magistrate working with us now and we persecute easily 100-150 people every day here that can be easy to 1000 people.”

Household

Households think they can do anything they like with their waste because the government is not enforcing any regulations or sanctions.

“Honestly, I can say we dump because the government is not enforcing anything here. And you can do whatever you like. And I know that this won’t cost me anything if I dump by the road or upon it somewhere close by. And there’s a lot of commonplaces that you can just dump your stuff even in the gutter we put a lot of waste food there. No one will challenge you for that. So, it’s of common practice something everyone does. So, no one is stopping you from doing that.”

PSP – Private sector participation

PSP call attention to the lack (or absence) of monitoring and enforcement on the part of the waste authority.

“The laws itself is actually a very good law and this is disseminated to the people through enforcement but hardly any law is enforced, Um..... smiling....in Nigeria, so waste management is another one which is very difficult.”

5.1.4.9 Waste Value

Authority

The interviewee at the Oyo State Ministry of Environment and Natural Resources elaborates that the authority is looking into composting agricultural waste in some parts of the state.

“We have abundant arable lands in Oyo state that compost can be useful for farming.”

Household

This household knows that some people pick recyclables on the heap of waste in the open spaces and on the dumpsites to sell.

“Yes, I use to see some people picking waste and taking it to the market to sell to some women trading bottles for reuse.”

PSP – Private sector participation

PSP in Ibadan would like to embark on a waste-to-energy project, however, the Nigerian constitutions do not have any incentive nor support plans to make such a project doable.

“I would love to use waste to generate energy but the problem we have is that the legislation doesn't, it is very expensive to do, and the legislation at this moment doesn't give you any subsidy for generating environmental energy, so it is to a very great degree.”

“In Nigeria, there are a lot of recycling companies starting up and none is actual producing, the end of starting up is that the factory is full of waste and that becomes hazardous, fire hazardous, environmental hazardous.”

5.2 Defining Themes

Having outlined the narratives from the interviews which were relevant to the research focus, Table 3 below summarises the narratives in each emergent theme from the whole thematic analysis process of the data collected from the fieldwork.

Table 5.2 1. List of themes that emerged from the thematic analysis of the fieldwork data

| Theme | Definition |
|---|--|
| Attitude | Authority claimed that the major problem lies with the households' attitude to proper waste management practices and that a positive attitude from the households will make a difference. Conversely, the households' view is that the government is not doing anything to make their life better. In this sense, they tend not to support any government strategy to improve waste management practices in the city. |
| Household behaviours | PSP and waste authorities' view indicated that households are the most difficult waste generators to monitor; households always find illegal ways to discard their waste. In spite of this, households believe that if the government carries out its functions appropriately, they will comply. |
| Poverty | Some stakeholders have opined that income level influences the attitude of the household toward proper waste disposal. The poverty level among people is very high and complying might be an extra cost. |
| Poor governance | There is a lack of continuity in policy and governance. On-going MSW solution projects are usually abandoned when a change in power occurs, and another project will usually start afresh. This has been the case in the case study cities; no waste project has ever fully achieved its goal. Moreover, it was claimed that the waste management budget is insufficient. In addition, civil servant salaries can be very unpredictable; therefore, people cannot guarantee the payment of regular waste collection charges. |
| Poor infrastructure | Most of the roads in the case study cities are in a poor condition. Waste transportation is at a high cost. Government dumpsites are getting full and they are not properly maintained. |
| Technology | For any foreign technical solution or idea to work, it must be embedded into the Nigerian local context. |
| Lack of awareness and engagement | There were many different types of stakeholders in MSW in Lagos and Ibadan. However, there is no form of collective engagement among these stakeholders. Each set of stakeholders holds different perspectives on MSW management in their city. The form of waste awareness that is going on in these cities is not effectively communicated, and it has little or no impact on people's attitudes to waste management. However, there is a certain level of collaboration between the authorities and the PSP operators. |
| Monitoring and enforcement | PSP collectors stressed the need for proper enforcement and more enforcement officers. |
| Waste value | According to the interview responses, there was a low level of awareness about the value that can be derived from waste. |

5.3 Visual Interpretations of Emerged Themes

5.3.1 Coding References in Dataset

A graphic representation of how the emergent themes appeared after the complete analysis of the interview transcripts, audio recordings and participation observations from both case studies is illustrated in Figure 5.4. The graph shows how people talked about all aspects that made up the themes. It is interesting to note that the themes vary in the number of reference counts from data in

each case city. However, it is important to recognise that the participants mentioned these aspects more times than other aspects mentioned during the entire interviews conducted in both cities.

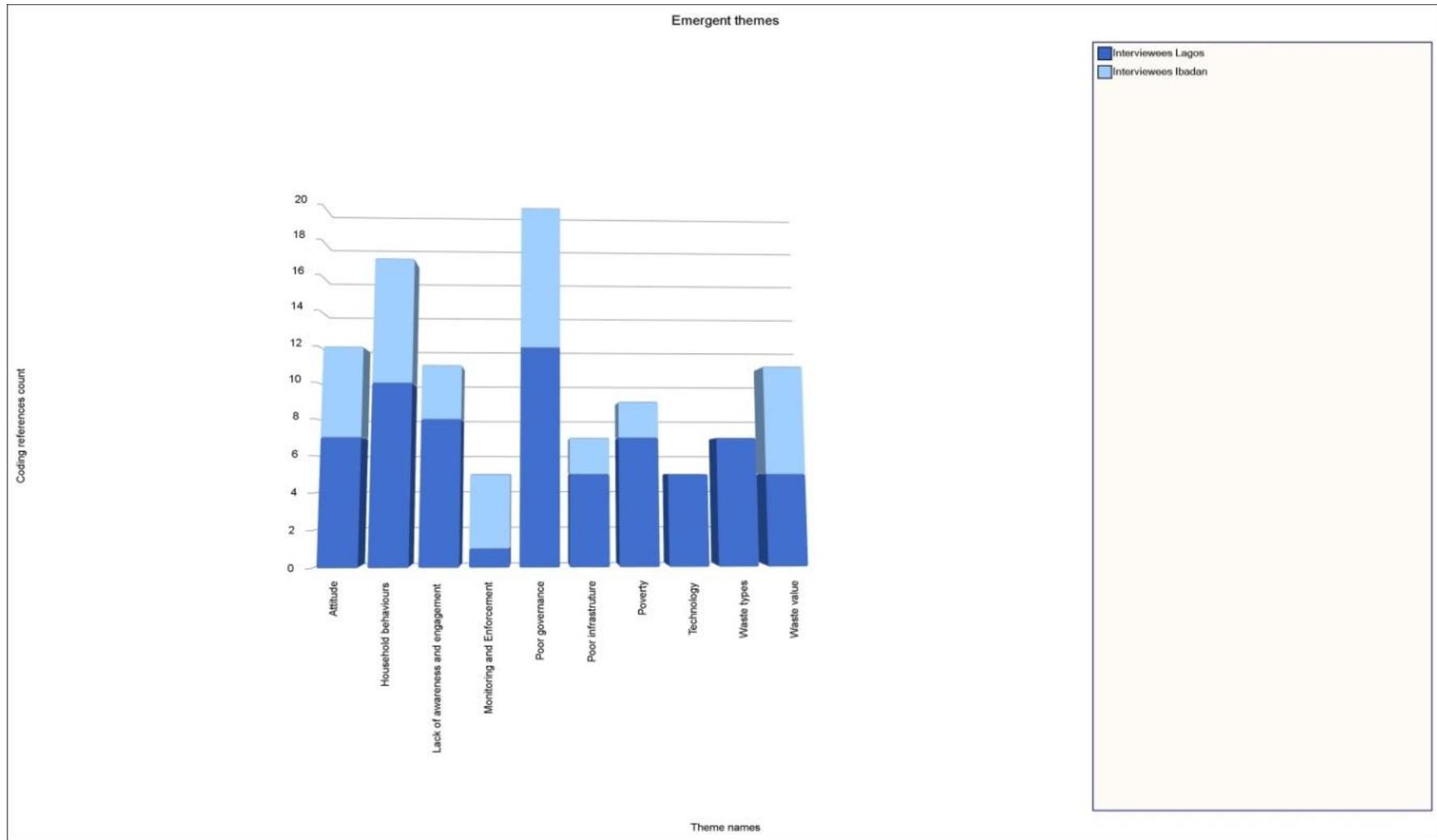


Figure 5.4: The graphical representation of themes coding references count

Figure 5.4 above indicates that poor governance is mentioned more than the other aspects mentioned in the dataset. This infers a very significant impact in relation to the development of stakeholders' collaboration in the MSW management. Lagos represents a relatively high level of poor governance compared to Ibadan city, whilst the waste authority in Lagos is doing more in terms of monitoring and enforcement than the waste authority in Ibadan. The graph shows a significant level of how other themes appear in the data with respect to each city.

5.3.1 Themes Similarities

Figure 5.5 illustrates a graphic representation of how some themes are interconnected whilst others are diverse. The themes that appear close together share more similar characteristics than those that are further apart.

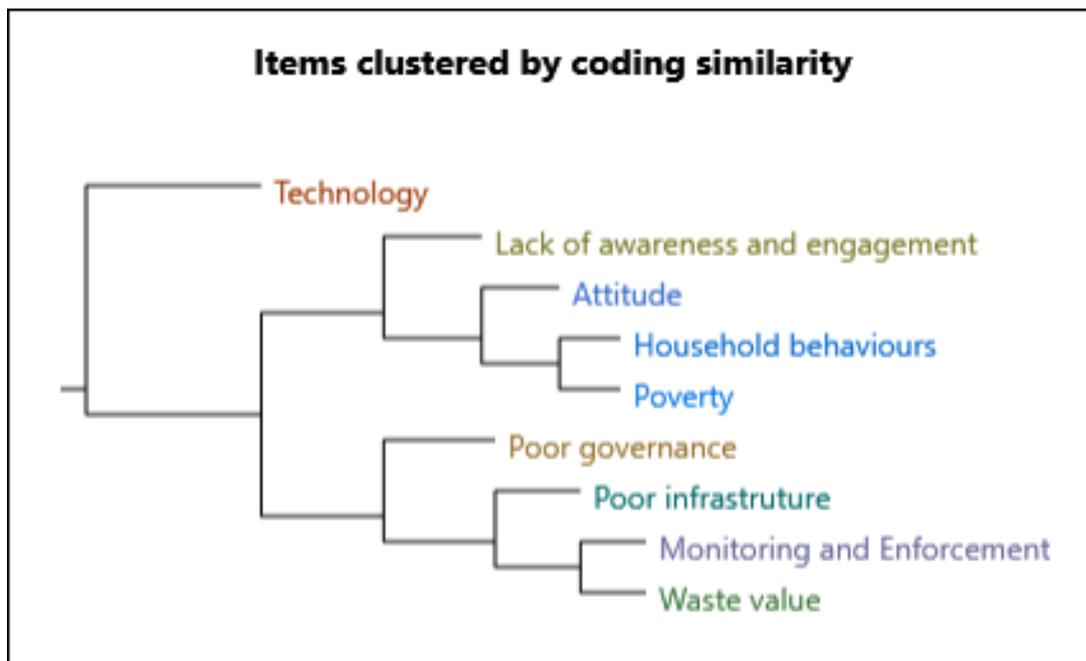


Figure 5.5: The clustered diagram of themes similarity

The degree of similarity and diversity of content between the themes is evaluated using Jaccard's coefficient in the cluster analysis in NVivo 12 software programme. Jaccard's coefficient measures the degree of similarity between codes in the transcripts. The clustered diagram in Figure 5.5 shows that household behaviours and poverty have a high degree of percentage implying there are more similarities between them, likewise, monitoring and enforcement and waste value also have a high

degree of similarity in features. It also gauges the similarity and diversity of other themes in relation to data sets. The summary of the coefficient value of the similarity and diversity between the themes exported from NVivo 12 is presented in Appendix D and the word frequency query of how codes appeared in the thematic analysis is presented in Appendix E

5.4 Summary of Thematic analysis

The hierarchy analysis chart of the themes and the codes that made up the themes as presented in Figure 5.6 shows that themes; monitoring and enforcement, household behaviours and poor governance occupied a bigger box in the chart. This illustrates that they are the more frequently mentioned aspects by the stakeholders, and it is assumed in this study that these identified themes are the major problem facing MSW stakeholders' collaboration in Lagos and Ibadan. Accordingly, it shows that attitudes, lack of awareness and engagement, poor infrastructure and waste value have relatively equal-sized boxes in the chart. This illustrates they have a big impact on MSW management, whilst technology and poverty have comparatively smaller boxes in relation to the other themes.



Figure 5.6: Themes mentioned by stakeholders as barriers to MSW collaboration

5.5 Insights from the Fieldwork

The outcome of the thematic analysis of the fieldwork data presented nine main themes that form the genuine findings of this research. The relationship between the insights gained from the analysis and the highlights from the literature review in Chapter 2 was put together as explanations of problems facing the MSW flow of the process that exists in Lagos and Ibadan.

5.5.1 Waste Generation and Category

Both the LAWMA and OYOWMA have no reliable data on the amount of MSW generated in their respective cities. However, LAWMA highlighted that its management is working towards collecting waste and keeping waste generation records in Lagos state. An overview of the percentage of the types of waste generated in the Lagos metropolis is illustrated in Figure 5.7 below.

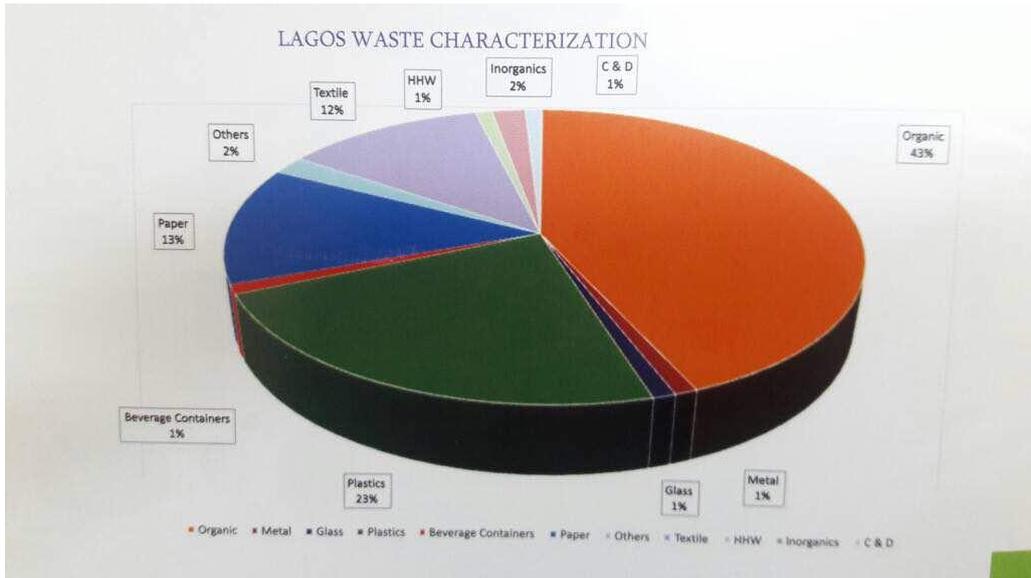


Figure 5.7: Percentage overview of municipal solid waste generated in Lagos in 2017(LAWMA, 2017)

During the interview with LAWMA, the interviewee explained that LAWMA estimated that every household will generate an amount of waste that can be cast away every week, however there the average quantity is unknown. They encourage households to manage their waste properly by way of bagging or via the use of sanitary refuse bins. This is so that a household of about 4-6 people is able to manage their refuse in a week before the PSP operator collects it. On the contrary, a household in Lagos explained that their waste never gets collected weekly; it is usually fortnightly and at times it can remain uncollected for four weeks. The household further explained that having a large amount of waste in their household leave them with no option other than to dump it along the road or in an abandoned space. The overview of MSW dumped on the roads and water bodies is presented in Figures 5.8 – 5.10.



Figure 5.8: Refuse dumped on a local road in Eruwa in Ibadan



Figure 5.9: Refuse dumped on the road in Bodija in Ibadan



Figure 5.10: Refuse dumped on the water body in a slum area in Lagos

5.5.1 Waste Collection and Transportation

The collection part of the MSW management is observed to be completely inadequate and signals the starting point of the failure of proper waste management practices in Lagos and Ibadan. Due to bad roads in the cities, waste vehicles are often seen broken down and abandoned. Those waste trucks that are in operation are often overloaded with refuse; something which gives a high possibility of further littering of the surroundings during transportation. Throughout the fieldwork period, waste was seen being dumped and littered everywhere in the cities. Notwithstanding, some residential areas are storing their waste in bins before being collected by PSP operators. However, one problem with this civil responsibility is that, on many occasions, the bins get full and the collectors miss the collection arrangement. Nevertheless, PSP operators linked the irregular collections to bad roads and poor accessibility around the city. They said their trucks often break down because of bad terrain and most of these trucks are imported vehicles which means it can be difficult to find spare parts when needed and, thus, these trucks end up being abandoned. Different scenarios of trucks that have broken down or been abandoned are presented in Figures 5.11 – 5.14.



Figure 5.11: Engineers repairing damaged waste trucks at the first Materials Recovery Facility in Nigeria MRF in Lagos



Figure 5.12: A abandoned waste-loaded PSP truck on a road in Lagos



Figure 5.13: Waste collectors collecting residential waste in Lagos



Figure 5.14: A waste collector overloading a truck in Lagos

5.5.1 Waste Treatment and Disposal

There is no other form of waste treatment in Lagos and Ibadan currently other than the collected waste is transported and dumped into designated dumpsites that are authorised by the government. At the dumpsites, waste pickers sort out the sellable materials (such as PET bottles, aluminium, cartoons,

metals and fabrics) and dismantle e-waste to take out recyclable materials in the equipment. A glimpse of what is usually picked from the dumpsites is shown in Figure 5.15.



Figure 5.15: Reuse and recyclable materials ready to be sold

Similarly, a material recovery facility MRF was built in Lagos in 2015 by a private investor. The facility was built purposely to receive collected waste from PSP operators, sort out recyclables and transport the non-useful residual waste to the nearby government-authorised dumpsite. However, the facility has been facing one major challenge which is the poor power supply shortly after it commenced its operation. It was noted during participant observation at the WestAfricaENRG MRF that daily operations in the facility have been hindered by an unreliable electricity supply in the country; the facility has been operating mostly with diesel fuel; something which investors highlighted as a very expensive way to run the facility efficiently. As a result, the facility has been unable to process incoming waste daily. Consequently, this has led to a huge accumulation of MSW in the facility without any form of measure to prevent this piled-up waste from polluting the

surrounding environment. On the spot where this waste is piled up, it gets moistened with rain and releases a pungent smell and leachate which sinks into ground-level soil, similar to the observation seen at dumpsites. Continuous leachate from this waste percolates into the ground soils and air pollution and rodents and birds infestation have been observed in the surrounding neighbourhoods. The image of the current situation of the MRF as of the time of the observation and interview with the manager of the facility as compared to the initial look of the facility two years ago when it was commissioned is presented in Figures 5.16 – 5.17.



Figure 5.16: Accumulation of MSW at Material Recovery Facility MRF, Solous Lagos November 16th, 2017: Current look



Figure 5.17: The first MRF in Nigeria Commissioned May 15th 2015: Initial look

The conclusion from the insights is that the solid waste management in the city of Lagos and Ibadan is seen to be at the rudimentary level compared to management that is happening in developed countries. Different residential area in the city exhibits different waste management practices whilst sustainable municipal solid waste management practice is a way to attain the level of the same management practice across every city. Improper waste management has not been seen by many Nigerian families as something important to improve, or something that has any impact on their wellness in society. An individual grows to see how waste is being handled and disposed of and tends to follow the trend with no intention of a rethink. However, the experience and understanding gained from fieldwork suggest that individual behavioural orientation in waste handling can change positively if good governance is in place and adequate awareness or education on waste management practice is given to people regularly. The efficiency of waste collection in the cities is impacted by poor roads. PSP shows dedication to giving consistent collection services to people who are willing to pay for the collection, but this dedication has not been met due to poor governance and poor infrastructure. Also, waste authorities are lacking sufficient government funding to carry out their activities effectively. In particular, drawing attention to what I have observed at MRF and other MSW management instances during the fieldwork clearly indicates that the basic social amenities and infrastructure to support proper MSW management are lacking in Nigerian cities.

5.5.2 Private Sector Participation Situation

The interviewees at the Lagos State Government Ministry of Environment and Water Resources explained that the inconsistency of waste collection services that is being complained about by the people is a result of the transition process that is going on in terms of the privatization of Lagos state waste management. This means that the collection, transportation and disposal of waste will now be managed by a private foreign-owned waste management company called Visionscape Sanitation Solution. The Lagos Waste Management Authority (LAWMA), which had been managing the whole process previously, will now be a regulative body to Visionscape. The contract agreement the state signed with Visionscape includes the management of other existing PSP operators that currently

working in collaboration with LAWMA, and this has generated concern and negotiations between Visionscape and the existing PSP operators. The existing PSPs believe they will be subject to Visionscape executive orders, and it will destroy their business model and they are happy about this government strategy. At the moment, PSP operators have stopped their activities while they are negotiating terms and conditions with Visionscape. Visionscape is yet to enforce the contract. However, in this transition process, the refuse dumping situation in the city had become unimaginable and alarming.

In Oyo state, the government had recently handed over the management of solid waste from the Oyo Waste Management Authority (OYOWMA) to a private operator called WestAfricaEngr. Ibadan metropolis is the major area that is being covered presently by the operator which has plans to expand to other parts of the Oyo state rapidly. At the time when the fieldwork was carried out, WestAfricaEngr manages the collection, transportation and disposal of waste and their operation is being regulated by the Ministry of Environment, Oyo state. In over 12 months when the WestAfricaEngr has taken up waste collection services in the city, there have been some certain improvements in the management practices. WestAfricaEngr has 70 local contractors working for the company daily and they believe they are collecting up to 60% of waste generated in Ibadan city. Though, the observation during the fieldwork in Ibadan revealed broad-based dumped MSW everywhere in the city than the collection rate figured claimed by the WestAfricaEngr.

However, PSP in Ibadan is concerned about what will work for the Ibadan people to make them change their orientation about waste handling and how the company would deal with the unplanned city structure which features many streets that are inaccessible.

The conclusion from this insight is that the Nigerian government has been found guilty of giving too much value to foreign ideas at the expense of local creative ideas and entrepreneurial venture senses. Crucially, this government's choices usually backfire because the government always failed to pre-assess how the ideas they bring will fit in with the conditions in Nigeria. Moreover, there could be more individuals investing in MSW collection provided MSW policy and regulation are active and

well implemented. There is a strong belief that if the government policy is implemented adequately, it will challenge households to abide by the rules and foster collaboration between them, PSP and the government.

5.6 Identified Barriers to Stakeholder Inclusive Approach

Poor governance

Drawing attention to how the poor governance and the codes that made it up were being mentioned in many counts than other codes in the analysis, it evinced the extent to which poor governance stands as the most significant aspect affecting MSW management collaboration in Nigeria. The political will of government has always been a barrier to governance continuity and the impacts of discontinuities of waste policies and governance when there is a change of power have been dragging down improvement in MSW management in Nigerian cities. This instance is seen in the MSW management that is happening in Lagos city where the successor politicians' discontinuity with the predecessor ongoing waste management strategies that have been implemented and familiar among the public, all in an attempt to introduce new policy and strategy of their own regime. Whilst, in the transition period to implement a change of strategy, the existing strategy usually collapsed because they will instantly cease to fund it. PSP that participated in this research shows discontentment regarding this political practice. Households are also concerned and discouraged by this government's way of administration, they emphasized that their current defying attitude to proper waste disposal behaviour stems from the failure of good governance.

Monitoring and enforcement

Monitoring and enforcement is another very important factor that came up as often in the data analysis. The lack of adequate and effective monitoring and enforcement hinders the progress of collaboration in waste management in Lagos and Ibadan city. The narrative obtained from the interaction with the participants in this study overemphasizes the impact of inadequate and irregular monitoring of waste activities in the city. Monitoring and enforcement should serve as the mechanism to bridge the deficiency of poor infrastructure and household behaviours in waste handling. Since infrastructure cannot be fixed overnight but having more environmental officers monitoring the MSW

situation in the city will promote behavioural change as people who dump do that because they know will get away scot-free and that is why they persist in dumping waste into every available space in the city.

Household behaviours

The empirical data analysis outlined households' behaviour as another significant barrier to proper MSW management in Lagos and Ibadan city. The study analysis revealed that the majority of households are neither cooperating with the government waste strategies nor abiding with the government rules on waste management. Households exhibit complex behaviours, and it is not clear-cut to understand what will motivate households to cooperate with other stakeholders. However, what is understandable from the interaction with household participants in this study is that households value a clean environment, but they have no motivation to promote cleanliness in their neighbourhood due to a lack of government support and the absence of enabling society.

Attitudes

People's attitudes toward MSW practices is lacking a sense of civil commitment and responsibility. The majority of people are neglecting their civil responsibility and commitment to do the right things for their environment because they believe the government is not doing anything to benefit their livelihood. However, by law, every household should have a bin to store their waste and they should not be dumping it in the canals, streets or roads but few households in comparison to the city population actually abide by this rule. Households want the government to be responsible for every aspect of MSW management in their city.

Aside from the people's attitude, another cultural aspect that this study believed to have impacted MSW disposal practices to a sizeable length is a family tradition and community setting. The tendency of family waste-handling traditions to be passed down from generation to generation is high likelihood. The observation during the fieldwork shows that some areas like Badia-ijora, makoko and the like in Lagos city will always follow the traditional form of doing things including waste disposal.

These residents have a widespread belief that their waste should be cared for by the authority perhaps, littering and dumping refuse in their neighbours do not disturb them from doing their daily activities therefore they are not bothered. They assumed the heap of waste everywhere in their community is part of their identity as the residents of the area and everyone grows up to emulate the pattern of behaviour in the family and community at large.

The observation documented during the researcher's stay in the case study cities shows small businesses and traders also have a negative attitude toward managing their waste. They are not committed to good waste management practices; they usually burn waste on their premises or dump it into open spaces available to them as long as they are not get caught by the authority.

Lack of awareness and engagement

Communicating waste awareness is one of the major responsibilities of government waste agents.

Authority needs to reach out to the public regularly and motivate the public to take the rightful action.

Clearly, this is not the case in Nigeria, LAWMA, the government waste officers do awareness campaigns, sensitization and advocacy programme.

LAWMA had embarked on a series of advocacy programmes to ensure adequate waste awareness and education get across to the public to foster their commitment to proper waste handling and disposal but most of these programmes have ceased to continue due to funding and infrastructural problems.

For instance, in 2012, LAWMA started an advocacy programme for incentive-based recycling named 'waste for food' where people will bring their waste in exchange for cash or food. The programme also included school advocacy and recycling clubs. In schools, LAWMA established a "catch them young" initiative, whereby they teach the pupils how best to manage waste and encourage them to teach their household so that the advocacy can reach a large number of the public. Crucially, many of these initiatives have become inactive as of 2017 when the fieldwork was conducted for this research.

The programmes are no longer carried on due to inconsistency of political will and regime-changing and poor infrastructure. However, during those years when these advocacy programmes were active people embraced and participated very well. People are recycling and those waste such as PET bottles, can, cartoons and papers do not get to the dumpsites in those areas that were covered in

programmes at that time. Though, the advocacy was usually limited and less visible in impact on the public orientation. Notwithstanding, the interpretation obtained from the data indicates that the public has a very low level of awareness regarding waste management and disposal. This study identifies a lack of waste awareness among Nigerians as a crucial barrier to sustainable solid waste management. The belief is that when people have the knowledge and in-depth understanding of the potential benefits obtainable from proper waste handling, human instincts would work to obtain these benefits. However, this study identified the impact of an enabling society on promoting adequate awareness and engagement among stakeholders in MSW management as being crucial.

Poor infrastructure

The government is failing in providing a good road network that is essential for effective MSW collection and transportation in Lagos and Ibadan city. Particularly, the situation concerning roads in the Ibadan metropolis is worse due to the majority of areas being unplanned. The intermittent supply of essential social amenities such as electricity and water is another major area where the government is failing as well, whilst, the lack of these amenities has been hindering a well-functioning MSW management in the city.

Technology

There are different developed techniques around the world to convert MSW into a resource rather than everything ending up in dumpsites. The technologies to convert organic waste into compost and fertilizer can be a good starting approach to sustainable MSW management in Nigeria as organic waste has the biggest quantity in total waste generation. The waste hierarchy that laid out the ideal ranking level of sustainable treatment waste management as prevention, reuse, recycles, energy recovery, and disposal would need a sincere assessment to determine which of the treatment management will work best for Nigerian cities based on local conditions and available resources. However, this research finds that the waste authority in Lagos city adopts foreign technology that does not really fit local conditions. For instance, in 2017, Lagos state signed a waste collection agreement with a foreign company called VisionScape to manage MSW collection in all Lagos

metropolis areas. This company branded their foreign-based ideas to address Nigerian conditions and as a result, the ideas failed even before being implemented.

Poverty

Poverty is an important global issue in developing countries, a large population of Nigeria is living in absolute poverty. Many people have very low incomes or completely lack income and they cannot meet their basic daily needs. Many families are really in a daily struggle to feed their members and paying for waste collection is not feasible in this set of people's agenda.

Waste value

Waste to value is a global focus on taking waste we generate and repurposing it to serve social, environmental and economic purposes. In waste there are enormous untapped potential investable resources, Nigeria just needs proactive legislation and policies that will support investment in waste management. Currently, there is no robust government incentive program to support investment in waste-to-value in Nigeria, some recycling initiatives embraced by the Lagos waste authority, cease to function after only a few years due to a lack of funding from the government. The only perceived way in which value is added to MSW is through the waste pickers' waste sorting from the dumpsites which they will sell to the middle dealers as means to support their livelihood.

The overarching indication from the thematic analysis of the collected dataset for this study is that the nine themes identified are the main barriers hindering progress in MSW toward sustainable waste management in these cities. This study believes these barriers have a very strong correlation to the poor stakeholders' collaboration and it is the root problem of non-functional municipal solid waste management that currently exists in Lagos and Ibadan metropolises.

5.7 Results: Application of Agent-Based Modelling

This chapter includes scenario simulations of the key insights that emerged from the thematic analysis of the empirical data. The inclusion of simulations in this research is mainly to demonstrate the applicability of Agent-Based modelling in providing support and virtual assessment in the decision-

making and strategic planning in MSW. This model is built to show the interdependencies between stakeholder actions, history-dependent social processes within the MSW practices and its implications in their social environment. The findings that emerged from the fieldwork data are translated to logical elements of the agent-based modelling with the aim of investigating the current situations of MSW under different scenarios and settings. The further assumption is that virtual representation of the identified impeding barriers will give a visual understanding of the reality that exists in the real world in Lagos thereby, aid the effective dissemination and assimilation of the research findings.

5.7.1 Simulation Overview

The input parameters and values from empirical findings were set in the line of codes for the model. Attributes, parameters and decision-making functions of each of the agents in the model were carefully introduced. Notably, it must be kept in mind that this is an empirical simple abstract model and has been developed to demonstrate the applicability of ABM to provide support for decision-making in MSW management and it is not a complete full model. In this sense, the number of parameters that were put into this model was not an adequate measure of the viability and reliability of the model. In this model, the agents are households, collectors, officers and the city (immovable agent). Agents' actions are interdependent and have a major effect on the city as a whole. Households have varying ways of disposing of their waste which can be legally through collection services or illegally through dumping within the city. Their households' decision is based on the current living standard which is broadly a measure of income and hygiene levels in this perspective. Road accessibility and payment for collection determine the behaviour of the PSP collectors. Officers move randomly in the city to monitor waste activities within the city, communicate environmental awareness to the households and fine the wrongdoers.

5.7.2 Model Description

In this simple abstract model, each agent is heterogeneous in attributes. Table 5.2 presents agents with their state variables and behaviours which this model uses as inputs to run different stakeholders' interactions scenarios and Figure 5.18 below demonstrates the general flow of simulated events.

Table 5.2. Agent-Based model description of stakeholders in MSW management in Lagos city

| Agent | State variable | Description | Behaviour | Action |
|-------------------|--|---|--|---|
| Households | <ul style="list-style-type: none"> - Income - Residence - Hygiene consciousness | <p>The household waste disposal decision is based on income level, hygiene and residential.</p> <p>Households willing to pay for waste collection dispose of waste in bins and use collector's services – this is a prevalent characteristic of households with high income and in low residential density.</p> <p>Households not willing to pay, have no bin but dump randomly in an open space or use public dumpsters</p> <p>-The perception of a large number of households especially residents with low- incomes is that it is the government's responsibility to collect waste free of charge.</p> <p>Assumption: households generally want to get rid of their waste, presumably based on aesthetic value to their residence.</p> | <ul style="list-style-type: none"> - Attitude | <ul style="list-style-type: none"> - Dump-open - Use-dumpster - Bin-collection |
| Collectors | <ul style="list-style-type: none"> - Payment - Accessible roads | <p>This agent collects waste with trucks from place to place where there is an access road. Collection efficiency is based on road accessibility and payment received.</p> <p>The main intention of collectors is to do business and make profits.</p> | <ul style="list-style-type: none"> - Receive payment | <ul style="list-style-type: none"> - Collect waste |
| Officers | <ul style="list-style-type: none"> - Funding | <p>Officers are government workers; they go from place to place to talk to people to change attitudes and monitor the waste situation in the environment. This activity requires government funding to carry out these functions.</p> | <ul style="list-style-type: none"> - Move around the city | <ul style="list-style-type: none"> - Monitor and enforce regulation |

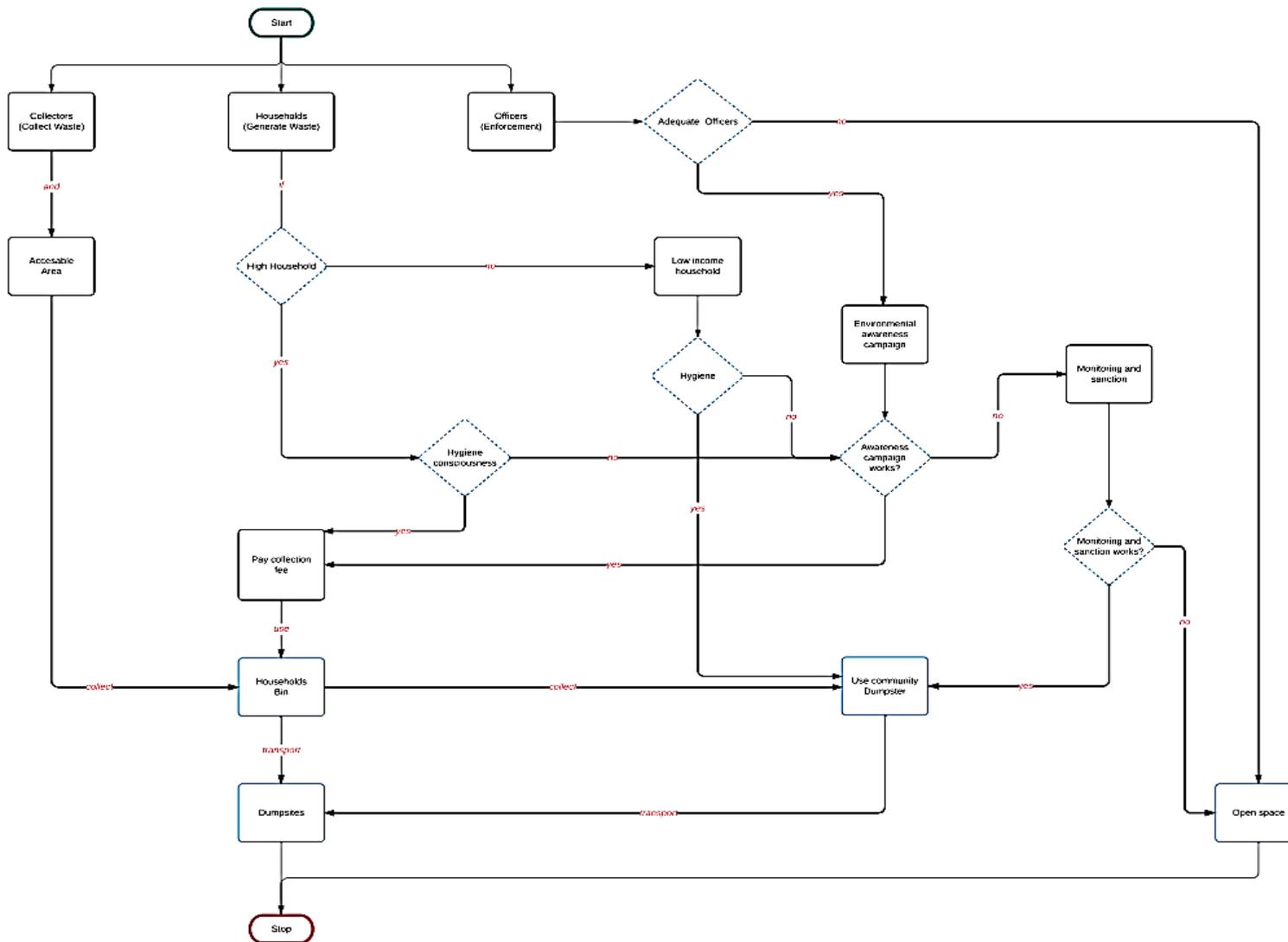


Figure 5.18: The flowchart of the Agent-based model for MSW in Lagos city

5.7.1 Simulation Scenarios

Five sets of situation scenarios were developed and tested on the model. The first scenario describes the real situation of waste management practice in Lagos city. The remaining scenarios consider how illegal dumping can be mitigated (or even eradicated) by predicting the steps to promote collaboration among waste management stakeholders. The test scenarios are as follows:

Scenario 1: Current situation

The objective of this scenario is to visualize the current situation of interactions among waste agents in Lagos city. The attributes and input parameters of agents are adapted from field surveys conducted by the researcher.

Scenario 2: Social influence on dumping attitude

This scenario aimed to test the effect of social influence on household disposal decisions. The assumption here is that the heap of waste in a neighbourhood have a high tendency to influence households' attitude, households in a such neighbourhood may change their behaviour to match the condition of their social environment.

Scenario 3: Increase the income level of households

This scenario aims to test the effect of poverty on household disposal decisions. The assumption is that an increase in income level can enhance households to the willingness to pay for collection services.

Scenario 4: Improve roads accessibility

This scenario aims to examine the changes in the quantity of waste collected by PSP when more areas are accessible for truck collection.

Scenario 5: Increase monitoring and enforcement activities

This scenario aims to examine the effect of adequate and regular monitoring by environmental officers in the city.

5.7.1 The Connection between Themes and Scenario Testing

Table 6 below depicts the empirical findings that connect themes and scenarios in this model.

The central insight in each theme that was generated through the thematic framework formed the bases for the scenarios that were set for testing. It is perceived that the scenario simulation of the research findings will shed more light on what can be adapted by Nigerian cities towards achieving integrated sustainable waste management. Due to the length of time taken by the researcher to learn and understand how to work on the programming language used (Netlogo), there was insufficient time available to explore and model all the insights gained from the thematic analysis.

Table 5. 3. The connection between the thematic themes and simulation scenarios

| Themes | Insights | Scenarios | Specific actions |
|----------------------------------|--|--|--|
| | <ul style="list-style-type: none"> The current situation in Lagos city. | <ul style="list-style-type: none"> Scenario 1 | <ul style="list-style-type: none"> No monitoring Limited road accessibility |
| Attitude | <ul style="list-style-type: none"> Attitude to waste management can either be good or bad. Household's attitudes can change based on their social environment | <ul style="list-style-type: none"> Scenario 2 | <ul style="list-style-type: none"> High hygiene Low hygiene |
| Household behaviours | <ul style="list-style-type: none"> Income dictates where a household will leave. Low-income people represent the larger population in the city. | <ul style="list-style-type: none"> Scenario 3 | <ul style="list-style-type: none"> Low-income households High-income households |
| Poverty | <ul style="list-style-type: none"> The poor people have no means of paying for waste collection services. Their primary focus is to get their family food to survive. | <ul style="list-style-type: none"> Scenario 3 | <ul style="list-style-type: none"> Increase the income of low-income households |
| Poor governance | <ul style="list-style-type: none"> Government is responsible to provide basic waste facilities in the city. | <ul style="list-style-type: none"> Provision of a basic waste facility includes in Scenario 3 | <ul style="list-style-type: none"> Community dumpsters |
| Poor infrastructure | <ul style="list-style-type: none"> Maintaining a good road network within the city enhances effective waste collection. | <ul style="list-style-type: none"> Scenario 4 | <ul style="list-style-type: none"> Limited roads accessibility Unlimited roads accessibility |
| Technology | <ul style="list-style-type: none"> Sorting and recycling are two main concerns that were opined on in the interviews. | <ul style="list-style-type: none"> Not tested | <ul style="list-style-type: none"> |
| Lack of awareness and engagement | <ul style="list-style-type: none"> Awareness and inclusiveness need good governance. | <ul style="list-style-type: none"> Impact of awareness includes in Scenario 5 | <ul style="list-style-type: none"> Adequate number of environmental officers Inadequate number of environmental officers |
| Monitoring and enforcement | <ul style="list-style-type: none"> Proper monitoring and enforcement officers | <ul style="list-style-type: none"> Scenario 5 | <ul style="list-style-type: none"> Adequate monitoring Poor monitoring |
| Waste value | <ul style="list-style-type: none"> Government intervention is required to add value to waste materials. | <ul style="list-style-type: none"> Not tested | |

5.7.2 Model Settings and Outcomes

This model captured four features of Lagos city which are population distribution, residential areas, income distribution, and road access. There are three types of residential patterns in Lagos - the low,

medium and high residential areas. The population of households in each area is calculated based on data obtained from the literature as 82% for high residential and the medium and low areas have a population of 15% and 3% respectively. In each neighbourhood, there are open spaces (in this model, open spaces can be along with street, road or water bodies) and the high residential area also have community dumpsters for people who do not want to dump into the open spaces but cannot afford the payment for collection. Low-income people live in the highly residential area whilst, middle-income and high-income people live in medium and low-residential areas respectively. The road accessibility varies with the residential areas, the high residential area has poor road access which this model set at low random values and the two other residential areas have relatively good road access which is set at high random values to reflect the observation made during the fieldwork. In all the simulations, household waste generation is set to 3.8kg per week based on the data from the literature and the model assumes households will dispose of their waste weekly through the disposal method they have chosen to use. Households have hygiene consciousness behaviour which is randomly assigned to each household and income level is assigned based on where they live. Households whose decision is to pay for the collection, use a bin to store waste before collection by the PSP whilst those that are not willing to pay for collection will take their waste to the nearest open spaces in their neighbourhood to dump it there. The low-income households that have high hygiene consciousness but cannot afford the payment will make effort to locate community dumpsters in their neighbourhood to dispose of their waste. In general, the model set different varying parameters to test different scenarios. The simulation outcomes are illustrated in Figures 5.19 – 5.26 and each simulation is run with the city population set to 500 hundred to facilitate an easy run of the simulation and the cycle for simulation is 365 days. The model pseudo code and the simulation interface from each scenario are presented in Appendix F.

The initial simulation demonstrates the Business-as-Usual (BAU) of MSW management in Lagos city whilst other scenarios test the new insights gained from the data analysis.

Scenario 1: Current situation: Business-as-Usual (BAU)

In this scenario, the current situation of MSW management in Lagos city is simulated to produce a graphical illustration of the perceptions and observations gathered during the fieldwork and the insights gained from the literature on the current MSW situation in the city.

Figure 5.19 shows MSW dumping is very high in the high residential areas compared to the other two types of residences found in the Lagos metropolis. This scenario indicates open spaces in all three residential types are used by households who chose to dump waste rather than pay for collection. A total amount of 293000 kilograms of MSW is dumped in the open spaces in low-income households' areas in a year. In Figure 5.19, the blue line plot represents waste put in the bins and it is measured as 75000 kilograms. This implies the amount of the MSW that is disposed of in the bins by households that chose to pay for collection. At the same time, the open spaces in neighbourhoods of middle-high income households are accumulating waste which indicates some households are dumping their waste as well in these areas.

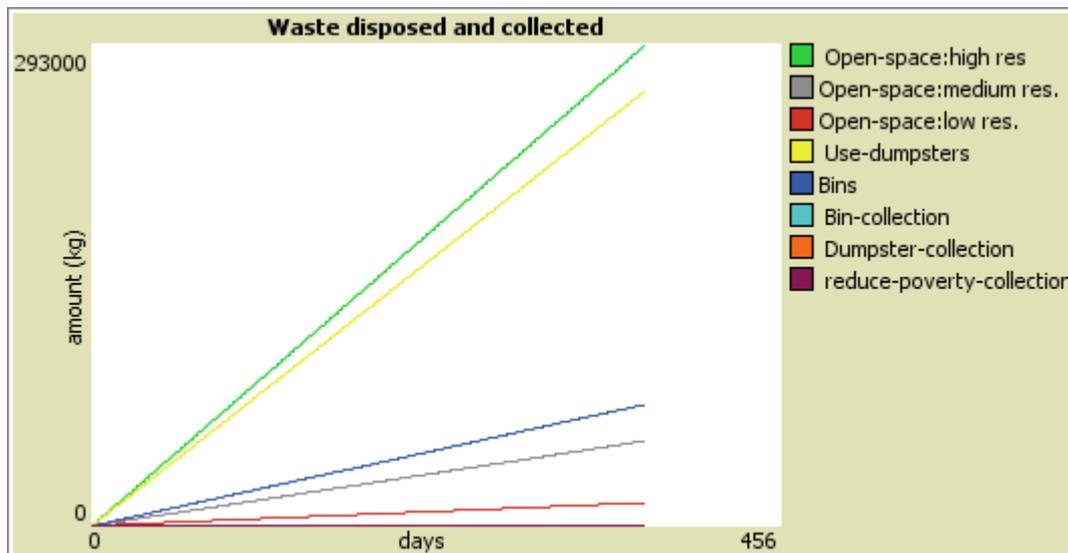


Figure 5.19: The amount of waste dumping residential areas and waste put in bins

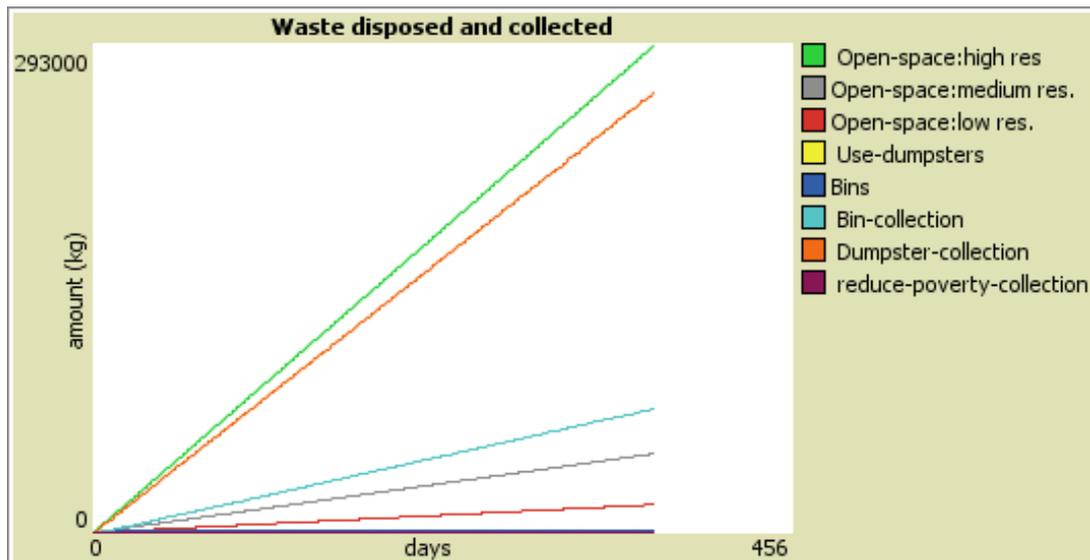


Figure 5.20: The amount of waste PSP collects from the bins

The light blue plot in Figure 4.20 shows the amount of waste PSP collects from the households that paid for waste collection. The amount is measured as 65000 kilograms as compared to 75000 kilograms of waste that are actually put in the bins. This indicates that about 87% of waste is collected by the PSP from the paid household in the city which means that not all bin wastes are regularly collected.

Scenario 2: Social influence on dumping attitude

Figure 4.21 shows an increase in the amount of MSW dumped in comparison with the amount in BAU. Social influence is believed to have played a significant impact on households dumping attitude in the situation projected in this scenario. The graph shows that dumped waste move from 293000 in BAU to 407000 about a 39% increase. The outcome of this scenario proves that social influence is a factor preventing households' cooperation in proper MSW management in the city of Lagos. A dirtier neighbourhood will encourage more households in the neighbourhood to dump to match up with attitudes in their social environment.

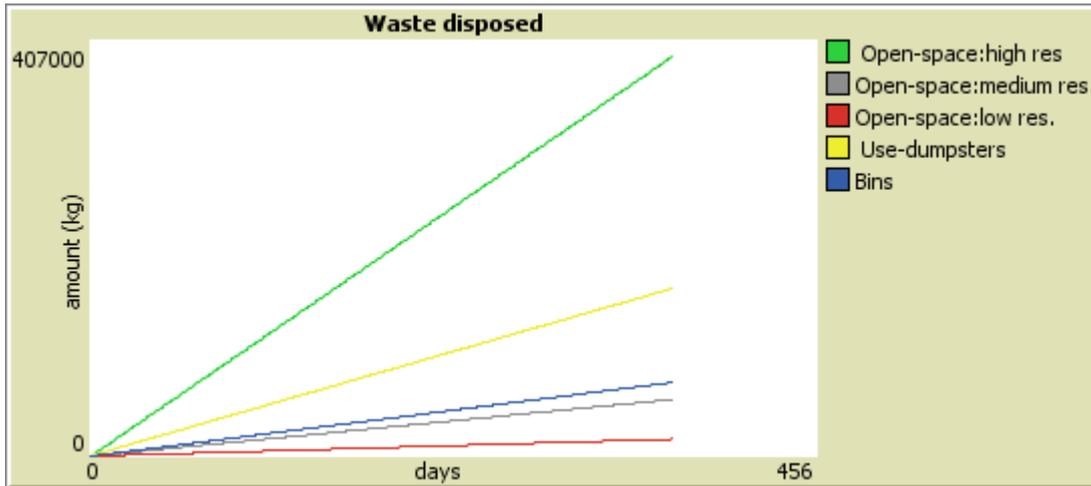


Figure 4.21: The impact of social influence on waste dumping in the neighbourhood

Scenario 3: Increase the income level of households

The poverty level is mentioned in the interview, but not as frequent as other issues mentioned by the stakeholders in the case study. Figure 4.22 simulates the possible effect if the income level of low-income households is increased by 50 per cent. The outcome shows waste dumping is reduced from 293000 kilograms in BAU to 268000 kilograms of reduction of 25000 kilograms amount of waste which implies a 9% reduction in dumping behaviour. The outcome of this scenario indicates that poverty is a factor among other factors however, poverty is not seen as the main factor in poor collaboration among the stakeholders.

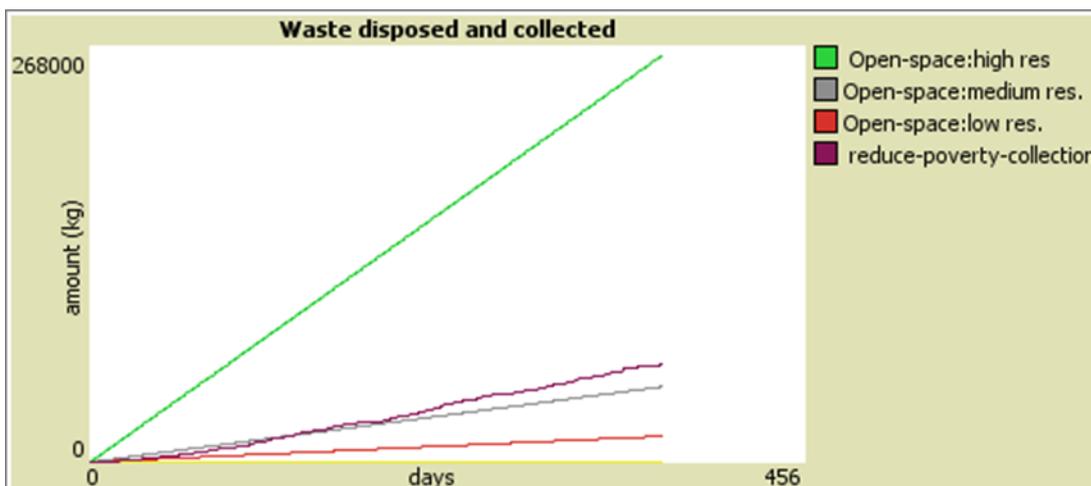


Figure 4.22: The effect of poverty on household behaviours

Scenario 4: Improve roads accessibility

In this scenario, the effect of road accessibility on waste collection in the city's residential areas is tested. The simulation of waste collection with good road accessibility and the collection under poor road accessibility produce a different outcome of the amount of waste collected in each case. The simulation outcome as shown in Figure 4.23 reveals that when the road accessibility is good – meaning an average threshold value on the model, 71500 kilograms of waste is collected from bins as compared to BAU collection which is 65000 kilograms. This shows that bin collection from the household that paid the collection services move from 87% to 95 % which implies bin waste is nearly collected under this scenario.

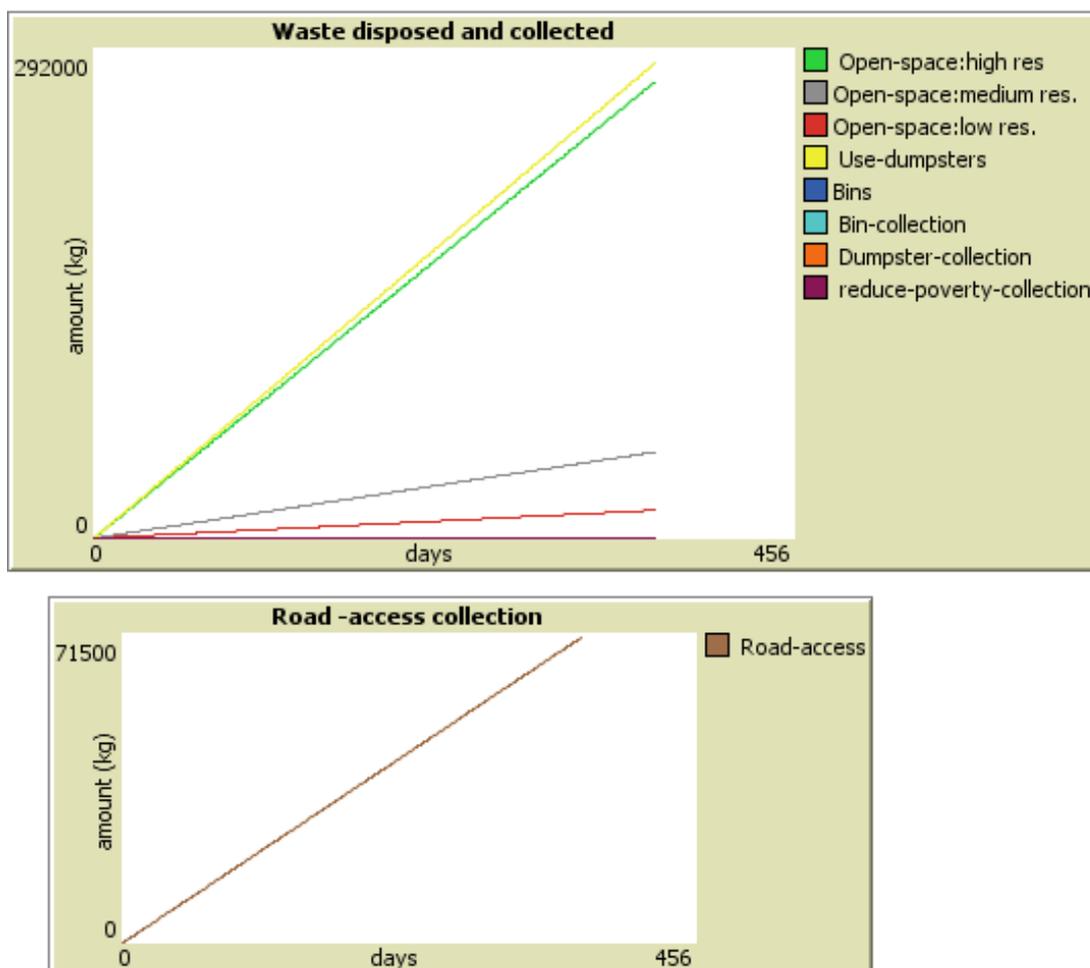


Figure 4.23: The impact of good roads accessibility on waste collection

Figure 4.24 shows that under poor road access to the city's residential areas, the waste collection was 35800 kilograms compared to the BAU of 65000 kilograms. This is equivalent to 48 % of waste

collection from bins from the paid households, this shows a significantly less amount to 87% collection in BAU. Notably, a value of 39000 kilograms of bin waste (blue line) is plotted on the graph which tells that 52% of bin waste is not collected due to poor road access for waste trucks to reach all residential areas in Lagos city.

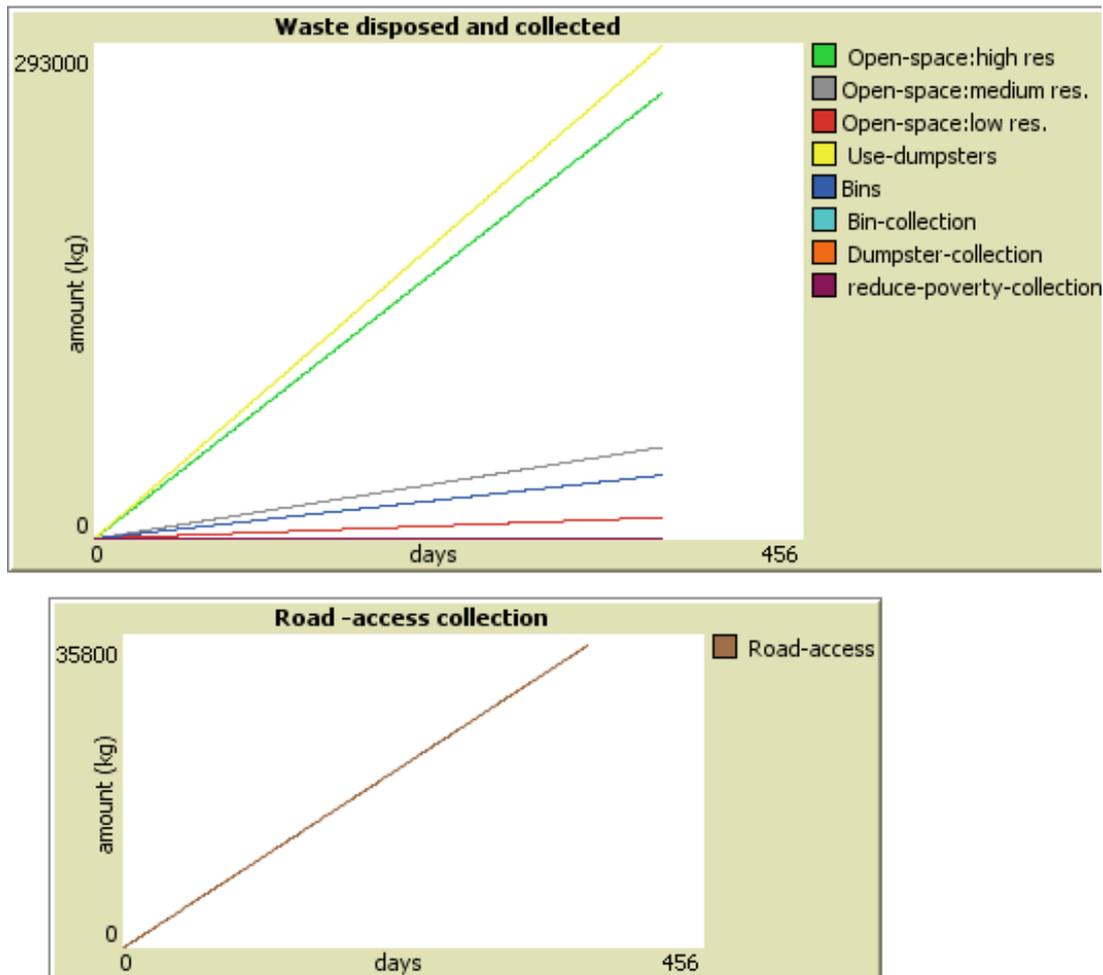


Figure 4.24: The impact of poor roads accessibility on waste collection

Scenario 5: Increase monitoring and enforcement activities

This scenario is testing the impact of monitoring and enforcement on the MSW management in the city of Lagos. The result of the thematic analysis outlined monitoring and enforcement as strong factors impeding the MSW management in Lagos city. The outcome of this scenario shows a huge change in household dumping attitudes when there is effective and regular monitoring and enforcement in place across the city. In Figure 5.25 the simulation revealed that from 30 days of regular monitoring, the amount of solid waste that is put in bins for collection starts to increase. Within 365 days, the bin waste moved from 75000 kilograms disposed of in BAU to 551000

kilograms which implies a 635% increase in households' attitude to bin waste for collection. At the same time, waste dumping in open spaces reduces to 197000 kilograms from 293000 kilograms in BAU, a reduction of 33% of waste dumping in the high-residential areas.

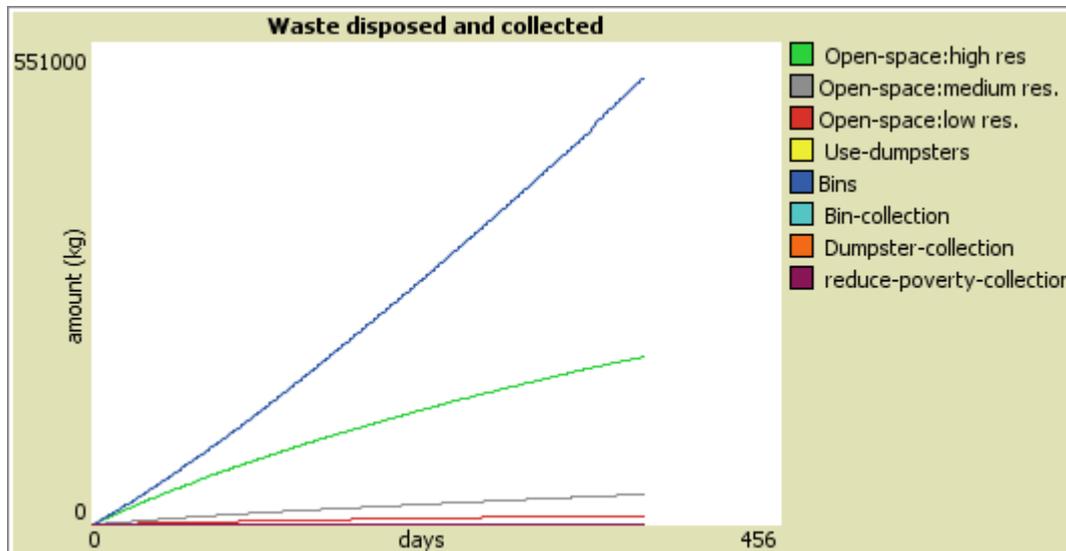


Figure 4.25: The impact of regular monitoring and enforcement on waste disposal for collection

An increasing number of officers

When officers are increased in number by half, a further significant increase in the MSW disposal in bin waste is observed. In this scenario the officers' number is increased by 50% from 4 to 6 officers in each residential area, Figure 5.26 shows bin waste increase from 75000 kilograms in BAU to 616000 kilograms means a 721% increase in households' attitude to bin waste for collection. In particular, waste dumping in open spaces reduces to 133000 kilograms from 293000 kilograms in BAU, which implies a reduction of 55% of waste dumping in the high-residential areas.

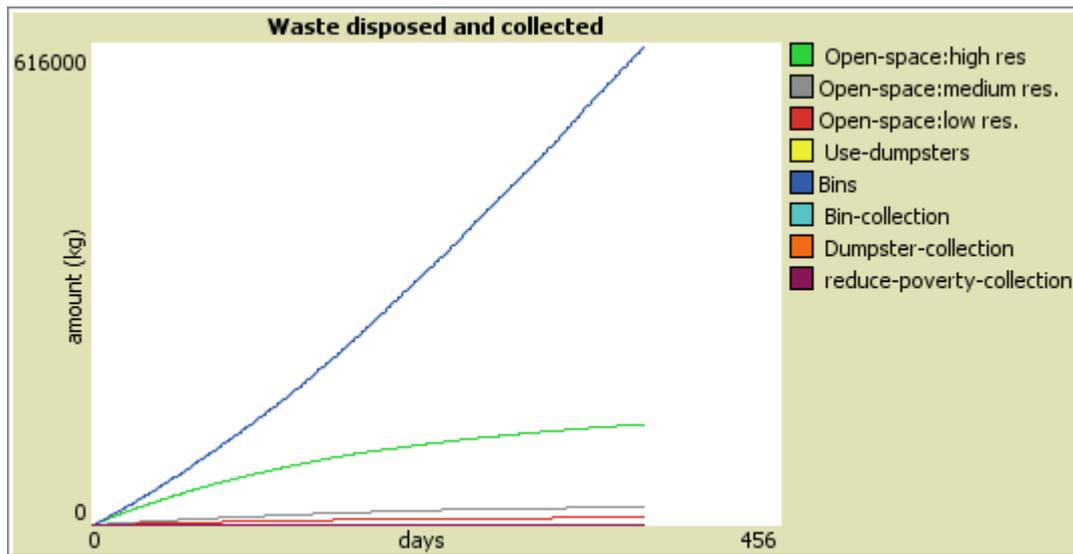


Figure 4.26: The impact of increase the number of monitoring officers across the city on waste disposal for collection

Overall, the simulations show MSW is being dumped and accumulated in the open spaces in all residential areas every day of the year. It was revealed that waste is put in the bins for collection by the households that are willing to pay for the waste collection services as well as, and waste accumulates in the community dumpsters. Whilst PSP trucks go to the households that have made payments to collect their waste. The simulation shows that a small percentage of households pay for the collection, and this, as a result, income inequality exists among people in the city, and this is perceived as a factor but not the main problem in household behaviour in disposing of their waste. Moreover, the hygiene consciousness of households plays a crucial role in disposal decisions. In a like manner, the outcome of the simulation confirmed that residential area cleanliness influences the disposal behaviour of households. When a neighbourhood experience some waste dumping, this creates an avenue for more people to dump in that area, as a result, the dumping rate increases. The findings also confirmed that introducing more officers for effective and regular monitoring across the city reduces waste dumping by approximately 55% compared to when officers' monitoring is irregular.

5.8 Discussion of the Findings from Fieldwork

The iterative process of generating meanings from the collected data evolved to emerge into nine categories of themes outlined as poor governance, inadequate monitoring and enforcement, poor

infrastructure, households' behaviours, lack of awareness engagement, attitudes, waste value, inappropriate technology adoption and poverty. This study identified them as major issues impeding stakeholders' collaboration in MSW management in Lagos and Ibadan city.

From the interpretation of the collected data, it is particularly apparent that collaboration efforts among stakeholders are largely missing. The authorities regard the waste problems as lying primarily with households and small businesses, whom they believe to be aware of proper waste management processes, but that they do not value cleanliness and are not prepared to 'do the right thing'. Nevertheless, the interviews with a household in Lagos city indicated that households wish for cleaner surroundings and will be willing to cooperate with the government rules as long as the rules are consistent. On the other hand, the lack of adequate monitoring and enforcement is giving room for improper waste management practices among many households as stressed by a household in Ibadan. Inconsistencies in the waste services provided by the government through the PSP discouraged many households, making them use illegal alternatives to dispose of their waste. Though, PSP argued that the inconsistency in the way they operate is high as a result of poor infrastructure in the city. They stressed that the road situations are poor which impacts their turnaround in the operation. Another reason for the absence of collaboration among the MSW stakeholders in case study cities is the fact that there is no official recognition of the impact of waste pickers' activities on the reuse and recycling of waste and their role in the economy. Correspondingly, the thematic analysis carried out for this study provided a new dimension of insights that can be applied to promote effective collaboration among the stakeholders in the MSW management in these cities. Drawing on narratives from 17 interviews and 2 focus group discussions conducted in this research, these identified themes are seen to be the main issues impeding stakeholder collaboration and these have been contributing to the lack of investment by the private sector in municipal solid waste management in Nigerian cities.

5.9 Discussion of the Agent-based Modelling

5.9.1 Agent-Based Modelling as a Sustainable Tool

This study adopts ABM to aid in visually disseminating the research findings from this research, the following narratives are the highlights from the simulations.

For modelling the current situation of MSW management in Lagos city, the outcome of this scenario showed that the rate of MSW collection by PSP is very low to the amount of waste that is being disposed of in bins every day in Lagos. In particular, waste dumping is high in low-income areas to middle-high-income areas. Moving towards integrated sustainable waste management requires the adequate promotion of waste awareness and the provision of good basic waste infrastructure in these areas.

For modelling social influence on household behaviours, ABM showed the social environment status of a neighbourhood has a lot to do with the household behavioural waste decision. The simulation revealed that the cleanliness of the neighbourhood has a significant impact on the households' attitude and this scenario show social influence encourages more households to dump.

Modelling the effect of poverty has shown to have a moderate impact on household attitudes. On the other hand, modelling the impact of monitoring and enforcement showed and emphasized the importance of an adequate number of monitoring officers carrying out the monitoring activities regularly in all residential areas of Lagos city. This scenario showed monitoring and enforcement as crucial barriers to achieving sustainable solid waste management in Lagos city.

In particular, the Agent-Based modelling used in this study has helped in visualizing the effect of these identified issues on the MSW management and creating insights into actions that can be adopted to bridge these barriers to make MSW stakeholders work together to move towards achieving the goal of ISWM in the city. Overall, the ABM simulation showed that households' behaviour and attitudes can be improved through interaction with other stakeholders' actions under good governance.

6 Conclusion

6.1 Research Contributions

This study set out to investigate the possibility of developing an integrated sustainable waste management system for Nigerian cities. Data was gathered through interviews with various stakeholders, focus group discussions, participant observations and field notes in two case-study cities, Lagos and Ibadan. The data analysis was carried out to gain an understanding of the current situation and identify barriers to MSW management progress. The thematic analysis revealed that there is currently no significant collaboration between the various stakeholders and authorities, householders and private contractors have differing views of the problems. The analysis outlined poor governance, poor enforcement strategies and inadequate infrastructure, lack of awareness among the stakeholders, public attitudes and households' behaviours, inappropriate technologies adoption and untapped waste value as the main factors impeding collaboration among the MSW stakeholders in Nigerian cities.

To understand how the problems identified in his study are interrelated and interdependent with stakeholders and to generate insights that can be used to address the identified problems. A framework of graphical representation of stakeholders' action and the relationship that exist between them is considered important to aid the uptake of the research findings. For this reason, this study developed an Agent-Based model as a design tool for integrated sustainable waste management for Lagos city. The Agent-Based model was used to create MSW management situations and to predict the behaviour change of the main stakeholders in the city under different problems identified from the thematic analysis. The model shows actions that can promote stakeholder collaboration toward achieving sustainable solid waste management in the city.

The experience from the development of ABM of MSW stakeholders' interactions has shown that collaboration and an inclusive approach to waste management are essential to address identified problems and knowledge gaps. The developed model depicts the importance of government waste officers interacting with the people to promote behavioural change as a step forward to achieving

sustainable solid waste management in the city. Behavioural change in waste handling among households will have a propensity for environmental, economic and social gains from MSW. The lack of waste awareness among the people as indicated in the data is a barrier to the utilization of potential resources embedded in waste. This model simulation shows when the office carries out regular and effective monitoring in the city, a significant number of households change their attitudes toward a more sustainable waste disposal choice.

The model revealed the impact of the social environment on people's behaviours, it tells that the incessant dumping attitudes exhibited by the households in the low-income residential area is an indication of path dependency. Path dependency is explained by (Pierson, 2004) as a “contingency element, which reflects the idea that large consequences can result from small events, and once started, chosen courses and actions can be hard-if not virtually impossible – to reverse”(Davis, 2014). This research model reveals that the cleanliness of the area where households live has corresponding effects on households' disposal behaviours. When modelling this effect, the model depicts an increase in the number of households dumping when there is a huge heap of waste in their neighbourhood. This observation confirms small differences in waste disposal behaviour can lead to a much more complex waste management system's behaviour in time.

The model shows the condition of roads in the city impact efficiency of waste collection, more waste is collected by the PSP from the areas where there is good road accessibility than in the areas where road access is bad.

Another highlight from this model is that poverty is not an underlying factor in the dumping behaviour of households rather dumping has to do with the attitudes and hygiene consciousness of the households. This observation supports Adeoti and Obidi (2010) report that underlined the income level of a household as a variable that could influence household attitudes toward solid waste management. The assumption made by these authors is that waste collection fees should not be uniform for all categories of households since the willingness to pay could be influenced by the

income status of households. This action suggested by Adeoti and Obidi (2010) is another strategy that can promote stakeholders, especially in areas with many households in poverty status.

In addition, the established model shows that the interaction among the stakeholder promotes collaboration which results in more sustainable waste-handling decisions among the stakeholders.

From what was observed in the modelling outcomes, ABM is a promising approach to understanding and improving waste management in Nigerian cities.

6.1.1 Overall Conclusion

The general, overarching conclusion of this study is that the research used the insights gathered from the key stakeholders in the MSW management in Lagos and Ibadan, Nigeria; the waste authorities, private waste collection contractors, waste pickers, households and the market traders to ascertain the actual problem areas that are barriers to stakeholders' inclusive approach to MSW management in Nigerian cities. The outcomes of the data analysis revealed poor governance, poor enforcement strategies and inadequate infrastructure, lack of awareness among the stakeholders, public attitudes and households' behaviours, inappropriate technologies adoption and untapped waste value as the main problems impeding collaboration among the MSW stakeholders in Nigerian cities. As it is a universally accepted fact that MSW management is a complex issue that involves multiple stakeholders and their interactions. Conversely, the analysis of the insights gathered for this research and the engagement of the researcher with the key stakeholders in these cities during the fieldwork discovered a poor collaboration among these stakeholders. In an attempt to solve these identified barriers in MSW management and to provide a framework solution to aid stakeholders' collaboration in these cities, this study designed ABM as a tool to model these complex interactions and to show how collaboration can be developed among the stakeholders to attain sustainable solid waste management in Lagos and Ibadan city. The model demonstrates actions that can drive the city towards achieving a stakeholder inclusive approach in MSW management. Interestingly, the outcome of the

model proved that a well-established interaction among the stakeholders promotes collaboration which results in more sustainable waste handling and disposal decisions making in the city. The proposition in this study is that if all stakeholders involved in the MSW practices can find a common ground of working together to improve their environment and the government plays its part, it is possible to achieve ISWM in Nigerian cities. Good governance strategies will ensure inclusiveness, sound institutions and proactive policies and financing. Whilst the establishment of good governance strategies will promote good public health and a sustainable environment. The economic and resource management can gradually be modified into the entire MSW management system as the city moves towards more sustainable practices. This study finally concludes that ABM is a useful tool that can be used to identify the area where the action is needed most in the MSW management decision-making process.

Additionally, this study submitted an abstract for the online conference *Im|mobile lives in turbulent times: Methods and Practices of Mobilities Research*, 8th & 9th July 2021. The abstract was published in the conference Booklet. This was organised by the Art and Mobilities Research - Centre for Mobilities Research. It also produced a full written research paper that was presented at the 11th WIT International Conference on Waste Management and Environmental and Economic Impact on Sustainable Development, 7 - 9 June 2022. The copies of these abstracts are presented in Appendix G.

6.2 Limitations

The drawback is the inability to allow for an adequate time during the fieldwork to explore extensively the social complexities of all stakeholders involved in the MSW management in the case studies. Informal actors such as waste pickers, cart pushers and recycling middlemen have not been adequately engaged and interviewed in this study. Clearly, the involvement of the informal actors in MSW management in the developing country is a noteworthy activity which plays important role in

MSW management in Nigerian cities. During the fieldwork for this study, the researcher intended to interact and conduct as many individual interviews as possible with a waste picker to compliment the focus group discussions that were carried out. Though, this was not possible to be carried out due to the time it takes to arrange for a suitable time for both the participant and the interviewer to conduct individual interviews.

Moreover, the researcher of this study is an advanced beginner both in qualitative research and simulation modelling. Dilaver (2015) highlighted that expertise in social research appreciates the laborious inductive analysis of the fieldwork data through thematic analysis and highlights that the beginner in qualitative research is required to adopt new research skills and collaborations between experienced qualitative researchers. Due to the research timeframe, acquiring this new research skill to the proficient level was limited.

The main limitation of ABM modelling as regards this study is in the ability to generalise the outcomes because of the limited data collected from the case study cities to conduct this research, thereby, the possibility of exploring this model on a bigger scale could be difficult. For this model to be more realistic, the insights adapted as inputs on the model need to have a source generation beyond the small group of participants who participated in the research. Another limitation is the concern of the model being extensible and reusable whether the model has been designed to evolve and be used beyond this research and whether the parameters on the model have been defined in a modular way that can allow for dimensioning, modifications and future extensions.

6.3 Recommendations

The qualitative data collected and used for this research contained relatively fewer households participants. Whilst households represent the larger part of MSW stakeholders in every city, this research recognized that households' views have not been sufficiently represented in this study. It is worthy of note that the need for more elaborate individual interviews with a representative sample size of waste pickers in Ibadan and Lagos cities is recommended to capture adequately the

perspectives of waste pickers' involvement in the MSW system in Nigerian cities. Similarly, this study recommends the inclusion of higher education institutions such as university campuses as important stakeholders in future studies. It is obviously that universities represent a large number of people that engaged in various complex activities which generate solid waste. These activities have direct and indirect impacts on MSW management in the various cities where their campuses are situated.

For inclusive households' perspectives, a further qualitative study of more views amongst households in the respective case study cities should be researched to elaborate more insightful ideas for an inclusive analysis of the MSW situation in Nigeria.

Also, it would be useful to have a fuller interview coverage with the informal sector which is referred to as waste pickers in this in future research this will enhance the completeness and accuracy of the data used to generate scenarios.

Another avenue for further research involving the empirical findings from the fieldwork that were translated into logical elements of the agent-based model under different scenarios and settings may contain uncertainties in the way parameters are adapted for this model. In this regard, this research recommends further study to verify the parameter setting and inputs used as data to code this model to improve the measures and the reliability and reusability of this developed model.

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Appendices

Appendix A

Example of interview transcripts



This interview is part of my postgraduate research on waste management practices in Nigeria. The research is seeking information from the key stakeholders in waste management in the country in order to understand the major factors impeding sustainable waste management in Nigeria. Your respondent is completely anonymous and this research project has ethic approval from the Faculty of Engineering and Environment, Northumbria University Research Ethics.

Part A. Main issues: household- Lagos

1. Can we start with a general question on waste? What does waste mean to you? What comes to your mind when I say waste or garbage?

Interviewee : when waste, we say waste is anything that we don't want again. Waste is something we cannot use again or we don't want any more at home and it must be threw away.

2. On a typical day, what does your waste consist of?

Interviewee: edible things, probably we couldn't finish it and it spoil. Our waste is usually food, footwear that is spoil and I can't dash out to people, containers, cartoons, bottles clothes, and furniture but if things I don't want any more but it is good, I dash it out to others.

3. What do you do with your waste? How do you normally dispose them? Can you tell me why you choose this disposal method?

Interviewee: we used to put everything in a bag and put it the communal dumpster. After we moved to new area which is still a developing area, so what we do it we just throw probably on an abandon land. Those time before moved there was a government sanitation programme so there is facilities to dispose one waste but this programme didn't last.

Dumping: What happens to the waste on the street/in the river after you dump?

Interviewee: one way, it is probably wash away into the river or block canal.....hummm.

What usually happen when the dumping space you use is full?

Interviewee: we burn it when it became nuisance or the waste is too much on the street

Not dumping to go Q.6

4. Are there waste containers such as bins, or a dumpster station somewhere close to where you live?

Interviewee: No (If not) If there were, would you dispose your waste there instead?

Interviewee: yes, of course, where we lived before and during the government programme around the 1995, we did put our waste in the dumpster provided by the government.

5. Do you think it is a good idea that everybody pays for their waste to be collected?

Interviewee: yes, even in the new area we are now, we had stopped throwing the waste because at one time government come and start on programme and prohibit throwing in the area. The government officers LAWMA come around every week especially when they just started. Every week we gathered our waste and give it them to dispose, whichever way. But along the line, you know how Nigeria nowww.....em..., they stopped coming regularly. Before they started coming, there are Hausa people that come around with their wheel barrow to collect your waste and we pay them. But even those cart pusher eventually throw the waste they collect somewhere, like illegal dumpsite. So when government came on board they warned them, so you don't get to see them around, so people started giving it to the government but they were not consistence, after what, the Hausa people came back on board. Government involvement in the waste management in our area then was just consistence for just two –three years continuously before it became inconsistent. How much to pay the Hausas depend on how good one is on barging, there is no fix amount per volume, one just bargain. We pay government as well but a fix price but not uniform because I think a room is \$0.3 per month irrespective of whatever you are disposing, while a flat will pay \$1-2 per month, even if it just two people in the household and a room might have up to seven people. We pay through the bank. It come to a time these government officer don't come regularly to pick the waste and still they still bring bills. So we still have to use the Hausa which is tantamount to two payment, so we rather use the Hausa alone.

How much, in your view, would be reasonable?

Interviewee: first, the amount must in some way justify what one generated.

6. How much do you pay for this service? *Interviewee: we pay around \$1.6 for our flat*

7. Does the waste service works efficiently? Are there any cases that your full bin is not collected?

Interviewee: yes (If there are) what do you do? Interviewee: we give our waste to the illegal cart pusher.

8. Is it important for you to have a clean surrounding? *Interviewee: yes, of course cleaner environment is what I think everybody should aimed for.*

9. Is your neighbourhood sometimes littered? How to do feel about it? How does littering affect you?

Interviewee: we all litter one way or the other, I don't know if it really affect me but what I know is that I don't like it. It irritate me sometimes, I prefer it to be tidier.

10. Whom do you think should be responsible for ensuring clean surrounding?

Interviewee: it is just an individual thing, government has to play a big role, do their responsibility right, I'm sure people will comply

11. Do you think you (or your neighbours) could contribute toward a clean surrounding?

Interviewee: yes we could, if we change our mind set.

12. Do have any idea on how government should management waste properly?

Interviewee: first thing is to educate people about cleanliness. Another thing which I think would be better is if government can make available waste facilities at interval on the roads, on the streets and so on. So people can see where to put their rubbish on their way, I think that will go a long way, aside if it is possible to get a waste bin for every house even if government is going to ask them to pay, most people will still comply as long it is consistent and the waste is pick regularly.

13. What do you think is counts as “good waste management practice”?

Interviewee: when there is no waste on the road and no dumpsites

14. In your own view, can waste have any value?

Interviewee: yes I know it have value

15. Do you think our country can benefit from turning waste into resources?

Interviewee: empowerment,

16. Which type of the waste do you think can generate most value in Nigeria?

Interviewee: well, more of food waste is generated more in Nigeria

17. Can we talk a little bit about faeces? Where do you defecate? When it full, how do empty your faeces?

Interviewee: my faeces is a waste, and we use septic tank and when it is full, we call the tanker and they will just bring their vehicle to evacuate it. Well, I didn't know but I do hear that they dispose it into the big rivers like lagoon. That is what I used to hear but I have never seen it with my own eyes.

18. Did you know that after our treated faeces can be used in many ways, for example it can be turned into fertilizer, fuel, and biogas and so on? What do you think about this potential? Would you consume products that use these resources?

Interviewee: it can be used for something, as long as it is treated and contain no health hazard, I will consume whatever faeces is used for.

Thank you very much for your time.

This interview is part of my postgraduate research on waste management practices in Nigeria. The research is seeking information from the key stakeholders in waste management in the country in order to understand the major factors impeding sustainable waste management in Nigeria. Your respondent is completely anonymous and this research project has ethic approval from the Faculty of Engineering and Environment, Northumbria University Research Ethics.

Part B. Main issues: waste management – LAWMA 1

1. Which waste categories are covered in your management? If not all, what happens to those categories that are not currently handled by you?

Interviewee: I will say all types of solid, it is solid that is LAWMA. Solid in terms of solid waste from household, commercial premises, industrial, public places, institutions and markets. We don't do waste that is not solid, no mining waste but agricultural waste em..., it is not that we have a particular plan for it. You know some of it will still end at landfill, I mean dumpsite rather. I know Some people do put in poultry waste, some of our commercial PSP operator bring animal waste, you know LAWMA is partnership with a company known as Health care, they convert waste of animals to fertilizers. This is in odogunyan in ikorodu, so some of these waste also end up there. Waste from breweries, fruit and vegetable markets are also take to this facility in Odogunyan. But I know I have seen poultry and farm waste in the dumpsite. Health care actually converts garden waste to compose to be used as fertilizer. They don't go around to collect organic waste from the generator, I don't know how it works now because of the new management but before LAWMA stationed working trailer at the ikosi fruit markets and a section of the miles-twelve market which also a fruit market. When these trailers are full instead of it to go and dispose it on dumpsite they take these waste straight to Health care and also some PSP that deals with waste from breweries take it to them. This health care company are still functioning and they sell their products to some farmers but now the business is not picking up well because Nigeria's farmer prefer inorganic fertilizers to organic ones "said the manager of Health care in June". I think farmer in this country are used to normal imported inorganic fertilizers than locally organic made. So the market is not big enough for them and they have capacity to do more. Their place is big and sale is not very encouraging. I don't think their organic fertilizer is expensive in comparison with inorganic farmers

they are used to, as a reason of no market for it. I think it is just the acceptability, and then for people to now understand the health benefits of organic fertilizers. From my own perspective I think farmers need more awareness on use and benefits of organic fertilizers, I know inorganic fertilizers will give them more yield but they have to look at end consumers' health implication from consuming these produces. I don't think is only the farmers that need the awareness but also the consumers as well. With e-waste LAWMA started not too long with handling but it also overlapping because LASEPA is also handling it. Presently, LAWMA collect e-waste and disassemble them and the parts that are not poisonous or hazardous are disposed properly and I think those that are hazardous are kept separately, I don't really have much knowledge on that.

2. Which waste categories in your view, are most important for protecting the environment?

Interviewee: I think we should look in all type of waste, all of them, even ordinary nylon can also constitute nuisance because those things don't decay on time also tyres. What we are actually advocating is that it is time we aim to reduce what get to the dumpsites, by educate people on re-use, whatever can be re-use don't throw it away and whatever can be recycle should be taken on along that chain, so whatever ends up at dumpsites will be minimal and there will be less contaminants. What we have in Lagos are not landfill but dumpsites, we end up bury those waste, so if we can reduce it will be better. So every types of waste is useful and the same time some can be very hazardous. All categories of waste should be given attention and it is possible we can do it.

3. Which waste categories are more difficult to manage?

Interviewee: domestic waste because it has do with individual and the level of compliance is low. Households always find illegal way to discard their waste.

4. I want to better understand your waste management process as a whole. Can you tell me about the major steps in your everyday operation?

Interviewee: now LAWMA involvement in the waste process is reduced, we are migrating to become sole regulator agent/ government for waste management. But before now LAWMA is managing the whole chain, what we do; we do collect, we transport, we do recycling, we dispose and we manage the disposal sites. How it started was that, initially there were communal depots in Lagos, people have communal places where they dumped, so burning and all sort things going on there. But after some time precisely during the time of

governor in 1999, that the government started....., we have cart pushers all over Lagos at time, and they are the only one people patronised then, you only see local government trucks go around. At point so we brought all the cart pushers together and encourage them to buy tippers at that time, some of them that have money buy tippers, some form cooperative where four- five people come together and buy one tipper. Those communal depot were eliminated, so that people can now give their waste to PSP, they will take it to the dumpsites. Later Compactors was introduced in 2001, we encourage the PSP to change to compact trucks and invest in the business so that they can make more profit and collect more waste because what two- three tippers will carry, a compactor will pick it once. This reduces operational cost and we able to collect more. There was when the issue of enforcement now started. There was a time when LAWMA stands as guarantor for PSP to obtain brand new Tata compactor from Sterling Bank. During this time LAWMA collected over 70% of waste generated, when I say over 70% it is not that we can't collect the rest of 30% but there are some parts of the Lagos that the people will not give you their waste. These are people that live in the swampy areas, they use their waste to fill the swamps around them, areas like Makoko, obadi, akala, sabo and the rest. For those areas we are doing a lot of enlightenment, tell them about the hazard of doing things like that before they bring little out. Even at time when the PSP were able to collect in these swampy areas the services were paid by the government just to encourage them to bring out their waste but still they are adamant.

5. Are waste facilities including collection, transportation and landfill, adequate for your operations?

Interviewee: our facilities is not sufficient to handle all the waste generated in Lagos metropolis

6. Do you have sufficient work force?

Interviewee:we have enough work force. They are distributed across the different departments for different functions. I can say LAWMA has enough workers

7. What are the major difficulties related with waste management in this city?

Interviewee: I think it is still the compliance level. The attitude of people to cleanliness is still poor. Compliance to dispose proper, have waste bin, compliance to pay waste bills. The payment is set according to income level or residential areas categories. The slums and very poor areas where people can't

afford to pay for their waste, government continues to pay PSP but people that in GRA, Banana Island, ikoyi and Lekki pay fully. The payment was just set at minimal in all categories, it cannot even cover the cost, and at least people are assisting the government. At that time, a face-to-face house was \$0.3 per room, a flat \$1.4 at minimum but a flat in Banana Island will pay more like \$3-4. We started like that, then started moving to the middle income people and even up till now, there are still some areas where PSP cannot collect their money, there some we can't identify which household is bringing waste out but we still need to collect from them. Presently almost all the commercial premises are paying and payment is based on the volume and the type of waste and frequency of collection. Household payment is based on property type and that is type of measure we have then, may be the new company will look into uniformity in the payment soon.

8. Do you think households cooperate with waste services when it comes to waste management?

Interviewee: some cooperative very well, while many do not.

9. In your experience, do people dispose their waste properly? If not, why do you think people do like that?

Interviewee: People just have to comply, the thing with our people is that they are not just ready to do the right thing, is not that they don't know, I am very sure of that. People know the proper thing to do. Somebody will bring the waste she generated at home to shop because she doesn't want to pay twice and say "is not the person that is generating it" whereas, what you generate in the shop is different from household waste. People don't want to believe there is different between commercial waste and domestic waste. When people are used to particular way of doing thing, they don't want to change is not they are not aware. I think is more of behavioural problem, people are just used to and it is when they know that there is punishment attach that they do it properly. You know this is democracy and the government are lenient because of political ambitions, may be when the private sector coming to play, might be more forceful. You know government are always careful because electoral positions, at they will be harsh and the same time cool down and allow people to it wrongly. Our people are just not willing, we should have move from where we are now.

10. Do think people are aware of the facilities and how to dispose their waste properly?

Interviewee: yes, people are aware that they need to have waste facilities to store their waste for PSP to collect.

11. What do you see about public awareness and orientation towards waste management?

Interviewee: yes, you know a lot of things happened when there is change in government and people always hide under that to say we don't know that it is still going on, presently we are doing a lot of recovering waste debt from people that owing us even when they know, they will still say we thought government say we are not paying again, when they have been paying before, people always look for opportunity to say we have new government, somebody told us something, so there was a time when we encourage people to bring their waste for incentive. Like almost 5- 6 years ago when we started with the recycling programme, monitoring and advocacy department go out on daily basis and there was programme on incentive based recycling, we asked people to bring their waste, even nylon, we weight it and pay them. There was time we are also doing waste for food, may be on children's day, we asked the children to come with waste and return with food. We are even doing the schools advocacy, where we can also talk to parents, we are having recycling clubs in public and private schools. So at the point we also collect PET bottles and pay for it, so that people begin to know that these things are useful and they can be used to make money instead of just dumping it. And people are forth coming and later recyclers are also encouraged. We say, if you know you want to recycle, you should partner with LAWMA, we licensed them and help them to talk to the company that produce that type of waste you want to deal with it. We have licensed lot of people that are doing recycling and those waste they handle such PET bottles, can, cartoons and papers don't get to dumpsite again. The separation of these waste are usually done at the source in companies before the PSP take them to the recyclers. Then from households, we have been always talk to people that if have plastics, nylon just separate them from your normal waste, it will reduce the stress and there was a time LAWMA had recycling bins, we placed it in along the strategic places and in the estate but some of them are no longer there. Any time we want to start a project like this, it easier to commenced it in a residential area that are well organised, where we have the space to place the bins and where we have someone that can monitor what get into the bins. So at time, major bus stops have those bins with three compartments; papers, plastics and other waste. And people were

complying, doing it properly at that time because the bins were there and somebody is always there to ensure that you don't put the wrong items in each, there we have officer on ground to monitor. So there was how enlightenment started then and I think some people are still doing it, it is just that not forth coming again, you know Lagosian, I wouldn't like to say Lagosian, for people generally, and it is very difficult to make them do something. Some will tell you it very stressful, how can I separate these, when it get there, go and separate it yourself. But then we are able to achieve certain level of compliance at point but now I don't think it is still the same level. What I know is that we still do advocacy and it always in an interactive platforms, where people can come and ask us anything they want to know. We do the advocacy with buses with mega phone moving from one area to another every day for general advocacy. We stop, asking people what they need such waste nylon bags or service they need in their areas or markets. Once in a month or two months advocacy do town hall meetings with CDAs and Landlords associations, so they move from Local government to local government for that and they usually send their report to us at LAWMA. In that forum, people always ask questions, people are enlighten and our resourceful or skill officers are always on ground to answer them.

12. Is there any environmental law which encompassing waste management? Do you think these laws are sufficiently enforced?

Interviewee: there is environment law that specify on waste management. You know there is new law that is recently pass, it is all encompassing. It also give avenue for private sectors to come in into every part of waste management chain. It is a robust law and the enforcement....,em..... Lagos State environmental ... LASGAG which, are just being newly set up, I will look for the meaning of the name. LASGAG is a unit of government that will handle the enforcement now. So LAWMA will do the regulatory and they are to handle the complaint and enforcement.

13. Do you do any form of sorting and recycling? If not, what would you say are the major factors impeding proper sorting and recycling?

Interviewee: yes, there are some form of informal sorting on the ground already. What is impeding normal proper sorting is the absence of TLS facilities in some areas and the conditions of those available TLS.

14. What do you think is necessary to start waste sorting and recycling in the future?

Interviewee: yes! Yes! Even the vision scape has started renovating our TLS, we have one Simpson area, we have one at Osodi and another one at Agege, so they are trying to renovate the places and it will now work like a TLS with sorting facilities. So when waste around that area is collected and put together, it will be dump at TLS and sort out and only what is remain for disposal that will leave TLS to the dumpsites. Those are the project that are really going on and very soon sorting will be done properly.

15. In your own view, can waste have any value?

Interviewee: According to my learned Ogas; one of my very good boss; he said waste is not a waste until you waste. Thus, we might have not gotten to that point yet in our situation here but it is a real facts, waste is valuable. It is now depend on how well and technical capacity do we have as state, as government to manage it.

16. Do you think our country can benefit from turning waste into resources?

Interviewee: of course, we can, we just need the right administrative and legal framework to do that.

17. Which type of the waste do you think can generate most value in Nigeria?

Interviewee: household waste, organic waste is the highest, plastics 23%, organic 43%, construction and demolition 1%, inorganic 2%, HHW., Textile 12%, others2%, paper 13%, beverage containers 1%. In five years ago, organic was about 60% and now it has reduced to 43% because there is a compose plant at Odogunyan, so most of the waste from our fruit and vegetable markets are taken there. The total MSW generated per day is 14000 metric tonne in Lagos metropolis.

18. Where do you think new ideas comes from, in relation to the way this city manage its waste?

Interviewee: Lagos city has always imbibe culture of partnering with private sector, handling over the operation to Visio Scape a private company is just an improvement of what we have on ground already. We have on ground is part of the waste management businesses outsource to the private sector and we give them the standards. This is how is done anywhere in the world, comply and conform to these standards.

Do these ideas come from developed countries or from local actors?

(If developed countries) Do these ideas work well in the context of Nigeria?

Interviewee: Well, Well, when we look at where we started from, this idea of private sector initiative in Lagos was a cry and fall out of what we saw happen out the country and I think, Lagos has the record of at least over 16 years we have been partnering with private sector.

So over time we have introduced the local context into it, like all these PSP companies, i.e all the private company that has been working with are all local companies. So we took the experience from what is happen outside there and try to adapt to our own local environment and it has been working for Lagos. All improvement are based on what we have presently and it is continuous. We continue to improve because we are still not there, we want to be able to measure our self-side by side among developed cities and countries of this world.

Do you remember a case where a local idea was used for improving waste management in this city?

19. Which one, developed country or local ideas, do you think are more useful?

Interviewee: I think both help each other.

Thank you very much for your time.

This interview is part of my postgraduate research on waste management practices in Nigeria. The research is seeking information from the key stakeholders in waste management in the country in order to understand the major factors impeding sustainable waste management in Nigeria. Your respondent is completely anonymous and this research project has ethic approval from the Faculty of Engineering and Environment, Northumbria University Research Ethics.

Part B. Main issues: waste management – PSP Ibadan

1. Which waste categories are covered in your management? If not all, what happens to those categories that are not currently handled by you?

Interviewee: So the areas we are working, specific areas that we are working, we don't work in wastewater, we work in municipal solid waste ,domestic, commercial ,industrial and medical waste- hospital waste as well in Oyo state. Specifically in Oyo state because majority of Oyo state population are in Ibadan, 90% of the work are in Ibadan. Although, increasingly in the last few months is growing larger, we have extended to Ogbomosho land, Oyo town and soon we will move to Saki and on, which bear the most population of Oyo state. We don't with the biodegradable waste or agricultural, pretty much farms recycle them by themselves, and most farm have small scale decomposing facilities thereby, they composing on the farm. In-term of e-waste, so we don't have that....., that doesn't get specifically treated within the waste management. Well it falls within the domestic waste that is what get collected but there is no specific category of electronic we managed. The e-waste still end up in the domestic waste. There is no concept of sort at source, there are no process facilities at the Oyo state at moment, so we doesn't them get sort out. (Interviewer: this e-waste are very hazardous, what do think we can do to improve such from ending on the dumpsite? When you look up in the waste management, the first thing is to get the collection right first. We shouldn't jump to processing facilities when that is not there, unless, the collection is right, the process facilities will fail. So, when we took up the waste management from the Oyo State Waste Management Authority (OYOWMA) which was about 12 months ago now collection was the biggest problem, even now, at time I will say about 20 - 25% of the waste being generated was collected. From Ibadan, you know yourself, most of these waste enter into the canals, enter into rivers or end up being burnt in the people's backyards. So we put lot of effort now on how to get the collection correct and our focus is being on the domestic, commercial and industries. The next stage of that development is the process, when we will

build a em....., we the WestAfricaENRG actually owned a factory in Lagos, where we do recovery facilities, where we sort municipal waste and put them into recyclable fractions and that is something we are planning for Oyo state as well and that form is when we can capture the electronic wastes. That said, there are, Nigerian are very enterprising and there are lot of what they called "bullyboys" that go around house to house for collecting electronic wastes and sort them themselves. The only one silly part of electronic waste is the batteries, there we say; we have high value of recyclable e-waste but low volume of batteries. So, the bullyboys are quite efficient with that, which is just a way for them to make money. So going to the dumpsite, I will say may be 30% of electronics waste actually enter to the dumpsites and 70% is being recycled, actually low volume, low volume.

2. Which waste categories in your view, are most important for protecting the environment?

Interviewee: domestic, domestic, em..... Is the major one, I think is the most important because that have so many alternatives that a house can do with the waste. So you know every other alternative expect for the good collection is a bad alternative, like burning at the backyard, throwing into canals, disposing on the highway or on the roads and that is what is happening. We need to focus on how to getting the domestic collection right and require good planning, system, good structure in place, good control and checks in place and so on. The commercial and industrial they need their facilities to be cleaned particular the industrial one. If you have poultry farm, food manufacturer they need to get their waste collected. So they come to us and begging to collect their waste because they need to keep the factory clean and so on. That kind of management itself, there is demand of constant cleaning. But small scale commercial in almost the same thing as domestic and they do not really care; they burn it or throw it into the environment in whatsoever. And we have large scale commercial such as banks, petrol stations and so on, they are place as industry. They use to come to us to arrange for their collections. But my biggest concern is domestic, in Ibadan there is high young population, children, so children in the household got easily susceptible to Lassa fever, fever, influenza, cholera and so on and so on. So we got to get the collection sort out properly, burning in backyards is not good for everybody and we need to sort it out.

3. Which waste categories are more difficult to manage?

Interviewee: I think across West Africa not specific in Ibadan, there is a co-collision with waste management. Waste management historical have been done in the past for free and never done well. If you want it to be done very well, you have to pay for it. In West Africa we work in Lagos, Ghana, and we have being to Sierra Leone as well, it has always been the same problem. We are in the developing region, I don't want to mention country, and poverty level is very high. People wonder and think if I pay for my food, why do I need to pay

for my waste, to grid of it. It is cultural aspect, now if explain to them why they need to pay for their waste so you will need not to pay for hospital bill when your children fall sick. The concept of long time planning for someone in high level of poverty is very difficult. They are only worried for where to work tomorrow, they are not worried about the hospital bills next month, which they never see it coming and it is a very religion area. So, constantly, they will say God will protect, en...em that is very fine, God protect it all, but it has in that mentality and cultural interaction to say this is my area, I must have pride in my area, I must keep it clean, I must pay for my waste bills and so on and on. In Ibadan in particular, have a problem in that from the flood of 2011, which was caused by waste built up in the canals. hist
(Interviewer: how do you think you can manage this? There is need to let them know in good way why they have to pay for waste collection.

Interviewee: we have three phases' approaches to that; firstly, we got to get the service right. I'm very convinced if we give good services to people, people will pay for it, and so we got to get the service right. And we are struggling to get the service right because going back to get people pay, if we don't get people pay, how do expect the company to invest in vehicles, staffs and so on and so on. We support with payment subsidies for our waste contractors; we said to them to go collect the waste, do your service properly, we will pay you. Our service is still about 60% of what it needs to be. Second one, is the enlightenment, where we do a lot of publicity campaign on radio, television, going out to community, housing association, sitting with them explaining what we are doing, trying to communicate what we are doing. And the third one is the state, the enforcement that is most important one. Someone can have a choice; high income areas pay about 2000 naira (\$6), medium income areas pay 1000 naira (\$3), low income areas pay 500-800 naira (\$1-3) and very low income area pays 200-300 naira (\$0.5- 0.8) per month for waste collection. If they don't pay will have to use enforcement and the fine will be 10000 naira (\$28). We say to them is your choice to take 1000naira or 10000naira, so you make that as a choice. So where we work is to do our service right, do our enlightenment and follow that to the enforcement after the service. We have dedicated magistrate working with us now and we persecute easily 100-150 people every day here that can be easily to 1000 people. What we find was that at very low income areas, that is where the most payment get to the government, so they are the one that are more willingly to pay than the high income areas. High income areas will say I will take you to court, I known high commissioner, my uncle is a commissioner for this, my mother is that, my sister is that.....bla,bla,bla.

Interviewer: what are their complains?

Interviewee: there is no particular thing, is that Ibadan people are particularly stubborn, if I could use that expression, basically they are adamant, they want to bargain with you, if ask for 1000 naira or 2000 naira , they will say I give 1800, this is not about bargaining because 200 Naira doesn't really affect them, is almost that they need to, need to beat the system, we have done a lot about that and what we noticed when we first started was that if they pay the contractor directly, they will end up into negotiations. All what we find is that when they go to the work, there might be arguing about the price and pay, so one person will say I'm paying 2000 and another saying I'm paying 1500 and the person that pay 2000 will come fight us on 500. So we do that they must all pay directly to the government, it is government tariff here and that is what government wants you to pay. On commercial is the same based on volume of the waste is how much we charge them and is the same with industrial as well based on the volume of waste and that has been a good process and we set the tariff and you can negotiate with 10% of that tariff, and we go through the manufactural association of Nigeria to see we have the constituent about the standard on the different type of manufactural and so on and so on. There are number of check and balance in place to make sure we are not charging too high rent to the people. We got to a way to provide a good services and got to pay for the landfill and I think those are some of thing people don't realised when they are paying 1000 naira, they just think is just for collection and they don't understand the rest of the whole process behind, that you have to manage the landfill, keep them sanitized and so on and so on as we going and that is part of the failure the system is going through.

4. I want to better understand your waste management process as a whole. Can you tell me about the major steps in your everyday operation?

Interviewee : at the moment our process is; operation the side of thing at moment, we are now having 70 contractors around the whole of Ibadan, my view is that we capturing 60% of the waste being generated, em.. which is not enough, we need to get close to 80- 85%. You never capture the whole that is just let us aim for 100 minus 5%. So, in the operation, domestics get collected at least twice in a month that is every two weeks they must collect domestic. Em.. Commercial they must do as required, at least once in a week by as required. The most commercial roads should be daily and commercial in once in a week and so on and so on. Industrial is as required, some of the industrial facility will want to done on every single day, some will want to done ten times in a day, others will done it once in week. As required we get reach to them. So, at moment is collection and disposal only we do. We have four landfill in Ibadan, the first is Lapite, Aba- eku, Agakanga and Awotan. On the average they about 12 hectares in sizes each, they are not burrow pit so they are flat land, waste get

disposed on it and they just doze out. They use to be on the outskirts of the Ibadan city and as Ibadan is growing, is growing into the landfill, so they are no longer in good locations at all and our goal is to close them down. At least three of them will get close by middle of next year as we are going through, that is what is covered in our processes. We have a master plan for waste management that we done here in OYOWMA and that will be a five years master plan about building Transfer Loading Station(TSL), the trip at moment is about 90km from Ibadan, once they do with routes, dispose and get back to Ibadan is too much for contractor. The cost of diesel is very high, no matter the amount of money we get from that doesn't pay for that, so we want to build at least three TLS inside in Ibadan, so it will be closer to get to and overnight we take out for process and final disposal at dumpsite to rid of them. That will happen in the five to six years now, we got to look at this as long time plan nothing is going to be fixed overnight. We are making sure it does not get out overnight, if get out overnight, it would not be done properly. At the landfill we have the informal scavengers and they do recycling, they do recovery of valuable fractions such as plastics, metals and cartoons, these are three main things they are looking for. These scavenger are registered on under our management and any one that buying from the dumpsite must be registered with us as well, so that we know them but the market, we leave the market alone to the scavengers determine their best price but you must being registered with us just to know what is going on and just to know who is recycling. The part of problem that we face in Nigeria is that lot of recycling companies will start up and none will actual produce, will end is factory full of waste and that become hazardous, fire hazardous, environmental hazardous, so get them registered with us, so we check their facilities, are you a general recycler or are you hobbyist, just to know what is going through there. And there are lot Nigerians, lot of Chinese and lot of Indian doing it now as well and there is demand for it.

5. How often do you collect waste from market and public places?

Interviewee: markets are big challenges for us, public places are done on daily bases but some markets should be daily, some markets they will facilities inside the markets where they disposed their waste and we evacuate the waste when it is full and others might be once in a week like that comes under commercial. Lot of dumpsite including disposal of animal faeces within the market should not be happening by law that shouldn't be happening, so, that comes under enforcement. There is peculiarity in Oyo state, a lot of these market are the larger voting base or voter base, if I can put it that way; so you can put too heavy handed on them because they are very politic active. If go to the market with lot measures, all of a sudden, you will find a lot of politicians that will start saying what is going on what is going on, you got to be treating them firmly and got to be treating them softly as

well as you go through there. All of these are illegal, actually we do try to go and do enforcement on it on days to days. On Thursday we do have environmental inspections on the markets. What I don't understand about Ibadan markets is that most of the markets women will pay more to the bullyboys to collect their waste and dump it into streams than what we will want to charge them. You know lot of these markets have no toilet facilities, if you go to Oje, Beere,(slums) the woman selling peppers, they don't have any toilet so there is no any consciousness of hygiene in her mind. The biggest thing we pick up in those markets is human faces in black nylon bags and they put on the road, so there is no consciousness of hygiene in those markets. You know is a cultural issues and mentality issues that needs to change and that is not only to Ibadan, is in Lagos, Ghana as well.

6. Are waste facilities including collection, transportation and landfill, adequate for your operations?

Interviewee: I can't say they are enough now, but we are really trying to provide enough facilities for an efficient performance but you know infrastructure is the major obstacles here , bad roads, long miles, trucks are breaking down every day.

7. Do you have sufficient work force?

Interviewee : yes, we have more than enough workers, we have employed nearly 3000 people in Nigeria.

8. What are the major difficulties related with waste management in this city?

Interviewee: I put it into two baskets, there is a structural issue and there is a cultural issue. The structural issue is that Ibadan as historical history as I know has no development planning in whatsoever. Most of the growth in Ibadan has been unplanned, even in the plan area is very difficult to get vehicles in there to collect waste. So many of the roads could not fix for compactor trucks and if you cannot use compactor trucks, the major cost of operation will gonna go up and this has been the challenges there, this is structural issues around development planning and then physical planning is as well we go through here, that is one and it is a big issues. And also this structural issue feed in into other issue and it is cultural issue and it is also a challenge. If the development is not being done properly, quite informal, you don't see government playing important role in your life, if don't see government paying important roles in your life, you don't pay taxes and you don't affiliate with government. Then see government as burden and challenge and a curse and so on and so on, these are challenges we face here in Ibadan. Eh..., thus; the present regime in Ibadan is making strike to do that. The making is difficulty for any single government to make that change in one instinct; hopefully, the next government will build on his success and one after we build on that success and so on. They have done Ibadan master plan for 2036 and what I have seen of that it looks very positive. It takes stress out on the central parts of the city, making satellite

town build around the city and that is very good idea in my own view, and that will bring development and proper planning. It is not just about waste, is about all the utility; power, water, road and so on. When they get those result sorts out, then you start to track industries, tracking jobs and create money. One of other challenges in Ibadan is that the majority of employers are for government, they are civil servants and we know the challenges, when the system collapse, to pay civil servants wages, salary and so on will end up collapse.

9. Do you think households cooperate with waste services when it comes to waste management?
10. In your experience, do people dispose their waste properly? If not, why do you think people do like that? Are they aware of the facilities and how to dispose their waste properly?

Interviewee: yah.... Everybody is aware, I'm just own to that, I think even most illiterate person knows he shouldn't be dumping his waste in the canals. There are facilities, we have communal facilities, by law every household should have a bin, and do they have a bin? No they don't. Is there any enforcement? No any enforcement. A bin cost 3000 Naira and no matter how poor you are, you can spend 3000 Naira on thing. Even if they come to us here, we give them for free, so it not hard and they know that but the problem is once somebody has a bin, everybody waste goes in to that bin, they put the bin outside their house, you come wake up in the next morning the bin will be overflowing. If you say to somebody where your bin is he will say I don't have any waste, what do you means you don't have any waste, I don't produce any waste. Tell me what do they means with I don't produce any waste. So, do they do it knows properly? Do they know? I think most literal person does that. Everybody see our trucks going around on the streets and we know they know because when our trucks is going down, they bring their waste down for our truck. So it is not as they were stupid and the other way I know is that when you going along the streets, the majority of the waste get disposed illegally on the road, they disposed it at night. We use to have bins inside major populated areas like a dumpster bins and what was happening was that `I'm getting go down on the poverty, I'm afraid` the unfortunate situation is that people dispose their dead bodies in these bins and so on and it was not great. We have specific case for that, where young children below the age of three and pensioner s dead bodies are disposed quite common among the body of waste may times. So we do away with the bins and also we found out most of the households will pack their waste in the back of their cars and disposed it in the public bins to get away from paying the contractors because they say government is doing it for free. So it is the altitude way to that, by law every households should have a bin and that law is coming into enforcement very soon. But we got have to be careful, people in Beere (slum), they don't have proper housing, how are we going to enforce proper bins?

11. What do you see about public awareness and orientation towards waste management?
12. Is there any environmental law which encompassing waste management? Do you think these laws are sufficiently enforced?

Interviewee: there are two laws that are set out. Two dedicated laws; the environmental and sanitation laws 2013 and the OYOWMA's law 2008. Both of them have a specific points about waste, solid waste management within the laws. The OYOWMA one is very specific about who else responsibility, the roles responsibilities of OYOWMA, what we can do and what we are not allow to do and in the environmental law sets ministry of environment as the regulator of OYOWMA and again re-emphasizes the requirement of the waste contractors and OYOWMA and so on and so on. The laws itself it actually a very good law and this is disseminate to the people through enforcement. Hardly any law is enforce (eheheheh.....smiling.....)in Nigeria, so waste management is other one which is very difficult. I don't think is policy implementation issues that lead to failure in enforcement, I think is a resource issues and I think the challenges is that we are in the developing economy, you can have very good laws but you don't the resources to enforce the laws, the laws is useless. So we are in the country where the cost of those resources is still quite high, I mean talk about people, vehicles, training, human capacity, and so on. To get that is actually very high cost, you got to know cost-benefit ratio, we have a very good laws but the cost of implementation is very high which means laws never get implemented. And by implementing laws, you actually getting the suffering to the people who are quite poor. So what do we do? There are lack citizenry attitudes, you know people themselves could have recognised actually this is my responsibility. Is always less government can do anyway, you know government cannot guarantee everybody with state of the rules of put the rubbish in a bin, put the rubbish in a bin, so some level everybody adopt the attitude that actually, I come from Ibadan and I want Ibadan to be clean, it takes on personal responsibility to do it. But the break down relationship between the government and the governed come into play as well. It is a problem which is being in many generation in making and it would not be fixed in one generations. So but it is em... I think the laws is very good and desire to enforce the laws is very good but the resources to do are not sufficient. I mean there are almost about 4 million people in Ibadan and we have 13 environmental officers in waste management, 13 in the whole of Ibadan, is not enough, we will need at least 300, why is that ? Is the cost, cost.

13. Do you do any form of sorting and recycling? If not, what would you say are the major factors impeding proper sorting and recycling?

Interviewee: There is no any form of sort from the source system or MRFs in Ibadan now. There are relatively high number of scavengers at the dumpsites doing kind of informal sorting of some waste fractions to sell to the recyclers as their source of income.

14. What do you think is necessary to start waste sorting and recycling in the future?

Interviewee: yes, that is what we aimed in the in next five years now. We are building MRFs to facilitate proper sorting and reduce the amount of waste that would be ending up in the dumpsites.

15. In your own view, can waste have any value?

Interviewee: absolutely!

16. Do you think our country can benefit from turning waste into resources?

Interviewee: yes, our next goal is the processing, we already had plan for the waste processing facilities, two processing facilities, one in the north of Ibadan and one in the south of Ibadan, which will be a material recovery facilities, where will sort the valuable fraction from the waste. Plastics, metals, papers, cartoons, biodegradable waste, biodegradable waste for composting, and other stuffs will be sold to the recycling or recycling ourselves to make polybags and so on and so on, and that is what we do in Lagos. We have a factory in Lagos and we sell the fractions to Kano state, as far as Abia state all the plastics and so on. I would love to use waste to generate energy but the problem we have is that the legislation doesn't, it very expensive to do, and the legislation at this moment doesn't give you any subsidy for generating environmental energy, so it is to a very great degree. The legislation at moment is if you produce 26 megawatts is got to get to the national grid, so you cannot do low scale waste to energy, it got to be 50-60 megawatts you do in there. The valuable of producing national grid, is not that much, so it is a bit of but we have done over study for it, we found and we know it is viable, we can do technical but the economy at this moment that we do not see it coming. So, we are working on that. Presently we are looking into compose, composting biodegradable waste. Biogas is much cost as well, if we come to biogas, we only need landfill for gas. You got to havawareness engineer landfills, you got to get it right from the beginning. I am certain that the compose will do well because of lot of agricultural lands but one of thing we must consider in that is that the chemical fertilizer is heavy subsidized in Nigeria. So, you need to communicate the benefits of natural fertilizers over chemical fertilizers, and that is the challenge, I found a farmer, I offer him my low cost possible but chemical fertilizer is still lower than my offer. Actually over the long time application of chemical fertilizers on the farm is quite harmful to the health and so on. Em..., getting those message to them is very important but I am sure compose will work, I am sure.

17. Which type of the waste do you think can generate most value in Nigeria?

Interviewee: Domestic waste, organic waste.

18. Where do you think new ideas comes from, in relation to the way this city manage its waste?

Interviewee: ideas come from both local and international best practices around the world.

Do they come from developed countries or from local actors?

Interviewee: actors are foreign people but are partnership with local private actors on waste management.

(If developed countries) Do these ideas work well in the context of Nigeria?

Interviewee: We hope and believe is going to work better, may be people will be nicer and cooperate with government.

Do you remember a case where a local idea was used for improving waste management in this city?

19. Which one, developed country or local ideas, do you think are more useful?

Interviewee: both are useful, foreign brings their technical skills but the local know the terrain better. So the local will help to fix in the technology into our terrain. They too, the foreign will also learn by discovering that we are different, if it is localized it cannot work. No foreign ideas, technology will work without the local content.

Thank you very much for your time.

Appendix B

Overview picture of the initial coding result from the Nvivo software

The screenshot displays the Nvivo 12 Pro software interface. The main window shows a list of nodes created during the initial coding process. The nodes are organized into a table with the following columns: Name, Files, References, Created On, Created By, Modified On, and Modified By. The 'Nodes' list is the primary focus, showing 40 items with their respective reference counts and creation/modification dates.

| Name | Files | References | Created On | Created By | Modified On | Modified By |
|-------------------------------|-------|------------|------------------|------------|------------------|-------------|
| Advocacy | | 3 | 9/15/2018 22:30 | AAA | 16/01/2022 01:33 | AAA |
| agricultural waste | | 3 | 6/15/2018 00:02 | AAA | 16/01/2022 02:46 | AAA |
| Attitude | | 4 | 15/15/2018 23:11 | AAA | 16/01/2022 02:26 | AAA |
| Authority | | 1 | 1/16/2018 16:43 | AAA | 16/01/2018 16:43 | AAA |
| Awareness and commitment | | 6 | 15/15/2018 23:41 | AAA | 16/01/2022 02:24 | AAA |
| burning | | 1 | 3/15/2018 22:54 | AAA | 18/01/2018 00:55 | AAA |
| cart-pusher | | 3 | 7/15/2018 22:52 | AAA | 17/01/2022 00:17 | AAA |
| commercial waste | | 1 | 2/15/2018 23:33 | AAA | 16/01/2018 17:38 | AAA |
| Cultural context | | 2 | 7/15/2018 23:07 | AAA | 16/01/2022 01:55 | AAA |
| domestic waste | | 3 | 13/15/2018 22:36 | AAA | 15/01/2022 23:33 | AAA |
| dumping | | 1 | 2/16/2018 17:35 | AAA | 18/01/2018 00:48 | AAA |
| dumpsites | | 1 | 4/15/2018 23:00 | AAA | 18/01/2018 00:12 | AAA |
| Economic context | | 2 | 11/16/2018 17:47 | AAA | 16/01/2022 01:18 | AAA |
| Environmental context | | 9 | 14/16/2018 17:42 | AAA | 17/01/2022 00:16 | AAA |
| e-waste | | 1 | 4/15/2018 22:28 | AAA | 16/01/2018 17:33 | AAA |
| Existing market | | 1 | 1/16/2018 18:24 | AAA | 18/01/2018 00:12 | AAA |
| Existing Practices | | 5 | 12/15/2018 00:06 | AAA | 16/01/2022 02:41 | AAA |
| Good practice | | 2 | 6/15/2018 23:46 | AAA | 16/01/2022 01:27 | AAA |
| Health risk | | 1 | 1/16/2018 17:41 | AAA | 16/01/2018 17:41 | AAA |
| High income areas | | 1 | 3/15/2018 23:22 | AAA | 16/01/2018 16:53 | AAA |
| Household complexity | | 3 | 14/15/2018 22:44 | AAA | 16/01/2022 01:55 | AAA |
| Ibadan collection 60% | | 1 | 1/16/2018 18:00 | AAA | 16/01/2018 18:00 | AAA |
| Income and poverty | | 3 | 9/15/2018 23:18 | AAA | 16/01/2022 01:50 | AAA |
| industrial waste | | 1 | 1/16/2018 17:39 | AAA | 16/01/2018 17:39 | AAA |
| informal recycler | | 2 | 6/15/2018 23:51 | AAA | 17/01/2022 00:38 | AAA |
| Insufficient waste facilities | | 5 | 12/15/2018 23:14 | AAA | 16/01/2022 02:24 | AAA |
| Lagos collection 72% | | 1 | 1/15/2018 23:04 | AAA | 15/01/2018 23:04 | AAA |
| low income areas | | 1 | 1/15/2018 23:22 | AAA | 15/01/2018 23:22 | AAA |
| medical waste | | 1 | 2/16/2018 16:43 | AAA | 16/01/2018 16:45 | AAA |
| medium income areas | | 2 | 3/15/2018 23:24 | AAA | 16/01/2022 01:46 | AAA |
| Monitoring and Enforcement | | 3 | 13/15/2018 23:36 | AAA | 16/01/2022 01:18 | AAA |
| not willingly to pay | | 1 | 4/15/2018 23:43 | AAA | 16/01/2018 17:58 | AAA |
| Political context | | 4 | 20/15/2018 23:39 | AAA | 16/01/2022 02:36 | AAA |
| Private sector | | 4 | 8/14/2018 23:32 | AAA | 16/01/2022 23:31 | AAA |
| recycling | | 1 | 2/15/2018 23:54 | AAA | 18/01/2018 00:33 | AAA |
| Shams | | 4 | 5/16/2018 16:55 | AAA | 17/01/2022 00:20 | AAA |

Thematic Analysis - first coding cycle.mxp - NVivo 12 Pro

File Home Import Create Explore Share

Clipboard: Cut, Copy, Paste, Merge

Properties: Open

Explore: Memo Link, Add To Set, Create As Code, Create As Cases

Query: Visualize

Coding: Code, Auto Code, Range Code, Uncode

Classification: Case Classification, File Classification

Workspace: Detail View, Sort By, Undock, Navigation View, List View, Find

Search Project

Nodes

| Name | Files | References | Created On | Created By | Modified On | Modified By |
|-----------------------|-------|------------|---------------------|------------|------------------|-------------|
| Sumo | | 4 | 5 16/01/2018 16:55 | AAA | 17/01/2012 00:20 | AAA |
| social responsibility | | 5 | 11 16/01/2018 17:00 | AAA | 16/01/2012 00:23 | AAA |
| sorting | | 7 | 11 16/01/2018 16:26 | AAA | 17/01/2012 00:28 | AAA |
| space | | 1 | 1 15/01/2018 23:56 | AAA | 15/01/2018 23:56 | AAA |
| Stakeholders | | 6 | 9 16/01/2018 16:19 | AAA | 17/01/2012 00:19 | AAA |
| Technology | | 8 | 10 16/01/2012 21:56 | AAA | 17/01/2012 00:37 | AAA |
| Terrain and access | | 2 | 10 15/01/2018 23:08 | AAA | 16/01/2012 00:35 | AAA |
| Types of waste | | 4 | 11 14/01/2018 23:18 | AAA | 16/01/2012 00:46 | AAA |
| waste composition | | 7 | 13 16/01/2012 00:47 | AAA | 16/01/2012 23:11 | AAA |
| Waste process | | 2 | 9 15/01/2018 22:48 | AAA | 16/01/2012 01:19 | AAA |
| Waste service fee | | 5 | 11 15/01/2018 23:31 | AAA | 16/01/2012 00:05 | AAA |
| Waste value | | 8 | 24 16/01/2018 16:27 | AAA | 16/01/2012 00:45 | AAA |
| wastewater | | 1 | 4 16/01/2018 16:36 | AAA | 18/01/2018 01:27 | AAA |

Quick Access: Files, Memos, Nodes

Data: Fieldwork pictures, interview audio, interview transcripts, literature review, pilot study audio, research progress, File Classifications, External

Codes: Nodes, Relationships, Relationship Types

Cases, Notes, Search, Maps, Output

AAA 40 Items

Appendix C

A list of codes and descriptions from the codebook generated from the initial coding

| Code name | Description | Examples |
|--------------------------|--|--|
| Advocacy | Communication on waste management and values to all age groups of people is going on in Lagos. | <i>“Government is doing a lot of orientation, advocacy every day, telling people why they have to pay, telling people how to cultivate and imbibe waste management culture, why you have to store your refuse, why you have to bag them before putting in a bin.”</i> |
| Agricultural waste | Agricultural waste which is mainly organic waste dominates the municipal solid waste composition. | <i>“More than half of the daily waste generated across Nigeria is organic in nature. Presently we are looking into composing, composting biodegradable waste.”</i> |
| Attitude | Authority claimed that the major problem lies with the households’ attitude to proper waste management practices and positive attitude from the households will make a difference. | <i>“The attitude of people to cleanliness is still poor.” “The thing with our people is that they are not just ready to do the right thing, is not that they don’t know I am very sure of that....”</i> |
| Authority | There are environmental laws but no resources to enforce the laws. Hardly any waste regulation is implemented in the case study cities. | <i>We have not gotten a strategy to enforce this law, to make sure that every household has a waste bin.</i> |
| Awareness and commitment | Municipal solid waste management is not about the individual level of education rather it is about people getting proper orientation and awareness. | <i>“Everybody is aware, I’m just own to that, I think even most illiterate person knows he shouldn’t be dumping his waste in the canals..... because when our trucks going down on the street, they bring their waste down for our truck.” <i>If the government can make available waste facilities at an interval on the roads, on the streets and so on. So people can see where to put their rubbish on their way, I think that will go a long way.”</i></i> |
| Burning | Municipal solid waste is seen burning on the streets, residential backyards and at the | <i>“We burn it when it becomes a nuisance or the waste is too much on the street.”</i> |

| Code name | Description | Examples |
|------------------|---|--|
| | government dumpsites in Lagos and Ibadan. | |
| Cart- pusher | Wheelbarrow waste collection is very common in Lagos. People give their waste to cart-pushers for an affordable charge. | <i>“There are Hausa peoples that come around with their wheelbarrow to collect your waste and we pay them. But even those cart pushers eventually throw the waste they collect somewhere, like an illegal dumpsite.”</i> |
| Commercial waste | Waste from commercial centres in the city; businesses usually pay for their waste to be collected by PSP operators, however small scale businesses such as grocery stores do not usually pay. | <i>“Small scale commercial in almost the same thing as domestic and they do not really care; they burn it or throw it into the environment in whatsoever.”</i> |
| Cultural context | Some observed household behaviours in waste management are one way or the other rooted in historical settings. | <i>“It has in that mentality and cultural interaction to say this is my area, I must have pride in my area, I must keep it clean, I must pay for my waste bills and so on and on.”</i> |
| Domestic waste | This includes household waste and market waste and it is majorly composed of organic waste. | <i>“Household waste is more important because the biodegradable in nature.....domestic, domestic, em..... Is the major one, I think is the most important because that have so many alternatives that a house can do with the waste. “We need to focus on how to getting the domestic collection right and require good planning, system, good structure in place, good control and checks in place and so on.”</i> |
| Dumping | Waste is dumped everywhere as long as it can be dumped without being questioned or punished. | <i>“We used to put everything in a bag and put it in the communal dumpster. After we moved to a new area which is still a developing area, so what we do is we just throw probably on abandoned land.” “.....disposing it on the highway or on the roads.”</i> |
| Dumpsites | Dumpsites are legally authorized sites for waste collection vehicles to empty their collection. | <i>“Another problem is landfill sites, they are getting obsolete, they are getting filled up and they are even in the middle of the town.”</i> |
| Economic | The socio-economic conditions of people | <i>“I don’t think is policy implementation</i> |

| Code name | Description | Examples |
|-----------------------|--|--|
| context | have significant relevance to waste disposal. Many workers in the city are not certain about when they will receive their salary or wages, so they can not commit to paying waste collection regularly. | <i>issues that lead to failure in enforcement, I think is a resource issue and I think the challenges is that we are in the developing economy, income and wages are very poor for people to be willing to pay for waste services."</i> |
| Environmental context | Water and soil contamination, air pollution and health risk from poor municipal solid waste management. | <i>"In Ibadan in particular, have a problem in from dumping....the flood of 2011, which was caused by waste built up in the canals." "The biggest thing we pick up as waste in those markets is human faces in black nylon bags and they are also put on the road."</i> |
| e-waste | E-waste which usually contains highly toxic chemical elements also ends up on the dumpsites or burning in the household's backyard. The eventuality impact is that these toxic materials leach into the environment and when human beings are exposed to these contaminants it can lead to irreversible health problems. | <i>"In-term of e-waste, so we don't have that....., that doesn't get specifically treated within the waste management. Well, it falls within the domestic waste and gets collected but there is no specific category of electronic that we managed. The e-waste still ends up in domestic waste. I will say maybe 30% of electronics waste actually enters the dumpsites."</i> |
| Existing market | The market for recyclable materials is growing but needs government legislation and support to make it flourish. | <i>"There are a lot of Nigerians, a lot of Chinese and a lot of Indians doing recycling now as well and there is demand for it."</i> |
| Existing Practices | The current waste management practices in the case study cities are uneven collection services, dumping and burning. | <i>"Actually at a point in Lagos, there was the government in place that actually bought these containers and distributed them to people up to where it could reach that point. But government policies, if the government had continued with that process, maybe every household in Lagos would have had that plastic container now."</i> |
| Good practice | A few households have begun to sort waste at home. | <i>"People are doing sorting from source informally. When you get to the household and look at their refuse, you will see a nylon bag full of PET bottles alone; it means that understanding is there from that point. Government just needs to provide structural things for them to make it work."</i> |
| Health risk | Severe health risks such as cholera, diarrhoea, malaria and such are associated with poor municipal solid waste management. | <i>"In Ibadan, there is a high younger population of children, so children in the household got easily susceptible to Lassa fever, fever, influenza, cholera and so on and so on."</i> |

| Code name | Description | Examples |
|-------------------------------|--|---|
| High-income areas | High-income people are committed to a tidy residential area so they pay for waste collection services. | <i>“The GRA, Ikeja, and rest of them, those one pay. There is low-medium, high-income areas that one pays.”</i> |
| Household complexity | Generally, there is a very low level of compliance among households toward proper municipal solid waste management. Households find many alternative ways to dispose of their waste. | <p><i>“They want to bargain with you, if ask for 1000 naira or 2000 naira for waste collection, they will say I give 1800 naira, this is not about bargaining because 200 Naira doesn’t really affect them, is almost that they need to, need to beat the system</i></p> <p><i>“The problem is once somebody has a bin, everybody waste goes into that bin, they put the bin outside their house, you come to wake up in the next morning the bin will be overflowing.”</i></p> |
| Ibadan collection 20 - 25% | Municipal solid waste is being collected in Ibadan as highlighted by WestAfricaENRG - a PSP operator in Ibadan. However, currently, the company is trying to do their service properly, to reach their target service of about 60% of what it needs to be collected. | <i>“From Ibadan, you know yourself, most of this waste enters into the canals, enter into rivers or end up being burnt in the people’s backyards. So we put a lot of effort now into how to get the collection correct and our focus is being on the domestic, commercial and industries.”</i> |
| Income and poverty | Poverty levels are high; a large number of people work but still find it hard to feed their families. | <p><i>“We are in the developing region, I don’t want to mention the country, and the poverty level is very high. People wonder and think if I pay for my food, why do I need to pay for my waste, to get rid of it.”</i></p> <p><i>“We use to have bins inside major populated areas like a dumpster bin and what was happening was that ‘I’m getting go down on the poverty, I’m afraid’ the unfortunate situation is that people dispose their dead bodies in these bins and so on and it was not great.”</i></p> |
| Industrial waste | Industries usually pay for waste collection services however, some few industries burn their waste on their premises. | <i>“We have large scale commercial such as banks, petrol stations and so on, they are placed as an industry. They use to come to us to arrange for their collections.”</i> |
| Informal recycler | Informal recyclers dismantle e-waste and sort dumpsite waste to take out sellable materials such as metals, plastics, PET, cardboard, aluminium and fabrics to sell as means of income. | <i>“At the landfill, we have the informal waste pickers and they do recycling, they do recovery of valuable fractions such as plastics, metals and cartoons, these are three main things they are looking for.”</i> |
| Insufficient waste facilities | Utilities such as power, water, roads, sorting stations, waste vehicles are important for | <i>“There is no any form of sort from the source system or MRFs in Ibadan now.”</i> |

| Code name | Description | Examples |
|----------------------------|--|---|
| | proper municipal waste management. A lot of recycling companies had started up but not actually operating because of irregular supply of electricity and high cost of fuel to power generators, so it ends up that the factory is full of waste and that becomes hazardous and causes environmental pollution. | <p><i>“There is only one TLS together with MRFs in the whole Lagos metropolis and this at Igando, Idimu in on local government.”</i></p> <p><i>“The management of waste is not profitable at all; the current financial and infrastructure we have in this country are not sustainable for waste business”</i></p> |
| Lagos collection 70% | 70% of municipal solid waste is being collected in the Lagos metropolis as highlighted by LAWMA. | <i>“There was a time when LAWMA stands as guarantor for PSP to obtain brand new Tata compactor from Sterling Bank. During this time LAWMA collected over 70% of waste generated, when I say over 70% it is not that we can’t collect the rest of 30% but there are some parts of the Lagos that the people will not give you their waste.”</i> |
| Low-income areas | The low-income area constitutes a larger part of the city. | <p><i>“You know Lagos social classification of people; we have low, very low-income areas, the Badiya, the Ijora of Lagos’s world. If you expect anybody to pay for refuse collection in those areas, you are just wasting your time.”</i></p> <p><i>“The slums and very poor areas where people can’t afford to pay for their waste, the government continues to pay PSP.”</i></p> |
| Medical waste | Medical waste is dumped on the dumpsites. | <i>“We have hydroclave machine, is stored at one of our local facility, where the medical waste is treated before they are eventually taken to the landfill sites.”</i> |
| Medium income areas | People that live in middle-income areas are either pay for waste collection or dump waste in the spaces in the city. | <i>“Household payment is based on property type and that is the type of measure we have.... there is low-medium, high-income areas that one pays.”</i> |
| Monitoring and Enforcement | The government has an enforcement strategy but it does not work better to curb dumping. | <p><i>“There are almost about 4 million people in Ibadan and we have 13 environmental officers in waste management.”</i></p> <p><i>“I think the laws are very good and the desire to enforce the laws is very good but the resources to do are not sufficient.”</i></p> |
| Not willing to pay | A larger percentage of households is not willing to pay for waste collection services. | <i>“One, is the attitude of our people, by attitude, I am mean our people still feel they do not have to pay for it.”</i> |
| Political context | Politicians influence laws for their ambition, people who break laws affiliate with | <i>“You know this is democracy and the government are lenient because of political</i> |

| Code name | Description | Examples |
|-----------------------|--|---|
| | politicians, no political will to do what will benefit the citizens. | <i>ambitions, may be when the private sector coming to play, might be more forceful. You know the government are always careful because electoral positions, at they will be harsh and the same time cool down and allow people to it wrongly”</i> |
| Private sector | PSP operators partner with Lagos Government LAWMA and Oyo state OYOWMA to collect waste in the metropolises. | <i>I think the new private company that is going to over the operation part of waste management in Lagos state (Vision Scape) have it plan to distribute more than 20,000 refuse bins across Lagos for a start.</i> |
| Recycling | Some forms of recycling activities have started in Lagos. 5 - 6 years ago, LAWMA started an incentive-based recycling programme to promote the recycling culture among people. | <i>“We have licensed a lot of people that are doing recycling and those waste they handle such PET bottles, can, cartoons and papers don’t get to dumpsite again.”</i> |
| Slums | Slums are within the metropolis and are usually not accessible by vehicles; people in the swamp slum area have other purposes for their waste than giving it out for collection. | <i>“We got to have to be careful, people in Beere (slum)Ibadan, they don’t have proper housing, how are we going to enforce proper bins? “ “These are people that live in the swampy areas in Lagos, they use their waste to fill the swamps around them, areas like Makoko, Obadi, Akala, sabo and the rest.”</i> |
| Social responsibility | There is an element of social responsibility that is required by all stakeholders involved in municipal solid waste management in the city. | <i>“It is just an individual thing, government has to play a big role, do their responsibility right, I’m sure people will comply.”</i> |
| Sorting | Nigeria’s first and currently only Material Recovery Facility for sorting waste is located in Lagos and the facility is facing the problem of irregular power supply which is crippling their performance. | <i>“When waste around that area is collected and put together, it will be dumped at TLS and sorted out and only what is remaining for disposal that will leave TLS to the dumpsites.”</i> |
| Space | There are many available spaces in the city to dump waste undetected. | <i>“....because they do feel they have not to pay so they look for every possibility and they take it to any available space in the city.”</i> |
| Stakeholders | Households and marketplaces generate a larger percentage of municipal solid waste; while informal recyclers, PSP and government waste agents manage the waste in disjointed management practices. | <i>“Lagos has the record of at least over 16 years we have been partnering with the private sector.” “Nigerian are very enterprising and there are a lot of what they called “bullyboys” that go around the house to house for</i> |

| Code name | Description | Examples |
|--------------------|--|--|
| | | <i>collecting electronic wastes and sort them themselves.”</i> |
| Technology | Adopting waste technical solutions from developed countries without considering local context is seen to be a setback. | <i>“We took the experience from what is happening outside there and try to adapt to our own local environment and it has been working for Lagos.”</i> |
| Terrain and access | Ibadan city is mainly unplanned, so road access is poor and also many areas in Lagos metropolis are not accessible by trucks. | <i>“Terrain and access is a big problem, I think the government over time has done one or two things to address....”</i> |
| Types of waste | There are different kinds of waste streams and types; organic waste represents the highest percentage of waste generated in Lagos and Ibadan. | <i>So the areas we are working, specific areas that we are working, we don't work in wastewater, we work in municipal solid waste, domestic, commercial, industrial and medical waste- hospital waste in Ibadan, Oyo state.”</i> |
| Waste composition | Lack of awareness of the importance of organic fertilizers among the farmers. Inorganic fertilizer is highly subsidized by the government. | <i>“I think it is just the acceptability, and then for people to now understand the health benefits of organic fertilizers. From my own perspective, I think farmers need more awareness on the use and benefits of organic fertilizers.”</i> |
| Waste process | Lagos city as well as Ibadan city is looking into building waste process facilities. | <i>“We aimed in the in next five years now. We are building MRFs to facilitate proper sorting and reduce the amount of waste that would be ending up in the dumpsites.”</i> |
| Waste service fee | Waste collection is not free in either city; however, the payment structure that the government is using is not uniform and not widely accepted by the citizens. | <i>We pay the government as well but a fixed price but not uniform because I think a room in Lagos is paying \$0.3 per month irrespective of whatever you are disposing of, while a flat with rooms will pay \$1-2 per month, even if it just two people in the household and a room might have up to seven people.”</i> <i>In Ibadan, high-income areas pay about 2000 naira (\$6), middle-income areas pay 1000 naira (\$3), low-income areas pay 500-800 naira (\$1-3) and very low-income area pays 200-300 naira (\$0.5- 0.8) per month for waste collection.”</i> |
| Waste value | Dumped waste is often sorted for sellable materials by the waste pickers who are constantly present on the dumpsites. Waste is providing some form of income and | <i>“There is a lot of money in waste and then more jobs will be created.....we just need the right administrative and legal framework to do that.”</i> |

| Code name | Description | Examples |
|------------|--|---|
| | empowerment for people, but there is still a lot to be done to promote waste as a resource in Nigeria. | |
| Wastewater | Wastewater is not covered in this research; however, some interesting insights on wastewater especially faecal sludge were obtained during the fieldwork that may be of interest for further research. | <i>“We use a septic tank and when it is full, we call the tanker and they will just bring their vehicle to evacuate it. Well, I didn’t know how they handle it but I do hear that they dispose of it into the big rivers like the lagoon. That is what I used to hear but I have never seen it with my own eyes.”</i> |

Appendix D

The export list of theme clustered by codes similarity using Jaccard's coefficient

| Code A | Code B | Jaccard's coefficient |
|---|---|------------------------------|
| Nodes\\Poverty | Nodes\\Household behaviours | 0.202 |
| Nodes\\Household behaviours | Nodes\\Attitude | 0.194 |
| Nodes\\Poor governance | Nodes\\Household behaviours | 0.178 |
| Nodes\\Technology | Nodes\\Lack of awareness and engagement | 0.171 |
| Nodes\\Waste value | Nodes\\Monitoring and Enforcement | 0.168 |
| Nodes\\Monitoring and Enforcement | Nodes\\Household behaviours | 0.167 |
| Nodes\\Poor governance | Nodes\\Monitoring and Enforcement | 0.155 |
| Nodes\\Poor infrastructure | Nodes\\Poor governance | 0.154 |
| Nodes\\Waste value | Nodes\\Technology | 0.147 |
| Nodes\\Poor infrastructure | Nodes\\Monitoring and Enforcement | 0.147 |
| Nodes\\Lack of awareness and engagement | Nodes\\Attitude | 0.147 |
| Nodes\\Waste value | Nodes\\Lack of awareness and engagement | 0.146 |
| Nodes\\Poor infrastructure | Nodes\\Household behaviours | 0.145 |
| Nodes\\Poor infrastructure | Nodes\\Attitude | 0.140 |
| Nodes\\Poor governance | Nodes\\Attitude | 0.135 |
| Nodes\\Monitoring and Enforcement | Nodes\\Attitude | 0.134 |
| Nodes\\Technology | Nodes\\Poor infrastructure | 0.129 |
| Nodes\\Poverty | Nodes\\Attitude | 0.128 |
| Nodes\\Poverty | Nodes\\Poor infrastructure | 0.127 |
| Nodes\\Monitoring and Enforcement | Nodes\\Lack of awareness and engagement | 0.127 |
| Nodes\\Poverty | Nodes\\Poor governance | 0.120 |
| Nodes\\Lack of awareness and engagement | Nodes\\Household behaviours | 0.119 |
| Nodes\\Poor infrastructure | Nodes\\Lack of awareness and engagement | 0.119 |

| | | |
|------------------------|---|-------|
| Nodes\\Poverty | Nodes\\Monitoring and Enforcement | 0.118 |
| Nodes\\Technology | Nodes\\Monitoring and Enforcement | 0.113 |
| Nodes\\Waste value | Nodes\\Poor governance | 0.109 |
| Nodes\\Poor governance | Nodes\\Lack of awareness and engagement | 0.108 |
| Nodes\\Technology | Nodes\\Attitude | 0.107 |
| Nodes\\Technology | Nodes\\Household behaviours | 0.101 |
| Nodes\\Poverty | Nodes\\Lack of awareness and engagement | 0.097 |
| Nodes\\Technology | Nodes\\Poor governance | 0.094 |
| Nodes\\Technology | Nodes\\Poverty | 0.085 |
| Nodes\\Waste value | Nodes\\Poor infrastructure | 0.083 |
| Nodes\\Waste value | Nodes\\Attitude | 0.078 |
| Nodes\\Waste value | Nodes\\Poverty | 0.076 |
| Nodes\\Waste value | Nodes\\Household behaviours | 0.072 |

Appendix E

Nvivo software: Word Frequency Query

| Word | Length | Count | Weighted Percentage (%) |
|-------------|--------|-------|-------------------------|
| waste | 5 | 273 | 4.21 |
| people | 6 | 128 | 1.97 |
| government | 10 | 92 | 1.42 |
| household | 9 | 49 | 0.75 |
| think | 5 | 46 | 0.71 |
| dumpsite | 8 | 43 | 0.66 |
| lagos | 5 | 42 | 0.65 |
| politicians | 11 | 35 | 0.54 |
| still | 5 | 35 | 0.54 |
| enforcement | 11 | 34 | 0.52 |
| ibadan | 6 | 32 | 0.49 |
| management | 10 | 32 | 0.49 |
| areas | 5 | 29 | 0.45 |
| awareness | 9 | 29 | 0.45 |
| income | 6 | 29 | 0.45 |
| every | 5 | 28 | 0.43 |
| going | 5 | 27 | 0.42 |
| sorting | 7 | 26 | 0.40 |
| thing | 5 | 26 | 0.40 |
| collection | 10 | 25 | 0.39 |

Nvivo Software: Matrix Theme Query

| Theme | A : Interviewees Lagos | B : Interviewees Ibadan |
|--------------------------------------|------------------------|-------------------------|
| 1 : Attitude | 7 | 5 |
| 2 : Household behaviours | 10 | 7 |
| 3 : Lack of awareness and engagement | 8 | 3 |
| 4 : Monitoring and Enforcement | 1 | 4 |
| 5 : Poor governance | 12 | 8 |
| 6 : Poor infrastructure | 5 | 2 |
| 7 : Poverty | 7 | 2 |
| 8 : Technology | 5 | 0 |
| 9 : Waste types | 7 | 0 |
| 10 : Waste value | 5 | 6 |

Appendix F

Pseudo code

The NetLogo world in this model is divided into three quadrants representing the three residential patterns in the metropolis city of Lagos. The major physical features of the city such as rivers, Lagoon, slum and bridges are excluded from the model to avoid the unnecessary background that are not related to the code and to avoid the model getting messy.

The simulation is to help visualise how each residential areas behave based on the attributes of households and infrastructure available in their area and to demonstrate how a collaboration can be built up among the key stakeholders in MSW system in the city.

| Agent | Attribute | Description |
|------------|--|---|
| Households | <ul style="list-style-type: none"> Income Residence Hygiene consciousness | Waste disposal attitude is based on income level, hygiene and residential area of a household. Households can either pay waste to be collected or dump in open spaces or use community dumpsters |
| Collectors | <ul style="list-style-type: none"> Payment Road accessibility | Where there is road accessibility and payment, waste collector goes to the household that met the conditions and collect the waste |
| Officers | <ul style="list-style-type: none"> Number of officers | Officers go residential areas to change attitudes of the households and monitoring the waste disposal situation in the city thereby, increase the hygiene consciousness of households in the area |

Initialize total households population in each residential area

```

Set high-residential 60 per cent of population
Set medium-residential 30 per cent of population
Set low-residential 10 per cent of population
set households colour green
If household "bin waste"
Set colour blue

```

Create open-spaces

```

Set open-spaces in each residential area
Ask open-spaces set colour red

```

Create dumpsters

```

Set dumpsters in high-residential
Ask dumpsters set colour black

```

1. Set households hygiene to random 10

Ask households at low-residential (**high income**)

If hygiene is greater than or equal to 5

```

"bin waste " (bin on the same patch where the household is)

```

else

```

"dump waste " in open-space in my residential area
accumulate waste in open-space

```

Ask households at medium-residential (**medium income**)

If hygiene is greater than or equal to 5

“bin waste “

else

*“dump waste “ in open-space in my residential area
accumulate waste in open-space*

Ask households at high-residential (**low income**)

If hygiene is greater than or equal to 5

use “community dumpsters “

else

*“dump waste “ in open-space in my residential area
accumulate waste in open-space*

2. Set road accessibility random-float between 0 and 1

If road accessibility is greater than or equal to 0.5

Collector moves to household

Collect “bin waste”

else

turn back

3. Set waste capacity for open-spaces

Ask household neighbours influence each other

If accumulate waste in open-spaces in my residential area is greater than waste capacity

hygiene decreases by one

else

hygiene increases by one

4. Officers move randomly in the city

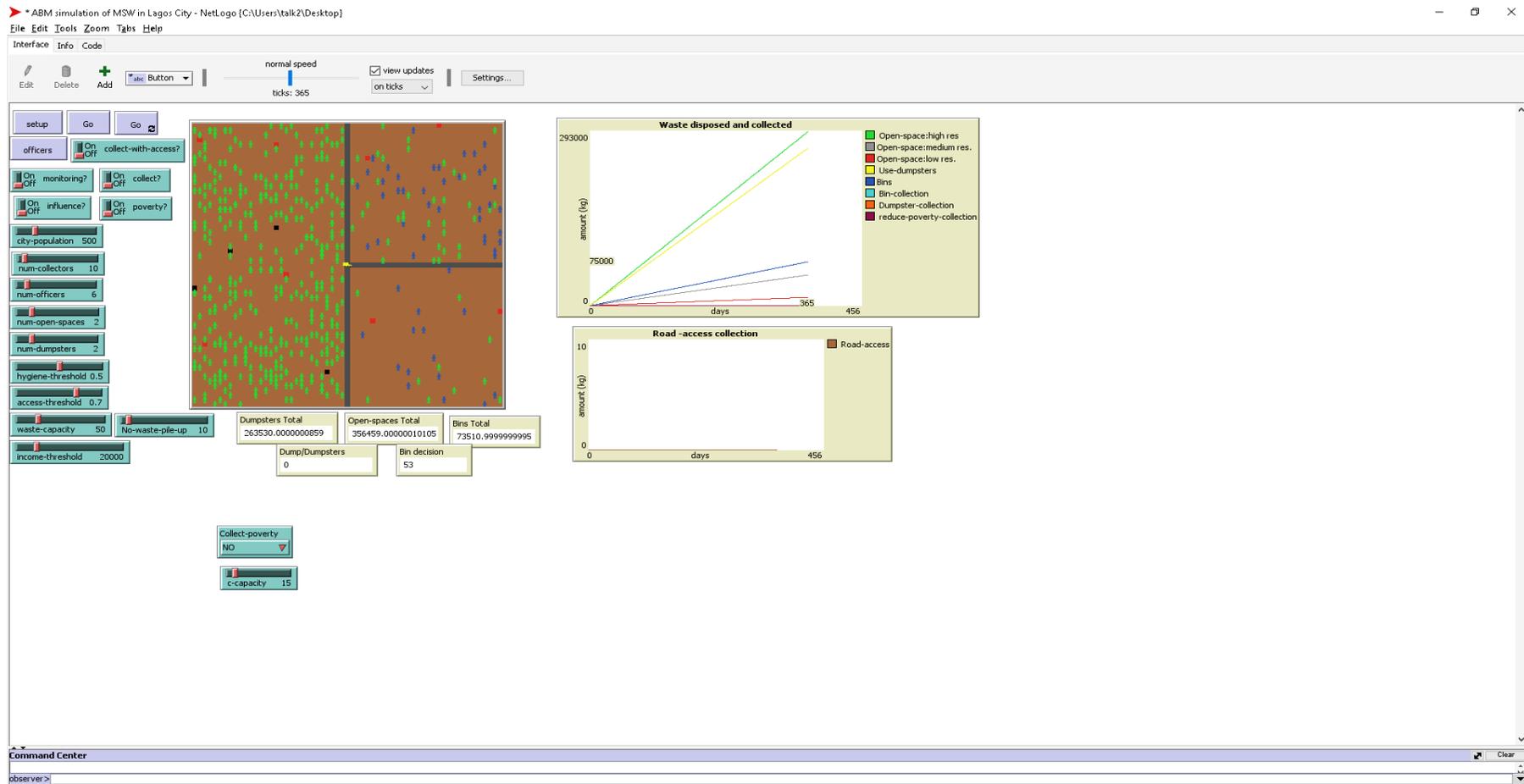
If officer at this household

hygiene increases by one

else

hygiene remain the same

The screenshots of AB-model simulation interface for each scenario.



ABM simulation of MSW in Lagos City - NetLogo [C:\User\talk2\Desktop]

File Edit Tools Zoom Tabs Help

Interface Info Code

normal speed ticks: 305 view updates on ticks Settings

setup Go Go

officers collect-with-access?

monitoring? collect?

influence? poverty?

city-population 500

num-collectors 10

num-officers 6

num-open-spaces 2

num-dumpsters 2

hygiene-threshold 0.5

access-threshold 0.7

waste-capacity 50

income-threshold 20000

No-waste-pile-up 10

Dumpsters Total 0

Open-spaces Total 224267.000000071

Bins Total 615.6

Dump/Dumpsters 0

Bin decision 45

Collect-poverty NO

c-capacity 15

Waste disposed and collected

Road-access collection

Command Center

observer >

ABM simulation of MSW in Lagos City - NetLogo [C:\Users\talk2\Desktop]

File Edit Tools Zoom Tabs Help

Interface Info Code

normal speed
ticks: 365

view updates on ticks

Settings

setup Go Go

officers collect-with-access?

monitoring? collect?

influence? poverty?

city-population 500

num-collectors 10

num-officers 6

num-open-spaces 2

num-dumpsters 2

hygiene-threshold 0.5

access-threshold 0.7

waste-capacity 50 No-waste-pile-up 10

income-threshold 20000

Dumpsters Total 291270.00000010495

Open-spaces Total 230106.00000000196

Bins Total 37521.19999999973

Dump/Dumpsters 0

Bin decision 52

Collect poverty NO

c-capacity 15

Waste disposed and collected

Road-access collection

Command Center

observer>

normal speed
ticks: 365 view updates on ticks

setup Go Go

officers collect-with-access?

monitoring? collect?

influence? poverty?

city-population 500

num-collectors 10

num-officers 4

num-open-spaces 2

num-dumpsters 2

hygiene-threshold 0.5

access-threshold 0.7

waste-capacity 50 No-waste-pile-up 10

income-threshold 20000

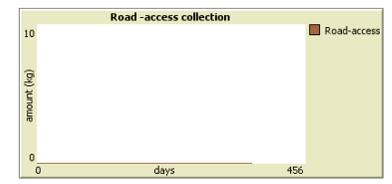
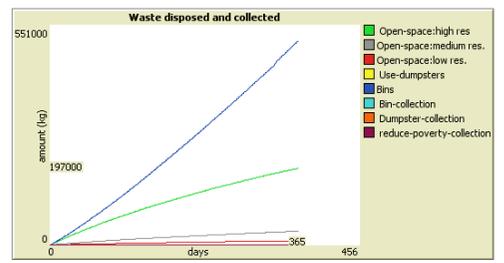
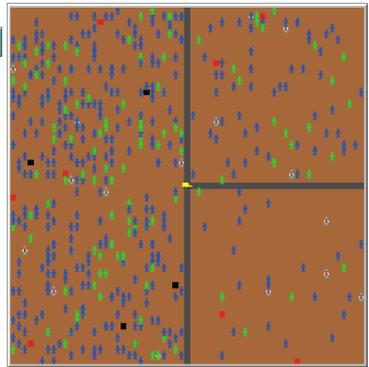
Dumpsters Total 725.80000000000004

Open-spaces Total 236.27640000002674

Bins Total 5108.263999999992

Dump/Dumpsters 0

Bin decision 384



Collect-poverty NO

c-capacity 15

Command Center

observer>

Edt Delete Add | normal speed | view updates | Settings...
ticks: 365 | on ticks

setup Go Go

officers collect-with-access?

monitoring? collect?

influence? poverty?

city-population 500

num-collectors 10

num-officers 6

num-open-spaces 2

num-dumpsters 2

hygiene-threshold 0.5

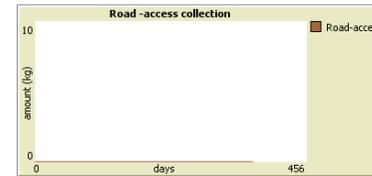
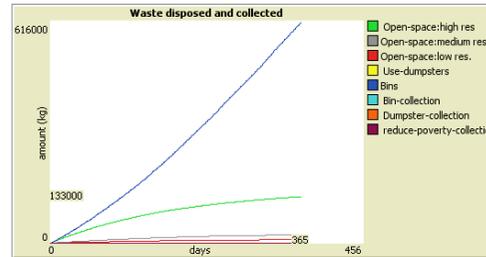
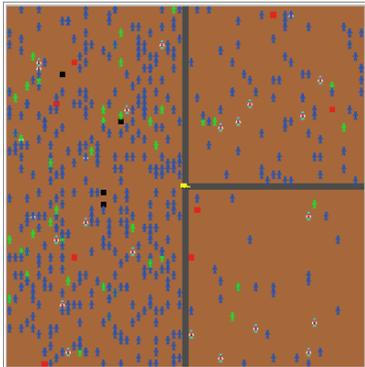
access-threshold 0.7

waste-capacity 50 No-waste-pile-up 10

income-threshold 20000

| | | |
|-------------------|-------------------|-------------------|
| Dumpsters Total | Open-spaces Total | Bins Total |
| 741.0000000000008 | 161131.4000000692 | 610238.1999999986 |

Dump/Dumpsters 0 Bin decision 458



Collect-poverty NO

c-capacity 15

Towards integrated solid waste management in Nigerian cities: a field survey

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Municipal waste management practice in Nigeria has been a persistent problem for many decades, with sustainable waste management seemingly a long way off. Solid waste is often seen piled on roads and open spaces, blocking drainage channels and in water bodies. Whilst there has been previous research, most of this has focused on proposed technical solutions to the problem.

Our research aims to investigate how an inclusive approach can be developed, encompassing social, environmental and regulatory factors as well as purely technical issues. To better assess the fundamental factors to the problem, a field data collection has been carried out by means of semi-structured interviews conducted with government agencies on waste management in Ibadan and Lagos, Nigeria, together with householders and small business operators. These have been subjected to a thematic analysis using the NVivo software.

The analysis of data shows income as a determinant to household decisions, whilst poor road accessibility affects collection services. Moreover, an inadequate regulatory framework and enforcement result in a lack of interest by the private sector in investing in waste management. A further consideration is the influence of residential area cleanliness on the disposal behaviour of households. The dirtier a neighbourhood, the higher the dumping rate in that neighbourhood, creating a path dependency in which small differences in behaviour can lead to much more significant results in time.

In view of these interconnected problems, adequate monitoring by the regulatory officers and improved road accessibility for waste collection services can encourage household commitment to sustainable waste management practices.

To develop further understanding, an Agent-Based Model of waste management is being developed. This can incorporate relevant social factors and will allow path dependency to be modelled. It will test our hypothesis that increasing stakeholder involvement and commitment to sustainable waste management will result in significant improvement.

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Mobilities and municipal waste in Nigerian cities: an illustration using Agent-Based Modelling.

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The management of municipal waste in cities involves mobility: waste must be moved from its source within residential and industrial areas to an ultimate destination at a recycling or disposal facility. Waste management in Nigerian cities has been a very significant problem for many decades. A large amount of the waste generated in most of the cities ends up in illegal spaces such as on the streets and in water bodies, causing health and safety risks for people and the environment.

A field survey consisting of interviews with householders and other stakeholders in Lagos and Ibadan was carried out to gain a deeper understanding of the factors causing illegal dumping of waste across the cities. It was found that socio-economic status of the household, which has a clear spatial dimension related to place of residence, coupled with the lack of accessible roads to allow mobility, the lack of waste handling facilities, insufficient resources for monitoring and unenforced regulation were the fundamental issues which underly the problem

An agent-based model (ABM) of waste management in Lagos, Nigeria has been constructed and tested to determine the effect of increasing the provision of regulatory officers. Mobility is represented in the model by the movement of officers and the consequent effect on the households nearby, officers and households being represented as geographically located agents in the model.

Test runs of this model show that an increase in regulatory officers from ten to 50 causes a 50% reduction in open dumping of waste in the city.

It is concluded that ABM is a promising approach to understanding and improving waste management in Nigerian cities. It is able to model existing trends evident from fieldwork and to test alternative management scenarios for municipal solid waste practices.