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Evaluation of Municipal Solid Waste Management for Improved Public Health and Environment in Nigeria

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ABSTRACT

Waste which is a product of living can emanate from municipal, industrial, family, individual and developmental activities such as Civil Engineering construction works. The research is a qualitative research and it is aimed to gather an in-depth understanding of solid wastes management in Nigeria. This was carried out through observations in numerical representations and through statistical analysis. Comprehensive reviews of online materials were utilized in this research and practical knowledge in the current state of solid waste management in Nigeria was also applied. It was established that an average Nigerian produces about 0.43 kg solid waste per head per day. Organic matter constitutes about 60% to 80% of total waste stream along with plastics, scrap metals and nylon as major recyclable constituents. The problems associated with municipal solid waste management in developing countries, like Nigeria, have become pronounced in recent years as a result of urbanization and inadequate disposal of waste. This work examines the current method of waste disposal in Nigeria with attempts to discover the most viable option of solid waste disposal (Integrated Solid Waste Management) and recommend ways of improving its operation. The solid wastes must be managed effectively for public health, wealth and efficient energy systems.

Key words: Solid Waste Management, Public Health, Environment
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1. INTRODUCTION

Waste (also known as rubbish, trash, refuse, garbage or junk) is unwanted or useless materials. Waste is directly linked to human development, both technologically and socially. Some components of waste have economical value and can be recycled once correctly recovered. Waste is sometimes a subjective concept, because items that some people discard may have value to others. It is widely recognized that waste materials are a valuable resource.

Waste can be defined as any material flow pattern that is rejected by the society. Waste according to their state can be either solid or liquid.

Industrial or domestic human activities generates waste, which if not properly disposed can threaten the environment and health of people living around it. However, several attempts have been made over the years to ensure solid waste disposal ranging from dumping to burning of waste and landfilling with attendant contamination of the environment with harmful pollutants. As a result of industrial revolution and increasing population, issues of environmental pollution and climate changes resulting from improper waste disposal has occupied the front burner in recent times.

According to Adejobi and Olorunmbe [1] and Amuda *et al.,* [2], the volume of waste generated in any city is often a reflection of the intensity of human activities such as population growth, urbanization and social development, resources exploitation and unchecked technological advancement. The environment and health conditions are hampered through the pollution of emanating from improper solid waste disposal, hence the need for the design of an engineered sanitary landfill for waste management in order to check the effect of improper waste disposal.

Unfortunately, many people in African countries including Nigeria, until recently, regard the concern for effective strategies for managing urban solid waste as a less important issue which may distract attention from the most urgent and serious problem of achieving a fast rate of economic growth. This attitude stems in part from the belief that

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environmental degradation with urban solid waste generation is an inevitable price of development [3-4]. According to Tobore [5], contributory factors to the challenge of ineffective solid waste management include inadequate regulatory framework that has manifested in lack of interest of private sector investment in service delivery (infrastructure); uncoordinated institutional functions; low political will, low capacity to discharges duties, poor data information for planning, wrong attitude of waste generator amongst others. Yet on the increase is the demand for good waste management service for public health and environmental protection.

Solid waste is defined as any garbage, refuse, sludge from waste treatment plant, water supply treatment plant, or air pollution control facility and other materials, including solid, liquid, semisolid, contained gaseous resulting from industrials, commercials, mining and agricultural operations from community activities [6]. Solid wastes are substances deposited on land, discharged into water bodies or the atmosphere for a certain period of time, whose presence may (or may not) be hazardous to human and the environment.

Nigeria is located at the Western part of Africa. It has 36 States and a Federal Capital Territory. The World Bank report of 2011 stated the population of Nigeria as 162, 470, 737 with a GDP of US$235.9billion. With increase in population, urbanization and industrialization including globalization, the challenge of solid waste management (SWM) in the Country has increased and even now complex.

Contributory factors to the challenge include inadequate regulatory framework that has manifested in lack of interest of private sector investment in service delivery (infrastructure); uncoordinated institutional functions; low political will, low capacity to discharges duties, poor data information for planning, wrong attitude of waste generator amongst others. Yet on the increase is the demand for good waste management service for public health and environmental protection.

1.1. Characteristics of Solid Wastes
- Corrosive: these are wastes that include acids or bases that are capable of corroding mental containers, e.g. tanks
- Ignitability: this is waste that can create fires under certain condition, e.g. waste oils and solvents
- Reactive: these are unstable in nature; they cause explosions, toxic fumes when heated.
- Toxicity: waste which are harmful or fatal when ingested or absorb

1.2. Forms of Solid Wastes
- Non Hazardous waste: refuse, garbage, sludge, municipal trash.
- Hazardous waste: solvents acid, heavy metals, pesticides, and chemical sludges
- Radioactive: high and low-level radioactive waste
- Mixed waste: Radioactive organic liquids, radio active heavy metals [6].

1.3. Causes of Solid Wastes
- Population growth
- Increase in industrials manufacturing
- Urbanization
- Modernization

Modernization, technological advancement and increase in global population created rising in demand for food and other essentials. This has resulted to rise in the amount of waste being generated daily by each household.

2.1. Waste Generation
There are varied data on waste generation and composition due to poor information management but notable use is the study carried out by Ogwueleke in 2009 [7] in some cities.

Table -2.1 Waste Generation and Composition [5,7]

City	Population	Tonnage/month	Density (kg/m^3)	Kg/Capital/Day
Lagos	8,029,200	255,556	294	0.63
Kano	3,2228,700	156,676	290	0.56
Ibadan	307,840	135,391	330	0.51
Kaduna	1,458,900	114,433	320	0.58
Port Harcourt	1,053,900	117.825	300	0.60
Makurdi	249,000	24,242	340	0.48
Onitsha	509,500	84,137	310	0.53
Nsukka	100,700	12,000	370	0.44
Abuja	159,900	14,785	280	0.66

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Presently, the rate of waste generation in Lagos (with estimated population over 10 million 2012) is 9, 000 tonnes/day (Lagos State Waste Management Authority, LAWMA) while in Kano State, the rate is 3, 849 tonnes/day (Bayero University Kano Consultancy Unit). Generally, the average rate of generation is estimated as 0.5 kg/capital/day.

Biodegradable waste account for over 50% of waste generated with other component estimated at different composition in different States. A recent study carried by the Bayero University Kano Consultancy Unit (March, 2012) estimated the following composition for polythene/cellophane (19%), paper (12.7%), metal (10%), glass (8.7%), plastics (11.3%), fines comprising of ash, dust and sand (12%) miscellaneous (9%) while a study by the Basel Convention Coordinating Centre for Africa in 2009 reveals that 70% of all imports were used electronic electrical equipment of which about 30% could be described as E-Waste.

Until recently, the concept of land filling was used to dump waste material for disposal. Therefore, not much care was taken about their construction. Placing the waste in the Earth's upper crust was considered as the safest practice of waste disposal. But with rapid industrialization and urbanization, land filling has metamorphosed. As uncontrolled landfills have shown potential of polluting various parts of the environment and many accidents have also happened, regulations have been imposed on landfill location, site design and their preparation and maintenance. A certain degree of engineering was made mandatory for landfills.

Fig. 2.1 A dump site for solid waste

Fig. 2.2 A dump site for solid waste affected by rainfall

2.2. Waste Management

According to Clark [8], solid waste management is defined as the branch of solid waste Engineering associated with waste control of generation, storage, collection and transfer, transportation, processing and disposal of solid waste in a manner that is in accordance with the best principle of Public Health Economics, Engineering Conservation, aesthetics and other environmental consideration. It entails administrative, legal, financial, planning and engineering functions. The term waste can be classified according to Oluwande [9] with respect to their sources into:

    i.   Agricultural wastes
    ii.   Commercial wastes
    iii.   Domestic wastes
    iv.   Industrial wastes
    v.   Municipal wastes
    vi.   Run off / Storm wastes

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Knowledge of the quantities and characteristics of solid wastes to be disposed is important since these factors affect:
1.   Method and frequency of pickup
2.   Viability of transfer stations
3.   Method of disposal to be selected (e.g., incineration, land filling, etc.)
4.   Size and/or throughput capacity of the disposal facility required.
5.   Environmental impacts at the disposal location (e.g., types of potential air or water pollutants)
6.   Viability of Resource Recovery and Recycling Programs (RRRP)
7.   Potential for waste reduction/minimization.

Hence, Solid waste types and quantities generated by a municipal community can best be determined by means of a field survey.

2.3. Overview of Solid Waste Management

Solid waste management is the most pressing environmental challenge faced by urban and rural areas of Nigeria. Nigeria, with population exceeding 170 million, is one of the largest producers of solid waste in Africa. Despite a host of policies and regulations, solid waste management in the country is assuming alarming proportions with each passing day.

Nigeria generates around 3.2 million tons of solid waste annually, out of which only 20-30% is collected. Reckless disposal of MSW has led to blockage of sewers and drainage networks and choking of water bodies. Most of the wastes is generated by households and in some cases, by local industries, artisans and traders which litters the immediate surroundings. Improper collection and disposal of municipal wastes is leading to an environmental catastrophe as the country currently lack adequate budgetary provisions for the implementation of integrated waste management Programmes across the States.

According to the United Nations Habitat Watch, African city populations will more than triple over the next 40 years. African cities are already inundated with slums; a phenomenon that could triple urban populations and spell disaster, unless urgent actions are initiated. Out of the 36 states and a federal capital in the country, only a few have shown a considerable level of resolve to take proactive steps in fighting this scourge, while the rest have merely paid lip services to issues of waste management indicating a huge lack of interest to develop the waste sector.

2.3.1. Situation in Lagos

Lagos State, the commercial hub of Nigeria, is the second fastest growing city in Africa and seventh in the world. The latest reports estimate its population to be more than 21million making it the largest city in entire Africa. With per capita waste generation of 0.5 kg per day, the city generates more than 10,000 tons of urban waste every day.

Despite being a model for other states in the country, municipal waste management is a big challenge for the Lagos State Waste Management Agency (LAWMA) to manage alone, hence the need to engage the services of private waste firms and other franchisee to reduce the burden of waste collection and disposal. One fundamental issue is the delayed collection of household solid waste. In some cases, the wastes are not collected until after a week or two, consequently, the waste bin overflows and litters the surroundings.

Improper waste disposal and lack of reliable transport infrastructure means that collected wastes are soon dispersed to other localities. Another unwelcome practice is to overload collection trucks with 5-6 tons of waste to reduce the number of trips; this has necessitated calls by environmental activist to prevail on the relevant legislature to conform to the modern waste transportation standard.

Fig. 2.3 A dump site for solid waste disposal in Lagos State

2.3.2. Situation in Oyo

Away from Lagos State, Oyo is another ancient town in Nigeria with an estimated population of six million people. Here, solid waste is regulated by the Oyo State Solid Waste Management Authority (OYOWMA). Unlike Lagos State, Oyo State does not have a proper waste management scheme that cuts across the nooks and crannies of the state, apart from Ibadan, the capital city, people from other towns like Ogbomoso and Iseyin resort to waste burning. In case the waste

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generators feels that the amount being charged by the waste franchisee is beyond their means, they dump the waste along flood paths thus compounding the waste predicament.

Fig. 2.4 A dump site for solid waste disposal in Oyo State

Kano and Rivers State with its fair share of population also suffers similar fate in controlling and managing solid waste. Generally speaking, population increase in Nigeria has led to an unprecedented growth in its economy but with a devastating effect on the environment as more wastes are generated due to the need for housing, manufacturing industries and a boost in trade volume.

2.4. Waste Generation

There are varied data on waste generation and composition due to poor information management but notable of use is the study carried out by TC Ogwueleke in 2009 [7] in some cities as shown below.

Table -2.2 Waste Generation in some cities in Nigeria

City	Population	Tonnage / month	Density (Kg/m^3)	Kg/Capita/Day
Lagos	8,029,200	255,556	294	0.63
Kano	3,248,700	156,676	290	0.56
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Generally, all waste streams are stored together in either bags or containers (such as used buckets) and plastics waste bins. LAWMA provides 240 litres bins for households after annual payment of the Land Use charge through the Land Records Company.

2.5 Waste Collection

Waste Collection service is offered mainly by the public sector though some State Governments operate some level of formal public private participation (PPP). It is not, however, uncommon to see informal waste collector using local vehicles (push carts) for collection services from door to door in some parts of Nigerian cities.

Collection service is mostly exclusive to the urban cities with not higher than 50% efficiency in most cities with Lagos and Calabar (in Cross Rivers State) as exception. The rural areas and urban slums are hardly rendered such services. The

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relatively success story of Lagos could be traced to the level of cost recovery from the public (waste generators) and strong political will towards good waste management in the State.

The Lagos State Government through LAWMA engages, coordinates and evaluates the activities of its private sector participant (they are over 300) into Municipal Solid Waste Collection. Collection frequency is either once or twice a week and usually on door –to-door basis. This is usually difficult in densely populated areas and it not uncommon that collection frequency is elongated.

Fig. 2.5 Waste Collection in Lagos State

2.6. Waste Transfer
Waste transfer station is not common in Nigeria the only State that has a waste transfer station is Lagos State. Below is the activity of the two-transfer loading stations in the State for the 1st half of 2012 as shown in table 2.3.
Table -2.3 Volume of Wastes in transfer station of Lagos State

MONTH	SIMPSON	OSHODI
JANUARY	6, 389.35 m^3	4,064.45 m^3
FEBRURARY	4, 988.86 m^3	4, 970.48 m^3
MARCH	8, 367.57 m^3	4, 770.89 m^3
APRIL	7, 404.70 m^3	3, 915.59 m^3
MAY	8, 562.08 m^3	6, 121.62 m^3
JUNE	8, 303.06 m^3	9, 276.42 m^3

Fig. 2.6 LAWMA workers on duty in Lagos State

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2.7. Recycling

Recycling activities have been more of the informal sector on selected valuable materials. The formal sector is becoming interested in some States as they are pilot projects either running or planned for. In such projects source separation of waste is encouraged.

Examples of recycling activities in Lagos State include;

- Compost plant at Ikorodu for the treatment of market waste, it generated a minimum of 24, 000tonnes and maximum of 42, 000.00 tonnes of compost in 2nd half of 2011
- Waste to Energy plant at Ikosi Market – generate biogas from the market waste that is used to operate 2KVA generator at the market.
- Plastic recycling plant at Olushosun for the conversion of water sachet into garbage bags – the Government introduced a buyback programme for water sachet, cartons, paper and glass.
  Formulation of recycling clubs in secondary schools to instill recycling habit in young people

Fig. 2.7 Sorting of bottles for Recycling in Lagos State

2.8. Informal Recycling Sector

The Informal recycling sector is very active in waste management system in Nigeria. We have them either as itinerant waste buyers or scavengers and they target valuable materials such as plastics, paper, used electronic electrical equipment, glass, metal etc. Their activities have great impact in the reduction of the net volume of waste disposed of. However their importance, there is no formal integration of this stakeholder into the system except in Lagos State.

Fig. 2.8 Conveying of Solid Wastes by Scavenger ofor Recycling

2.9 Disposal of Solid Wastes

Wastes are disposed in dumpsites at designated land either owned by the government or private owner and in some cases in burrow pits and empty spaces illegally. The largest dumpsite possibly in Nigeria is the Olusohun dumpsite in Lagos. The Lagos State Government is working on extracting methane gas from the site as well as another dumpsite at Abule Egba. There are five approved dumpsites in total in the State. Below is the disposal activity for the 2nd half of 2011 and 1st half of 2012.

2011 half year report (Amount in Tonnes)	
July	263, 429.58
August	278, 770
September	274, 547
October	261, 694.40
November	267, 657
December	239, 282
2012 half (Amount Cubic metres)	
January	171, 092.65
February	355, 701.98
March	339, 020.58
April	350, 218.41
May	287, 193.77
June	314, 824

Fig. 2.9 Example of Open dumping Site in Nigeria

3. METHODOLOGY

The type of research used in this study is qualitative research. The research aimed to gather an in-depth understanding of solid wastes management in Nigeria. We examined the phenomenon through observations in numerical representations and through statistical analysis. Comprehensive reviews of online materials were utilized in this research and practical knowledge in the current state of solid waste management in Nigeria was applied in the course of this research.

This work is concerned with solid waste from a municipal environment in Nigeria. The management of solid waste through less hazardous when dry, requires a more careful attention and treatment. According to Betts (1980), solid waste management comprises of the following operation units:

    i.   Storage of solid waste
    ii.   Collection from source and storage
    iii.   Transportation of waste
    iv.   Disposal of waste

3.1. Integrated Solid Waste Management

Integrated Solid Waste Management (ISWM) is a comprehensive waste prevention, recycling, composting, and disposal program. An effective ISWM system considers how to prevent, recycle, and manage solid waste in ways that most effectively protect human health and the environment. ISWM involves evaluating local needs and conditions, and then selecting and combining the most appropriate waste management activities for those conditions. The major ISWM activities are waste prevention, recycling and composting, and combustion and disposal in properly designed, constructed, and managed landfills (Figure 3.1). Each of these activities requires careful planning, financing, collection, and transport.
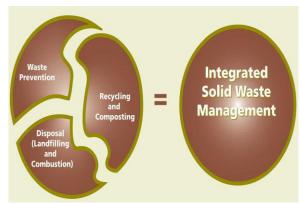
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Fig. 3.1 Integrated Solid Waste Management

3.1.1. Waste Prevention

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

3.1.2. Recycling and Composting

According to Sridhar, Material recovery and recycling is becoming popular in many countries due to dwindling natural resources and increasing demand for raw materials by manufacturing industries. Recycling is a process that involves collecting, reprocessing and/or recovering certain waste materials (e.g., glass, metal, plastics and paper) to make new materials or products. Some recycled organic materials are rich in nutrients and can be used to improve soils. The conversion of waste materials into soil additive is called composting. Recycling and composting generate many environmental and economic benefits For example: they create jobs and income, supply valuable raw material to industry, and produce soil enhancing compost leading to better agricultural productivity.

3.1.3. Disposal (Land filling and Combustion)

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

4. ANALYSIS OF RESULTS

The government at the federal level as a matter of urgency needs to revive its regulatory framework that will be attractive for private sectors to invest in waste collection, recycling and reusing. The environmental health officer's registration council of Nigeria would do well to intensify more effort to monitor and enforce sanitation laws as well as regulate the activities of the franchisees on good sustainable practices.

Taking the advocacy further on waste management, to avoid littering the environment, some manufacturing companies (e.g. chemical and paint industry) have introduced a recall process that will reward individuals who returns empty/used plastic containers. This cash incentive has been proven over time to validate the waste to wealth program embarked upon by the manufacturing companies. It is also expected that the government will build more composting and recycling plants in addition to the ones in Ekiti and Kano State to ensure good sustainable waste management.

Recently, a draft Policy on Municipal and Agricultural Wastes was reviewed (August, 2012). It is hoped that the Policy in time will lead to development of a comprehensive legislation and possibly a plan that will address the issue of waste management in the Country. One major challenge in Nigeria is the enforcement and implementation of policy.

5. CONCLUSION

Nigeria is good in designing policy statements but implementing them is another concern. Whilst there're environmental policies in Nigeria, there's little or no waste management strategy. . It was established that an average Nigerian produces about 0.43 kg solid waste per head per day. Organic matter constitutes about 60% to 80% of total waste stream along with plastics, scrap metals and nylon as major recyclable constituents. Most environmental agencies do not have adequate records on waste management. The numerous dumpsites and heaps of dumps here and there in the Country pose serious environmental and health challenges and there is a need to check them.

There is a need to look beyond the challenges and collaborate on finding sustainable solutions that are viable in our local environment

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The Waste Management Society of Nigeria (WAMASON) with interest to develop waste management industry and practice in Nigeria has intervened in the following ways amongst others;

• Develop professional training courses to meet the manpower gap need of the waste industry
• Occasionally conduct campaigns to enlighten the public on proper waste handling.
• Develop a proposed Bill on National Waste Management and Control (the project is yet to be actualized)

The use of open dumps remains the most feasible option of solid waste disposal in the study area due to its ease of operation. It is the simplest, cheapest and most cost-effective method of disposing of waste for inhabitants of the study area. However, there is an urgent need to improve the open dumping system. It may be necessary to upgrade it to semi controlled landfill; the base should be compacted, to reduce infiltration of leachate to ground water. The waste should also be covered with soil on a regular basis to prevent disease vectors, such as flies, from getting to the waste. This also will reduce the amount of odour that is released from the dumpsites. The dumps should be fenced off in order to prevent animals and scavengers from getting into the site. Since that there is poor awareness on the health risks and environmental effects associated with poor waste management practices such as dumping of refuse on open dump sites, drains and water channels and burning of refuse in open places.

Recommendations

The following recommendation should be taken into consideration:

i.   There should be an aggressive enlightenment campaign for segregation of waste and recycling Programmes and support for scavengers in every community in Nigeria
ii.   The generation of waste should be avoided where practicable and economically feasible;
iii.   Where practicable, waste reduction, waste recovery, reprocessing, reuse and recycling should be encouraged.
iv.   Residents in municipal areas should be educated on the need to segregate waste in order to assist in the recycling process.
iii.   The open dumps in many cities should be upgraded to semi-landfills in order to prevent infiltration of leachate and contamination of ground water
iv.   Comprehensive legal framework and enforcement of the existing regulations
v.   High investment in infrastructure and adequate human capacity for administrative and technical issues should be encouraged.
vi.   Right attitude of the public towards solid waste disposal
vii.   Proper Financing –Cost recovery is low in most States and no funding
viii.   Proper Planning – High data management and controlled urbanization
ix.   Coordinated institutional functions such as high academic research and industry linkages should be funded at all levels.

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