

A SYSTEMIC ANALYSIS OF URBAN SOLID WASTE MANAGEMENT IN NIGERIA; A CASE OF SOKOTO METROPOLIS

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ABSTRACT

This paper examined the nature and magnitude of solid waste generated in Sokoto metropolis as well as the types and efficacy of the waste management strategies. Commercial, institutional, recreational and residential areas were purposively sampled to collect data for the study. Field observation and structured questionnaire were used to determine areas of high solid waste generation while institutional efforts in the collection, transportation and disposal of solid waste in the metropolis were assessed through interviews. The paper found out that solid waste in the metropolis is composed of biodegradable waste (58%), non-biodegradable waste (24%), construction and demolition wastes (12.8%) and other types of waste which are mainly automobile parts and plastic materials (5.2%). It also found that commercial areas generated more solid waste but experienced low collection frequency while institutional and recreational areas generate comparatively less solid waste but have a higher collection frequency. However, there are generally few official waste dumps, limited number of collection vehicles, staff and disposal options. Sanitary land filling and disposal in nearby farms are the most prominent waste disposal options while waste recycling and conversion are nonexistent in the area.

Keywords: Composition, Disposal, Recycling, Recovery, Transportation

INTRODUCTION

Waste is generally defined as any unwanted material which the owner has no further use for and which he/she is willing to throw away (Van de Klundert and Anschütz, 2001). Waste is simply described as a discarded material which has no consumer value to the one who disposed it of (Daniel and Edward, 2003). It may be derived from agricultural, commercial, communal and industrial activities (Kgathi and Bolaane, 2001) and may be in solid, liquid or gaseous forms. Solid waste can be categorized as biodegradable when it constitutes degradable materials such as agricultural waste, food remnants, wood, paper and fruits or non-biodegradable when it constitutes non degradable materials such as bottles, plastics, cans, tins and tetra packs among others (Ruveena and Balwinder, 2015).

Urban or municipal waste is waste generated by any activity in urban or peri-urban areas. This includes waste from

households, non-hazardous solid waste from industrial, commercial and institutional establishments (including hospitals), market waste, yard waste and street sweepings (Schubeler, 1996; Shekdar, 2009). The collection, transportation and final disposal of this category of waste is usually the responsibility of the municipal or other governmental authorities (Al-Khatib and Arafat, 2010).

Urban waste generation and management continue to be subjects of environmental concern in Nigeria (Agunwamba *et al.*, 1998; Afon and Okewole, 2007; Nabegu, 2010; Bichi and Amatobi, 2013) and other developing countries (Buenrostro *et al.*, 2001; Al Khitab and Arafat, 2010; Sakawi *et al.*, 2013) where there are usually inadequate, inactive or weak environmental policies, regulations and awareness; inadequate sanitation facilities, undeveloped technology and very poor

people's attitude to environmental sanitation. In these areas, there is pronounced increase in human population, urbanization and industrialization and excessive consumption of modern daily life. These contribute to the continued generation of large quantity of waste, thus creating more environmental and administrative challenges (Seng *et al.*, 2011). The situation is further compounded by inadequate or complete absence of information about the generation and composition of wastes in these areas (Buenrostro *et al.*, 2001) which are very critical to successful waste management (Thenmozhi and Sulaiman, 2014). As such, waste management policies and programmes continue to be fraught with unnecessary bottlenecks.

Urban Waste Generation

The global annual generation of urban solid waste is 1.3 billion metric tons and this is expected to rise to about 2.2 billion tons by 2025 (Kawai and Tasaki, 2016). Waste generation and accumulation in urban areas of Nigeria and other developing countries is caused by continuous increase in urban population, urbanization, changes in the rate and pattern of consumptions as well as increase in the level of economic activities. The type and amount of waste generated in a particular area therefore, is a function of economic activity, resource consumption, and economic growth (Ngoc and Schnitzer, 2009) as well as individual income levels (Wilson *et al.*, 2012). For instance, while per capita waste generation in Nigerian cities was estimated to be 0.5kg in Onitsha (Agunwamba *et al.*, 1998), 0.25kg in Maiduguri (Dauda and Osita, 2003), 0.13kg in Ibadan (Afon and Okewole, 2007), 0.13kg in Ogbomoso (Abel, 2007) and 0.32kg in Sabon-gari, Kano (Bichi and Amatobi, 2013), the per capita waste in the Palestinian territories was estimated to be 0.6 – 0.8kg (Al Khitab and Arafat, 2010), 0.61kg in Morelia, Mexico (Buenrostro, Bocco, and Bernache, 2001) and 0.25kg in Bhutan (Phuntsho *et al.*,

2010). In the developed countries however (Canada, Switzerland, France, United Kingdom and USA), per capita waste generation varies between 0.9 – 2.7kg (I. Korner, 2003-2006). The variability in waste generated per capita can be explained by the difference in the level of development and incomes in these places.

Increase in waste generated in urban areas is usually associated with a corresponding increase in the cost of managing waste in the areas thereby further complicating the problem. There is also the problem of inadequate planning, staffing, vehicles and technology (Sherub *et al.*, 2010). In addition, the collection and disposal systems are not efficient as they were not planned in a way that particular needs of most urban areas of developing countries were taken into consideration (Katrina, 1997). These coupled with less government commitment in waste evacuation and management, leaves heaps of waste materials in the streets of many urban areas in developing countries, Nigeria inclusive.

Composition of Solid Waste

There is a relatively little amount of literature on the composition of solid waste in Nigerian cities (Abel, 2007) and much of what has been documented is based on estimates as the studies were in most cases based on segments of the cities not the whole and usually covering short periods of time. However, Sridhar and Bammeké (1988) found market wastes in Ibadan to be largely composed of easily decomposable matter (68%) originating from food, leaves and paper and the other non-degradable waste accounting for the remaining 32%. Dauda and Osita (2003) found solid waste in Maiduguri to be composed of organic materials (25.8%), ash, dust and stones (21.5%) and plastic materials (18.1%). Others were textile material, glass and metals accounting for about 17.3%. In another research, Bichi and Amatobi (2013) found solid waste in Sabon-gari Kano to be composed of 57.5% organic materials, 17.6%

plastic materials while other types of waste including paper, glass, ceramics, electronic wastes and metals accounting for 13.6%. It could be deduced from this that the bulk of solid waste generated in most Nigerian cities is composed of organic materials followed by plastic materials.

Solid Waste Management

Waste management is a planned system of effectively controlling the production, storage, collection, transportation and processing as well as the disposal or utilization of wastes in a sanitary, aesthetically acceptable and economic manner (Uchegbu, 2002). It is essentially a large material-handling system that covers the urban area as well as its outskirts (Shekdar *et al.*, 1991) and includes all administrative, financial, legal and planning functions as well as the physical aspects of waste handling.

The principle of waste management focuses on removing discarded materials from the environment in a timely and orderly manner so that the occurrence of diseases, fires and injuries to environmental aesthetics can be prevented or at least, reduced to the barest minimum. The main purpose of waste management therefore, is to reduce the generation of wastes from the source and thus, the disposal costs, the environmental impact and the impact on human health (Dinie and Don, 2013). It focuses on an environmentally acceptable manner of disposing the discarded materials.

All around the world, the issue of waste management is causing growing concerns due to increasing generation rates (Pedro and Gina, 2011). This is so in many urban centres in Africa, where it has been established that the problem of waste management has become a monster that has aborted most efforts by city authorities, states and federal governments and waste management agencies (Onibokun and Kumuyi, 1999). According to Kwawe (1995), waste handling is one of the greatest challenges of the modern

times in spite of the numerous technological achievements that have been well documented. Seng *et al.*, (2011) also identified solid waste management as a major challenge in urban areas particularly in the fast growing cities and towns of the developing world. In Nigeria, increase in the quantity and generation rates coupled with lack of efficient and modern technology has helped solid wastes to defy effective management (Babayemi and Dauda, 2009).

The panacea to this problem therefore, is sustainable waste management. Sustainable waste management has its roots in the sustainable development paradigm which stresses a “development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987). Sustainable waste management is therefore, a waste management process that “enhances sustainability by protecting the environment, human wellbeing and by saving primary raw materials, to meet legal requirements or obligations and even to obtain economic gains” (Siebel and Nabende, n.d.). This according to Tavares *et al.*, (2004) is achieved through integrated management system and government policies that encourage waste prevention, reuse and both materials and thermal recycling. It is against this background that this paper explores the type and magnitude of solid waste generated in Sokoto metropolis as well as government’s effort at managing it with a view to proffering ways through which the process of waste management in the metropolis can be made sustainable.

In Sokoto metropolis, solid waste is being mainly managed by 3 waste management organs. These are the State Ministry of Environment through the Sokoto Environmental Protection Agency (SEPA), the State Task Force Committee on Environmental Sanitation and a private company (Tsafta Hygiene Services Company Ltd). Prior to the establishment of the State Ministry of Environment in 2008, the Sokoto Urban

Development Authority (SUDA) was solely responsible for the management of waste in the metropolis up to the year 2008 when the responsibility was transferred to SEPA.

Sokoto Environmental Protection Agency (SEPA)

The Sokoto Environmental Protection Agency (SEPA) is the main Government agency that oversees the evacuation and disposal of solid waste in the metropolis. Its functions include provision of personnel and waste collection trucks for the exercise. It is also responsible

for the establishment, supervision and maintenance of refuse bunkers and skips throughout the metropolis. In addition to 120 illegally created waste disposal dumps, SEPA has a total of 150 designated solid waste disposal points from which it collects and disposes wastes. There is also a total of 100 refuse skips and 12 refuse collection bunkers that are strategically placed by SEPA for solid waste collection in the metropolis (SEPA, 2009). Plates 1 and 2 show a skip and waste bunker at SEPA designated collection points.



Plates 1 and 2: A skip and waste bunker at one of the SEPA designated collection points

Committee on Environmental Sanitation

The State Task Force Committee on Environmental Sanitation was formed in December, 2008 with the aim of complementing the activities of SEPA in the management of solid waste in the metropolis. It is a 14 member committee headed by a member of the state executive council. The committee collaborates with youth clubs, voluntary organizations and professional associations as well as private individuals to evacuate large volumes of waste on the designated sanitation days. Similarly some private, and community based organizations in conjunction with SEPA and the state environmental sanitation committee, organize

special sanitation programmes in the metropolis periodically.

Tsafta Hygiene Services Company Ltd

Tsafta Hygiene Services Company Ltd was contracted by the State Government through SEPA to provide waste management services in the metropolis in May 2009. The terms of reference accompanying the contract include evacuation, transportation and appropriate disposal of solid waste from selected township roads in the metropolis which included Ahmadu Bello way, Emir Yahaya Road, Ali Akilu Road, Abdullahi Fodio Road, Kano road and Maiduguri road among others.



Plate 3: Staff of Tsafta Hygeine Company at work in the metropolis

Apart from the government and individual efforts at managing solid waste in the metropolis, some parastatals and corporate bodies take the responsibility of managing the wastes they generate which range from evacuation to disposal and sometimes open burning or incineration.

MATERIALS AND METHODS

The study area

Sokoto metropolis is the headquarters of Sokoto State, Nigeria. It is located on latitude 13° 3' 5"North and 5° 13' 53"East. The city geologically falls within the Wurno formation, belonging to the cretaceous Rima group which is part of the extensive Sokoto basin (Kogbe, 1979). It lies in the Sudano-sahelian ecological zone where semi-arid climate prevails. It is influenced by the Tropical Continental (cT) and the Maritime Tropical (mT) air masses to have alternating long dry and the short rainy seasons. Average rainfall in this zone is estimated to be 814.33mm but its incidence, distribution and annual total vary considerably

from year to year (Swindell, 1986). Temperature may be as low as 22°C during the months of November to February which corresponds to the harmattan period but as high as 38° to 40°C during the months of March to May which in other words is the hot season (Sokoto State Government, 2004).

The vegetation of the area is characterized by sparse shrubs generally less than 6m high which are dotted by large isolated trees usually cultivated as economic trees (Alagbe, 2006). The most prominent ones include *Parkia biglobosa*, *Adansonia digitata*, *Mangifera indica*, *Tamarindus indica*, *Balanites aegyptiaca*, *Lannea microcarpa*, *Diospyros mespiliformis*, *Piliostigma reticulatum*, *Prosopis africana* (Dangulla, 2013) and *Azadirachta indica* which was widely propagated throughout the Northern region through the Northern Nigeria Forestry Department in the 1950's for wood supply and wind breaking purposes (Usman and Adefalu, 2010).

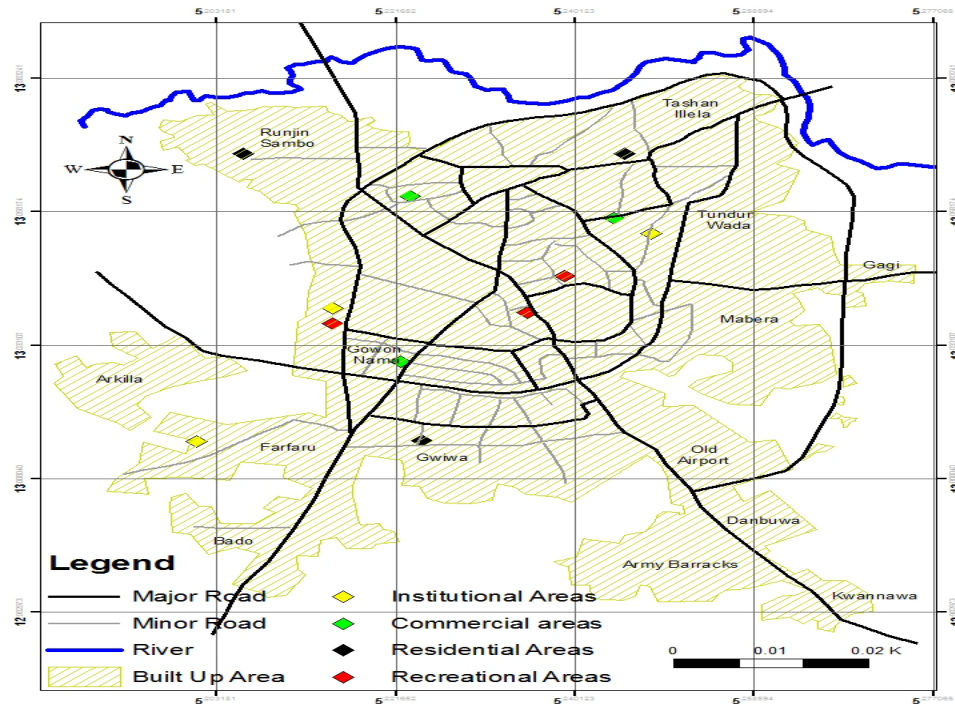


Figure 1: Study area showing the sampled areas and road network in the metropolis

Sampling

A reconnaissance survey was first carried out to determine areas of high volumes of solid waste at designated collection centers. From the information gathered, the metropolis was divided into four land use classes –

commercial, institutional, recreational and residential areas from each of which three areas were purposively selected (Table 1) for field observation, questionnaire administration and interview.

Table 1: Sample sites

SN	Land use Class	Selected Areas
1.	Commercial Land use	1. Sokoto central market 2. Gawon Nama mini market 3. Tsohuwar Kasuwa
2.	Institutional Land use	1. Specialist Hospital Sokoto 2. Shehu Kangiwa Secretariat 3. Sokoto State Polytechnic
3.	Recreational Land use	1. Giginya Hotel 2. Shukura Hotel 3. Shehu Kangiwa Square
4.	Residential Land use	1. Garkar Waziri 2. Guiwa Low cost 3. Gidan Igwai

Source: Fieldwork, 2012

A total of one hundred and twenty (120) copies of a structured questionnaire were distributed for the study. Ten copies were

distributed to residents in each of the selected areas at sight. The questionnaire covered educational and employment status of

respondents, perception of waste management problem, volume of domestic waste, method of collection from households or collection centers, availability and type of collection containers, frequency of collection and availability of staff and collection vehicles.

Interviews and field observation were also used to collect data on the physical state of waste, illegal dumping centers, number of collections per week, number of personnel used and to also interact with personnel and residents on waste generation and management matters. From the interaction, respondents were interviewed on waste collection methods and frequency in their areas. Similarly, some waste management personnel including the drivers, laborers and management staff of Sokoto Environmental Protection Agency, Sokoto central market, Tsafta Hygiene Services Company Ltd were interviewed on the methods, efficacy and

availability of logistics for waste collection, transportation and disposal as well as disposal options available.

RESULTS AND DISCUSSION

Solid Waste Generation in Sokoto Metropolis

According to the Sokoto State Environmental Protection Agency (SEPA), a total of 1125 metric tonnes of solid waste is disposed off at landfills on daily basis. However, this does not include waste collected by farmers and that collected by individuals for construction and other purposes (SEPA, 2011). Table 2 summarizes the weekly waste generation in the metropolis. The table shows that commercial and residential areas generated more solid waste per week while institutional and recreational areas generated comparatively less waste.

Table 2: Weekly Total of Waste Generated from the Sampled Areas

SN	Area	Tonnes/week
1.	Commercial	450
2.	Institutional	300
3.	Residential	540
4.	Recreational	270
Total		1560

Source: Fieldwork 2012

Although *Tsohowar Kasuwa* has low commercial activities compared to Sokoto central market, it was found in this study to have more volume of waste compared to other commercial areas in the metropolis. This may be explained by the fact that the management of Sokoto central market collects

and disposes its waste on daily basis while *Tsohuwar kasuwa* does not have a unified system of waste management. **Plates 4 and 5 show heap of uncollected waste in Tsohuwar kasuwa and waste collection activities** and Sokoto central market respectively.



Plates 4 and 5: Waste dump at Tsohuwar Kasuwa and Sokoto Central Market

In the recreational areas, the bulk of solid waste constitute more of papers, toiletries, food remnants and polythene bags which do not occupy much space and hence, the comparatively low volume generated. In addition, waste in these areas is being managed by individual organizations. It was thus not surprising that waste collection frequency in these areas is higher than what was obtained from other areas in which government agencies provide waste management services.

Waste generation in residential areas was found to be high. However, this was found to be related to the number of people as well as type and income levels of individual households. The larger the family therefore, the more waste is generated; so also the higher the income level of individuals, the more waste they generated in their respective households. Plates 6 and 7 show waste generated and disposed in Gidan Igwai residential area.



Plates 6 and 7: High volume of waste in Gidan Igwai residential area

Nature of Solid Waste in Sokoto Metropolis

Solid waste found in the metropolis was classified into 4: Bio-degradable which includes materials such as animals dung, vegetables, food remnants, paper, cartons, textile materials, animal wastes, leaves, grass and wood. The second group is the non-biodegradable wastes which include bottles, glass, plastic materials, polythene bags as well as pieces of iron bars and sheets. The third category includes construction and demolition wastes while the fourth category constitutes

parts of automobile machines; this category is referred to as “others”.

Figure 2 depicts the composition of solid waste in the metropolis. This finding contradicts that of Oumarou and Diso (2016) who established that the cumulative percentage of biodegradable solid waste in the metropolis was 55.35%, non-biodegradable 38.06% and others 6.59%. This may be due to rise in economic activities in the last few decades.

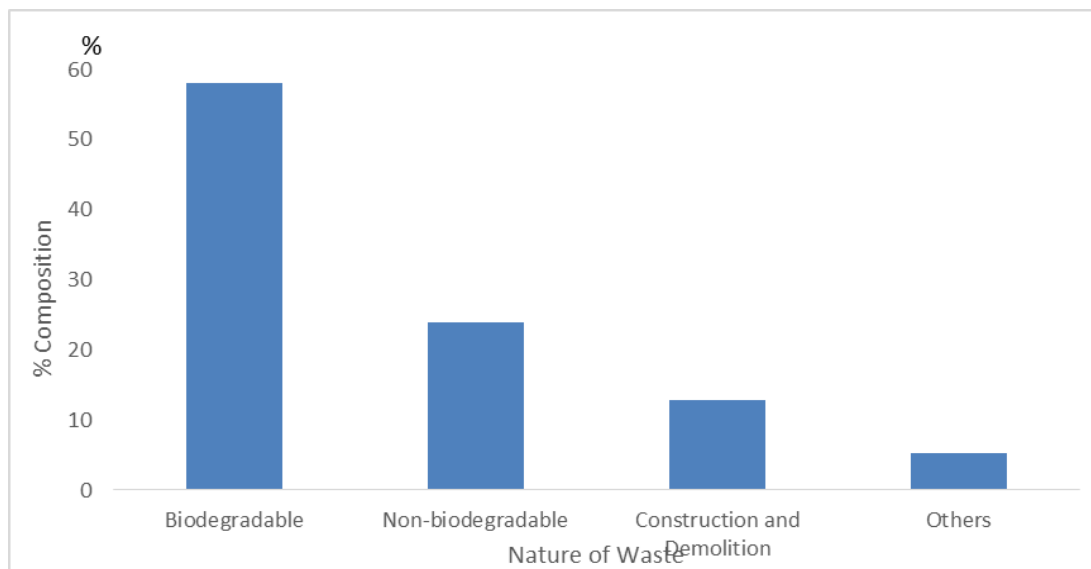


Figure 2: Nature of Solid Waste in Sokoto Metropolis

Waste Collection Sites and Frequency in the Metropolis

Figure 3 shows the number of both legal and illegal dumping sites in the metropolis. From the survey, there are more illegal dumping sites than legal ones and this has led to indiscriminate dumping of refuse and other forms of waste. Waste collection frequencies are presented in table 3. From the table, the area with highest waste collection frequency

is the commercial areas from which waste is collected on almost daily basis. The least however is the recreational area which has only 3 collections per week. This may not be unconnected with the low volume of waste being generated in this area. The residential and institutional areas each have 5 collections per week.

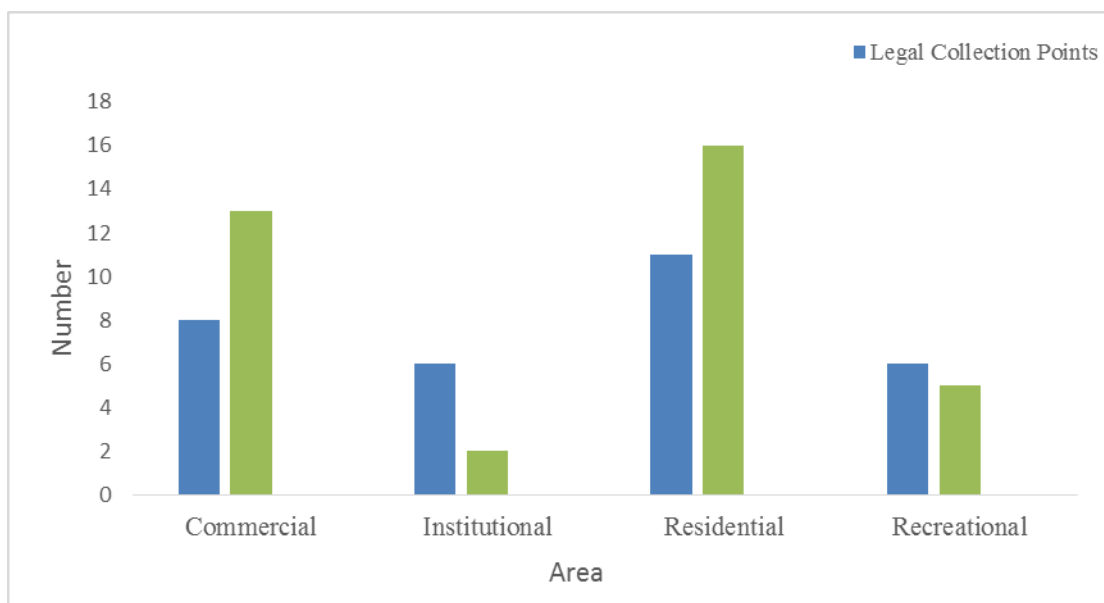


Figure 3: Legal and Illegal collection sites

Table 3: Collection Frequencies

SN	Area	Average Collections/ Week
1.	Commercial	7
2.	Institutional	5
3.	Residential	5
4.	Recreational	3

Source: Fieldwork, 2012

Waste Disposal in the Metropolis

The most prominent method of waste disposal in the metropolis was found to be open dumping where solid wastes are dumped in nearby farms. This method is used to dispose about 48% of the waste generated in the metropolis. The second disposal method is landfill; an effort which is mostly plagued by individual requests for the waste (Plate 8). Land filling is used to dispose about 33% of the generated waste. Incineration is another method adopted mostly by institutional establishments in reducing the volume of the waste especially when it has not been collected for a long time. Incineration reduces

the volume of waste, simplifies collection and disposal and also emits less carbon compared to open burning. It also reduces the menace of polythene bags that fly the streets and barbed fences in the metropolis. Incineration accounts for 4% for waste disposal. Open burning accounts for 7% while composting and scavenging of metal, aluminum and bottle account for 5% and 3% of total solid waste disposal in the metropolis respectively (Figure 4). Although the state in conjunction with the Federal Government is making an attempt at recycling waste generated in the metropolis, the recycling plant is yet to start operating at the time of writing this paper.

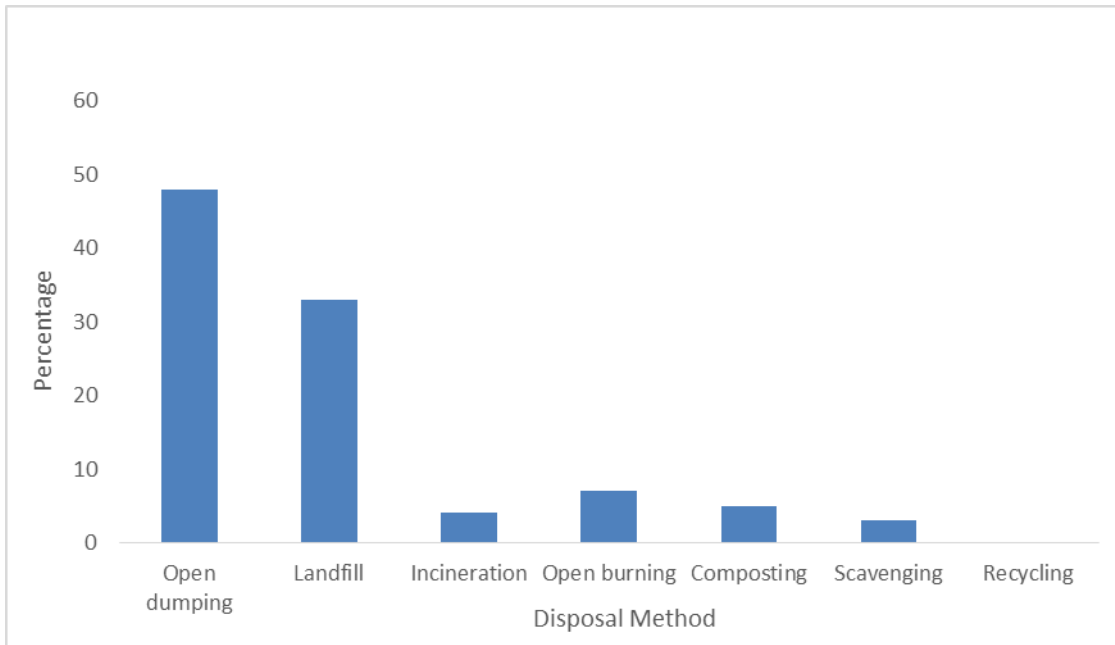


Figure 4: Waste Disposal methods in Sokoto Metropolis



Plate 8: A Landfill at Gagi, Sokoto

CONCLUSION

Like many cities of the developing world, solid waste generation and management is one of the major challenges facing Sokoto metropolis. It was found out that about 1560 metric tons of solid waste are generated

weekly from the sampled areas of the metropolis. The waste is being managed by SEPA (a government agency), a contracted private company and a few non-governmental organizations. However, despite the effort of

these institutions in placing mechanisms for eradicating wastes related problems from the metropolis, there is still much that needs to be done. There are inadequate waste collection points and limited options for sanitary disposal of waste in the metropolis as only open dumping, land filling and burning are currently being practiced. Waste is

RECOMMENDATIONS

Aggressive public enlightenment and awareness campaign on waste management are seriously needed to enlighten the people on hygienic handling and disposal of waste. However, the number of official waste collection points, waste collection vehicles and waste management staff should be considered and reviewed to tally with the rate of waste generation in the metropolis.

The state government should expedite action in the completion of the waste recycling plant and exploring the possibilities of waste recovery in the state. The biodegradable part of the waste can be

unattended to in good time in many waste collection points while lack of adequate official waste collection points, illiteracy of the people caused by inadequate awareness have led to the propagation of many illegal waste dumps. This has no doubt frustrated the efforts of ridding the metropolis off waste.

converted to biogas to complement if not substitute fuel wood as a source of domestic energy. This can go a long way in ensuring proper waste management, creating employment opportunities, reduce the rate of deforestation and generally lessen pressure on the environment.

Private sector participation in waste management should be encouraged in the metropolis with a view to providing house to house collection facilities and services. The relevant environmental sanitation laws should also be reviewed and adequately enforced in the metropolis in particular and the state in general.

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