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Municipal solid waste management in developing countries.

Case study: Lagos, Nigeria

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<p>Waste is a global issue and if not properly handled, it poses a threat to the environment and public health. Waste is generally linked to the way society produces and consumes and should be of concern to everyone. Waste is one of the biggest challenges society is grappling with in the 21st century, especially urban centres. As such waste management is a necessity for humans.</p> <p>The aim of this thesis is to study waste management and the challenges it poses to developing countries. The thesis discussed solid waste management, sanitation, and provision of food, energy, transport and potable water which is beneficial to the society. The thesis addresses the consequences of doing nothing and the cost of managing waste. It examines what has been done to solve the waste challenges in Lagos, Nigeria. Lagos state, Nigeria as one of the most populated cities in Africa, with huge tonnes of organic waste. Hence, it is very important and ethical to have a comprehensive waste management strategy. Due to lack of equipment, adequate funding, the sector has been plagued with inefficiency.</p>	
Keywords	E-waste, Kilovolt Ampere, Energy plant, Scavengers, Biogas, Landfill, Anaerobic digestion,

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LIST OF ABBREVIATIONS AND UNITS

AD Anaerobic digestion

EPA	Environmental protection agency
FEPA	Federal Environment Protection Agency
GDP	Gross Domestic Product
GNI	Gross National Income
KVA	Kilovolt Ampere
KAI	Kick against indiscipline
LSG	Lagos state Government
LAWMA	Lagos waste management authority
LGA	Local Government Area
MSW	Municipal solid waste
MSWM	Municipal solid waste management
PPP	Public private partnership
PSP	Private sector participant
SWM	Solid waste management
UNEP	United Nation Environment Program

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1. Introduction

The term solid waste management is the process of collection, treatment and recycling of solid waste in a sustainable manner to avoid the adverse effect on the environment (1). The problem of waste management has been an issue since human existence, the challenge of how to better transform this waste into a valuable product is referred to as waste management. Since the industrial revolution, waste has become a challenge to every society. With the technological advancement and better standard of living industrialization has brought, there this is also problem we have to deal with, which is waste management. Solid waste management should be taken seriously by everyone, both household, businesses, industries as well as the government. There are various sources of solid waste, they include household waste, industrial, commercial, construction and demolition, treatment plants and sites, agriculture and medical waste (2). This thesis focuses on the collection, transportation and recycling of solid waste and the whole value chain of waste management from disposal to treatment. It also discusses policies and legislation of municipal waste management using Lagos state, Nigeria as a case study. Furthermore, this thesis discusses the process of waste recycling and disposal. It is written from the point of view of low- and middle-income countries, such as Nigeria, which is a developing country.

The main focus is on municipal solid waste which includes waste from food and kitchen, recyclable materials (such as paper, tin cans, metals, cardboard, glass), electrical waste (light bulbs, computers, electrical appliance etc.), other types of waste like hazardous waste, agricultural waste and also waste from larger industries are not discussed.

2 Description of solid waste management in Nigeria

In Nigeria, solid waste management functions is divided into three stages: the federal, state and local government. The ministry of Environment at the federal level is charged with overseeing all environmental concerns (9), hence they play a huge role in providing a healthier environment for the country. Their functions are complemented by a sister agency called the National Environmental standards and Regulations agency. Before 1999, all environmental matters were handled by the federal Environmental Protection

Agency (FEPA). Despite all these bodies, the problem of managing waste is still a herculean task, hence sovereignty was granted to states to allow them create smaller agencies to better reach most communities at the grassroots level. Figure 1 below shows the map of Nigeria.

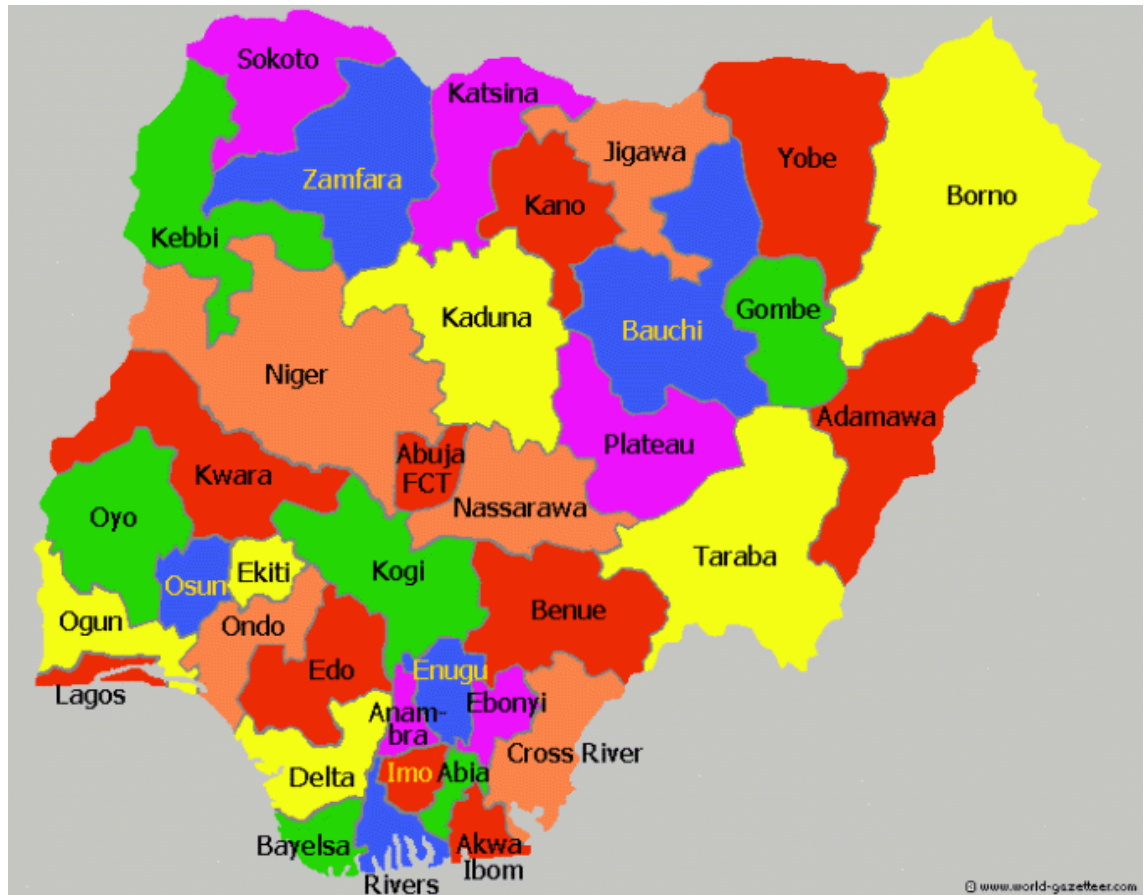


Figure 1: Map of Nigeria, taken from Google images

From that period onwards, solid waste management has been the function of the local government. Efficiency in carrying out this task was an issue, which is obvious from large chunk of garbage sites seen from on streets across major cities in the country.

Nigeria has been facing the problem of managing its waste for a long time now and successive governments are yet to find a solution to this environmental menace. Hence, the need for a strategic approach to solving this problem is urgent. This could involve a strict implementation of all the existing environmental laws, improvement in the use of

technology to track waste collection from household, businesses and also implementation of the hierarchy of waste management, which is collection, transport and deposition.

2.1 Municipal waste generation in Lagos

Waste generation in Lagos, with a population of over 23 million in 2015 was about 13,000 metric tons per day, the average waste generated per person was estimated at 0.5kg/person /day (6). Organic waste components account for more than 50% of the waste generated, it varies from other states in the country.

Figure 2 and 3 below shows waste components in Lagos and the percentage of waste components respectively.

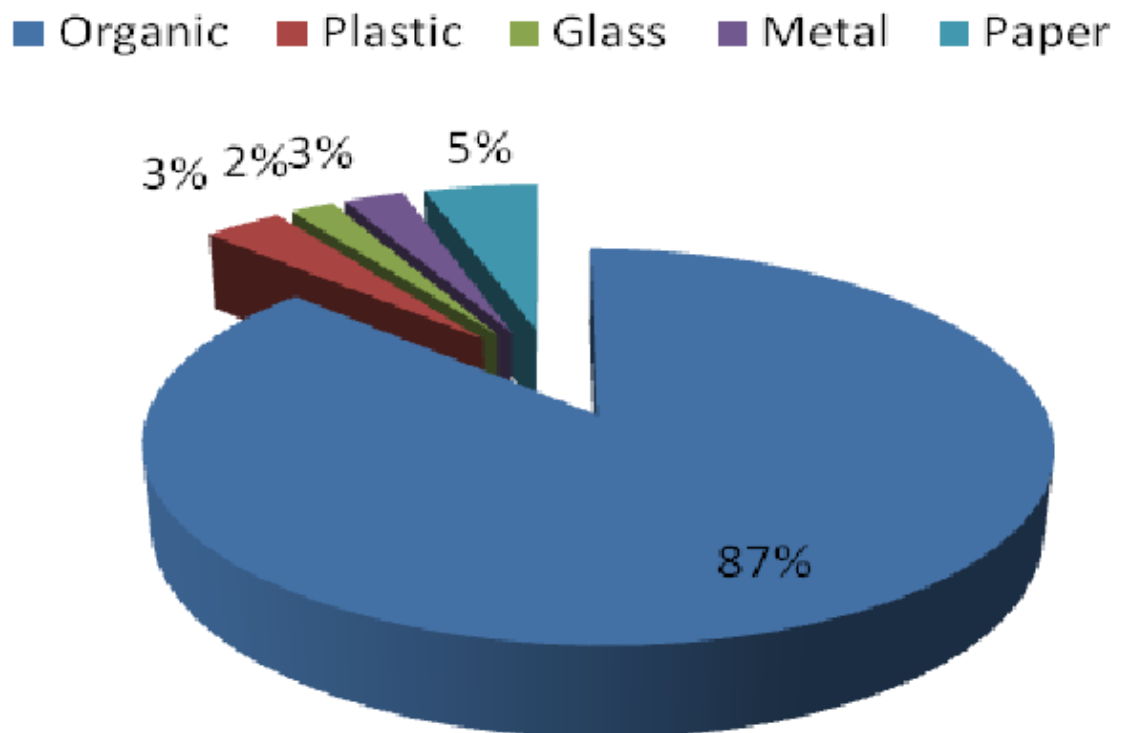


Figure 2: showing different waste components in Lagos (source LAWMA)

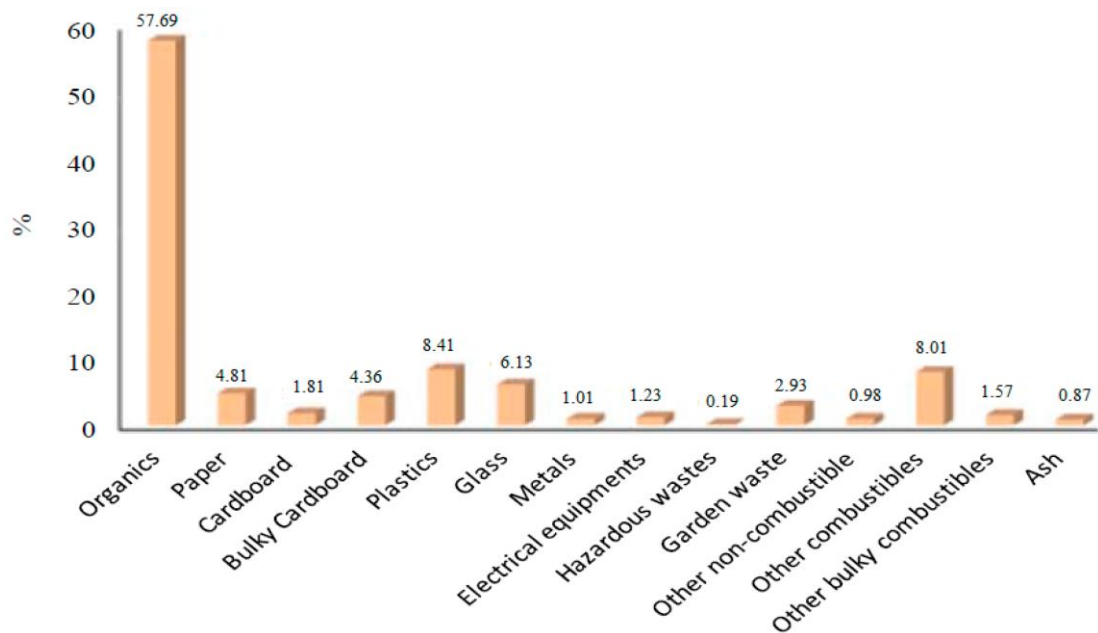


Figure 3: Percentage of waste components in Lagos, Nigeria (LAWMA)

A survey carried out in March 2012 by the Bayero University in Kano, estimated the waste composition in Nigeria as over 70% organic, while the other components such as polythene, papers, metal, glass and plastics share the remaining percentages. Another study by Basel convention center for Africa suggests that most imports to Africa were used electronic equipment and over 30% of it is described as E-waste (9).

Overall, waste are stored in a plastic container and plastics bins. LAWMA provides household with a 240 liter bin container for storing waste (6).

2.2 Waste collection and transport

Waste collection should be operated in an integrated way, which means the hierarchy of waste management should be designed in a sustainable manner to enable the compatibility of all components. For example the truck used for collection of waste should fit the type of container used to store the waste , also when recycling is done care should be taken to avoid contaminating the material being recycled . If waste is to be deposited in

a landfill, the collection truck should be compactible for transporting the waste to the landfill. This thesis discusses the timing of the collection of the waste and also considers the point of collection – where the waste is transferred from the household to the equipment of the collection agency (1) and then present the methods used to load and transport the waste to the next stage. Residents are less concerned about the frequency of collection from their storage points or containers, (1) but if the wastes are littered over the street, resident in the area might set fire on the waste, which will lead to pollution of the environment (1). Figure 4 below shows a collection site in the street of Lagos.



Figure 4: Shows a collection site in the streets of Lagos



Figure 5: waste collection container (source LAWMA)

Cost is a factor to consider in waste management hierarchy, collection of smaller quantities of waste on many occasion will be expensive but the cost can be reduced if primary collection is employed, this is peculiar to low income areas. Frequency of collection is useful to household if they transport their waste with a smaller container, to a collection point. Also waste should not be left in steel containers for a long time, this may result in corrosion. Reliability is also considered, waste collectors must adhere to a strict time table for collecting waste from household and businesses, but adjustment are made during public holidays, but waste generators must be informed in advance. Waste collection is done mainly at daylight hours, in some cases at night due to traffic congestion in some streets during day hours.

The Cleaner Lagos Initiative was signed into law on the 1st of March 2017, and will now control waste collection operations within the state (6) The role of LAWMA was changed to a regulatory agency to oversee the entire waste management sector. There are over

400 approved waste collection operators assigned to collect commercial waste from non-household, which is schools, religious centers, and industries. Visions Scape Sanitation Company is now charged with residential waste collection in Lagos state (6).

2.3 Recycling

The current state of waste disposal, treatment and recycling in low wage countries is ineffective. The definition of recycling has been limited to the process of converting material gotten from waste to be re-used, but is much broader than that (3). Recycling is termed any process of returning waste material back to the economy. Recycling encompasses all the components of waste management for example, composting can be regarded as a recycling when market is readily available for the products (2). Incineration is also considered a recycling as well as disposal (open dumping and landfilling). The most important part of recycling is to ensure there is minimal impact on the environment.

2.3.1 Recycling by the informal sector

Recycling by the informal sector is mainly for economic reasons, which is different from the formal sector. Youths in local communities mainly engage in these activities for sustenance and this is common in developing countries. The formal sector recycling is much more complex and technologically advanced. Recycling activities in the informal sector have focused more on some particular kind of waste materials for recycling and this has been very innovative, due to the activities of the informal sector, the formal sector has partnered with states in the country (Nigeria) to improve on this innovation. Recycling activities in Lagos state includes; the compost plant at Ikorodu, Waste to energy plant at Ikosi market (this generate biogas which is used to power 2KVA generator), recycling plant at Olushosun for plastics recycling (6). Informal recycling activities has played an important role in waste management across the state. This sectors consist of

waste buyers and scavengers. They constantly search for useful waste materials which includes; glass, disposed electrical equipment, metals and plastics. The activities of scavengers have led to the reduction of waste disposed to landfill, because they are been reuse. LAWMA introduced recycling banks, a system designed to encourage deposit of recyclable materials like plastics, bottles, cans. Scavengers have been employed in these recycling banks as resource managers (6). Apart from the wage they are paid by the government, they are permitted to take these recycled materials .The wages they receive discourage them from working at the dumpsites which is good for their health. However, the number of recycling banks is insufficient to cater for the number of scavengers in the cities, hence, some of them are still allowed to scavenge materials at the site but are encouraged to use protective equipment (7) .Table 1 and Figure 6 below show a chat of the quality of life of scavengers and scavengers at a dumpsite respectively.

	Income level (in Nigerian naira)	Housing quality	Water/sanitation ^a	Safety/security	Transportation	Health services	Recreational facilities	Education
Main social indicators	1–2000 (66.9%)	1–2 rooms (90.8%)	Borehole (89.8%) Sachet water (70.6%)	Not guaranteed	Human portage (80%)	Drug stores/self-treatment (79.2%)	Nil	Secondary (42.9%)
Public perception of pickers	Hard-working (11.8%)	Dirty (12.5%)	Mad (30.3%)	Criminal (2.0%)	Mistrust (15.6%)	Business people (2.3%)	Lower class (15.1%)	Don't know (10.4%)
Pickers' quality of life expectation	Decent work	Free education	Medicare	Affordable housing/facilities	Improved standard of living	Lower living cost	Safety/security empowerment	
Potential outcomes	Improved solid waste management		Improvement in pickers' quality of life	Reduction of poverty in the informal recycling sector		Sustainable urban livelihoods		

Source: Nzeadibe, Anyadike, and Njoku-Tony (2012).

^aMultiple response.

Table 1: Quality of life of scavengers (waste pickers in Lagos)



Figure 6: shows scavengers at a dumpsite in Lagos (Reuters)

2.4 Treatment

Waste treatment is one of the stages of waste management component that ensures the least impact on the environment. Types of waste treatment includes among others, incineration and landfilling. Incineration is the combustion of organic substance while landfilling is a site for disposal of waste material. Both of these will be discussed later.

2.5 Reuse

Reuse is another hierarchy of solid waste management. It is the act of employing a material after its first use, either for the same purpose or a different one altogether. Reuse is a very important concept because it actually reduces the amount

of waste in the economy, but the process is costly because the material to be reuse must be of high quality.

2.6 Case of Lagos State

The agency responsible for SWM in Lagos is the Lagos State Waste Management agency (LAWMA). In the late 70`s the act for the creation of refuse disposal board was enacted. It later became the Lagos State Waste Disposal board, ever since then the need to better handle the challenges of sustainable waste management has been on the table, hence the establishment of LAWMA. Before now there have been inefficiencies in Lagos MSWM which includes lack of funding, indiscriminate waste disposal by household, lack of institutional framework, corrupt practices among others. However the positive side of the cooperation between LAWMA and private operators has led to increased efficiency in the system. The engagement of the private sector under the PSP scheme was a success.

2.7 Disposal

Disposal of waste in Lagos is mainly by landfilling. The state has three landfill and two dumpsites for all MSW. They are the Olushosun landfill located in Ikeja LGA, it has been in existence since 1992 (LAWMA), the second is at Abule -Egba, and the third located at Alimosho LGA (6). With the giant strides made in MSWM, there is still a lack of an integrated approach to SWM, which is mostly seen in the developed countries. More attention have been paid to the landfilling and dumping, neglecting the more urgent area of collection and transporting of waste. It is therefore important for the government to provide more resources at that end of the value chain.

3 Policies and legislation of municipal waste management

Environmental legislation are rules and regulations to protect the environment. These laws can be in form of fines, imprisonment which are enforced against persons who infringe on the laws. In Nigeria, the most common environmental problems arise from oil exploration, deforestation and industrialization. This legislation must be enforced to fulfil their desired result, but this is not the case. In Nigeria, enforcement and implementation have been a major problem, there is always a political consideration and social status in implementing these laws. These environmental laws are enshrined in the 1999 constitution of the federal Republic of Nigeria, which is to protect and improve the environment and safeguard the water, air and land forest and wild life in the country (7). The first enactment that comes to mind is the act establishing FEPA in the year 1988. It was vested with the authority to protect the environment. In 1992, degree no 86 was enacted to complement the role of FEPA.

3.1 Role of the private sector

The private sector has played a huge role in MSWM in Nigeria. It is important to understand why they play such an integral role in the country. The following list suggest some common reasons.

1. The government needs a more efficient waste management strategy which can be better provided by the private sector.
2. The failure of municipalities in waste management, the private Sector have has filled the vacuum.

3. Cost is also key, as the private sector spends less on waste collection
Due to less corruption in the system.
4. There is less Bureaucracy in private sector administration hence faster
Decision is taken.
5. There is also access to expertise and trained personnel.

3.2 Role of the community members

Community participation is the process where community members are involved in the SWM with the purpose of achieving a set of goals. For example, local authorities lack adequate funding for effective waste management, due to this the community members can make contribution to help bridge the gap in funding due to this. The community will be involved in the decision making process. Community participation is also key to initiate strategies for improving sanitation. Above all the community members also keep the surrounding clean by proper disposal of their waste in collection containers, separation of different waste components for effective recycling. Individuals can also organize awareness campaigns and meetings.

3.3 Financing mechanism

Waste management financing in Lagos, Nigeria is undertaken by vision Scape Company under a public private partnership PPP agreement. This involve a long term contract and it's beneficial to both parties

3.3.1 Cost and benefits

Waste management expenditure are competing with investments in health, education and other infrastructure, thus weighing the relative benefits to society becomes crucial.

MSWM expenditure is always not considered as misused because of its benefits to the society as a whole, apart from its legal requirement it also makes economic sense. Because the adverse effect of indiscriminant waste disposal to the environment is a huge cost. However, in cases where waste management is failing, environmental impacts of waste are much greater. It is important that policy makers prioritize the cost of developing a sound waste management system rather than bearing the huge cost of inaction.

The benefits of sound environmental waste management systems to the economy and the environment cannot be over emphasized, apart from adding to the GNI or GDP, it also makes people live healthier.

4. Waste treatment technologies

Composting is a waste treatment technology that involves the process of recycling organic materials (waste products) to produce soil conditioner (10). Compost contains nutrient which is beneficial to the land and also serves as a form of fertilizer to plants. Composting is an aged technology which is still being used.

4.1 Uses and markets for compost

When landfills get filled up, with the ban of organic waste another means of organic waste management is composting. Composting can replace materials such as topsoil, as seed starters, container mixes, peat etc. There is a growing demand for compost because of its use in agriculture.

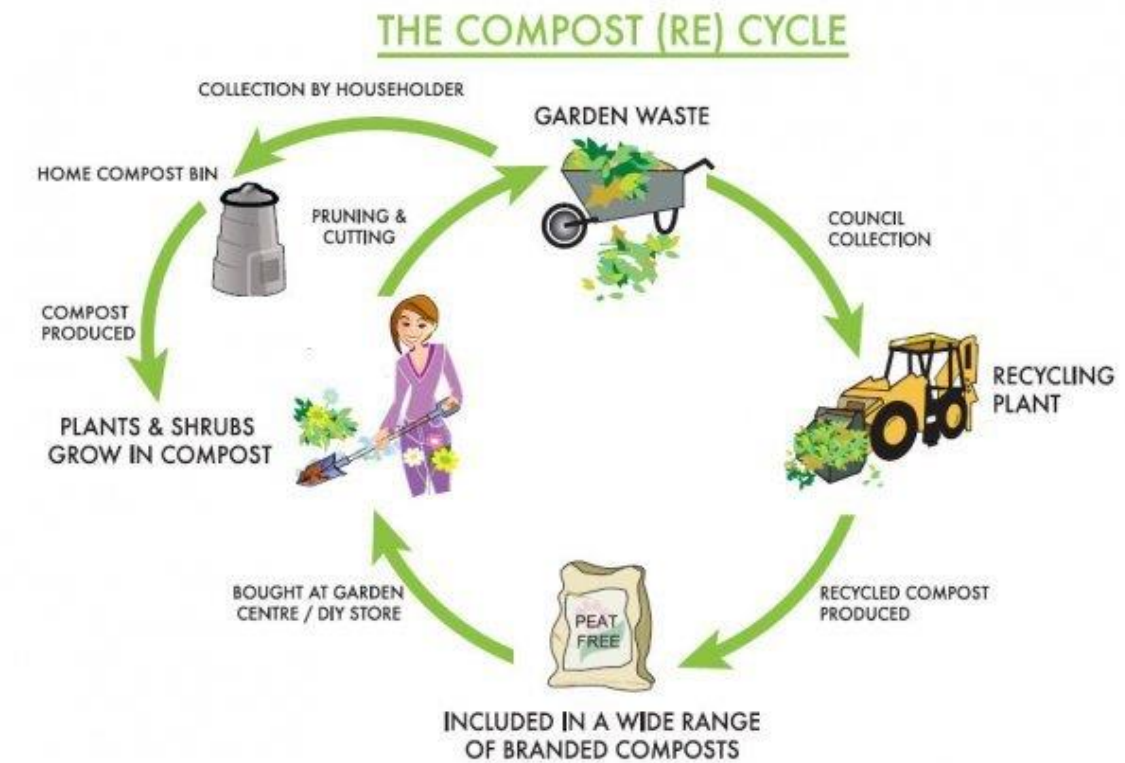


Figure 7: waste composting plant

4.2 Benefits of adding compost to soils

The capacity to improve the features of the soil which are physical, biological and chemical. Adding compost to soil increases the fertility and can reduce fertilizer requirement. The figure 8 below shows the stages of food waste composting.



Figure 8: Stages of food waste composting (source: google images)

4.3 Aerobic vs. anaerobic composting

Compost occurs either aerobically (with oxygen) or anaerobically (without oxygen) when organic materials are mixed and piled together. Aerobic composting is the most efficient form of decomposition, and produces finished compost in the shortest time. If the proper amounts of food (carbon), nutrients, water and air are provided, aerobic organisms will dominate the compost pile and decompose the raw organic materials most efficiently (11). Table 9 below, show the stages of anaerobic digestion.

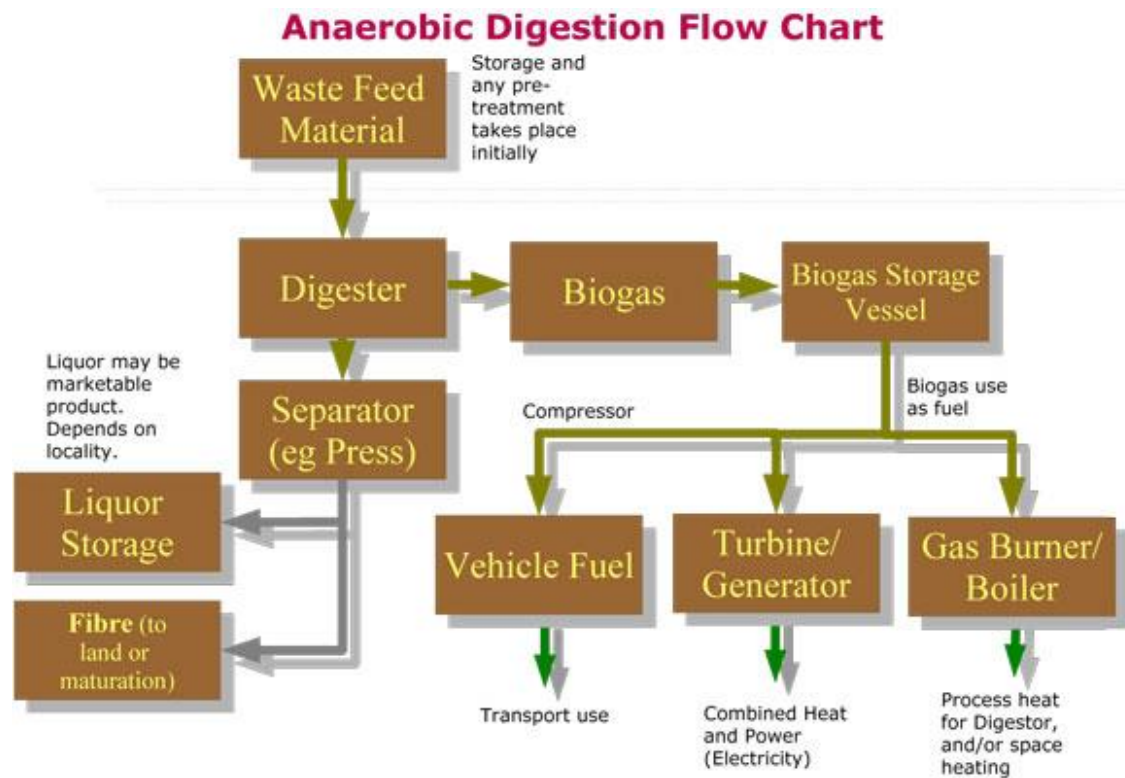


Figure 9: process diagram of an anaerobic digestion process

5 Incineration

Incineration is the process of combusting organic components contained in waste materials. It is not an effective or sustainable SWM option, because of the high moisture content and low calorie value of organic waste (9), it is therefore not recommended for use in Lagos. Figure 10 below shows a waste incineration site in Lagos.



Figure 10: Indiscriminate waste incineration site in Lagos (source: Bio Energy consult)

6 Clean Lagos Initiative Goals

The goals of the Clean Lagos initiative was to improve the living condition of all citizens in the state through the provision of clean water, cleaner and safer environment. It also aims at providing funding for hiring and training community sanitation workers to better meet the needs of local community. Other goals are to ensure that in public areas, people stop littering and engage in improper disposal of waste in drainage systems.

7 Conclusion

Waste management in developing countries has been a critical problem for most governments including Nigeria, hence the need for a holistic approach to this environmental menace. Lagos state, Nigeria has taken the lead in this regard, apart from the establishment of LAWMA and other agencies, they have taken the issue of MSWM head on, and hence the clean Lagos initiative was introduced. Lagos with a huge population of 23 million people according to Lagos state bureau of statistics, managing the waste will be a herculean task.

This thesis has been able to describe the waste management chain as well as the regulations governing MSWM in Nigeria.

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