MUNICIPAL SOLID WASTE MANAGEMENT IN AFRICAN CITIES: A CASE STUDY OF LAGOS STATE, NIGERIA

Ogbonna Alban Chidiebere[1]*, Mikailu Abubakar[1] & Jiya Gideon Shabako[2]

[1]*Department of Civil Engineering, Waziri Umaru Federal Polytechnic, Birnin Kebbi, Kebbi State, Nigeria.*
[2]*Department of Civil Engineering, The Federal Polytechnic, Bida, Niger State, Nigeria*

*Corresponding Author: alban.ogbonna@yahoo.com

Abstract: Lagos State is one of the densely populated and highly industrialised States of Nigeria. Recognizing that the continued pollution of our environment will, if uncontrolled be difficult to rectify in the future, the subject of municipal solid waste management is both timely and important. This research evaluated the solid waste management strategies in Lagos State, Nigeria. The activities involved with the management of solid wastes from the point of waste generation to waste disposal were evaluated. Structured questionnaire and interview were employed to collect data within the thirteen Local Government Areas (LGAs) of Lagos State, Nigeria. The results showed that the rate of municipal solid waste generation out weight the present management strategies and the number of recycling firms in Lagos State. The study therefore recommends the need for Lagos State Government to review the municipal solid waste management strategies for sustainable development and job creation.

Keywords: *Municipal solid waste, sustainable development, waste generation, waste disposal, waste management.*

1.0 Introduction

According to Leton and Omotosho (2004), solid waste could be defined as non-liquid and nongaseous products of human activities, regarded as being useless. Peavey *et al.*, (1985), defined solid wastes as all inclusive wastes arising from human and animal activities that are normally solid and that are discarded as useless or unwanted in a given setting. It encompasses the heterogeneous mass of throwaways as well as the commercial activities as well as the more homogeneous accumulations of a single industrial activity. It should be noted that the wastes that are discharged may be of significant value in another setting. Table 1 shows the classification of materials comprising municipal solid waste.

The rate of generation of municipal solid waste is high compared with the ability and technical knowhow of government agencies, registered waste contractors and the informal sector to manage. According to Oyebode (2013), solid waste management in Nigeria is characterized by inefficient collection methods, insufficient coverage of the collection system and improper disposal of solid waste. The quality of solid waste generated in urban areas of industrialized countries is higher than in developing countries, still municipal solid waste management remains inadequate in later. Most developing countries including Nigeria have solid waste management problems different from those found in industrialized countries in areas of composition, density, volume of waste, waste collection, political and economic aspects of waste management framework, awareness and attitude to waste management (Ogweleka, 2009, and Oyebode, 2013).

Municipal solid waste management refers to the collection, transfer, treatment, recycling, resource recovery and disposal of solid wastes in urban areas. The goals of municipal solid waste management are to promote the quality of the urban environment, generate employment and income, and protect environmental health and support the efficiency and productivity of the economy (Ogwueleka, 2009). While the issues discussed by previous researchers are of great importance and provide a perspective on the waste management problems in general, the fact remains that the day to day management of the municipal solid waste is a complex and costly undertaking. According to Peavy, *et al.,* (1985), direct activities that must be considered and coordinated on a daily basis include waste generation rate, on site storage and processing, collection, transfer and transportation, processing and recovery, and disposal. These activities are associated directly with the management of solid wastes. Indirect activities that are also an important part of solid waste management programme include: financing, operations, equipment, personnel, cost accounting and budgeting, contract administration, ordinances and guidelines, legislatives, regulations and public communications. Table 2: describe the direct activities and functional elements of municipal solid waste management system.

The quantity and general composition of the waste materials that is generated is of critical importance in the design and operation of solid waste management system. Unfortunately, reliable quantity and composition data are difficult to obtain because most measurements are of the quantities collected or disposed of at a landfill (Peavy *et al.,* 1985). Factors that influence the quantity of municipal wastes generated include; (1) Geographic location, (2) Season of the year, (3) Collection frequency (affects the amount collected), (4) Use of kitchen waste grinders, (5) Characteristics of populace, (6) extent of salvaging and recycling. (7) Public attitudes enlightenment and orientation (8) Legislation (9) Population density (10) Level of commercial and economic activities and (11) level of industrialization, (Peavy *et al.,* 1985). Significant reductions in the quantities of solid wastes generated will occur when and if the public and consumer oriented companies are willing to change on their own volition to conserve national

resources and to reduce the economic burdens association with the management of solid wastes.(Aliyu, 2010), and (Bari *et al.*, 2012).

Table 1: Classification of materials comprising municipal solid waste (Peavy *et al.*, 1985).

S/N	Component	Description
1	Food waste	The animal, fruit, or vegetable (also called garbage) resulting from the handing, preparation, cooking, and eating of foods. Food wastes will decompose rapidly, especially in warm weather.
2	Rubbish	Combustible and non-combustible solid wastes, excluding food wastes and other decomposable materials. Typically combustible rubbish consists of materials such as paper, cardboards, plastics, textiles, rubber, leather, wood, furniture and garden trimmings. Non-combustible rubbish consists of items such as glass, crockery, tin cans, aluminium cans, ferrous and nonferrous metals, and dirt, and construction wastes.
3	Ashes and residues	Materials remaining from the burning of wood, coal, coke and other combustible wastes. Residues from power plants normally are not included in this category. Ashes and residues are normally composed of fine, powdery materials, cinders, clinkers, and small amounts of burned and partially burned materials.
4.	Demolition and construction wastes	Wastes from razed buildings and other structures are classified as demolition wastes. Waste from the construction remodelling and repairing of residential, commercial, and industrial buildings and similar structures are classified as construction wastes. These wastes may include dirt, stones, concrete, reinforcement steel bars, bricks, plaster, lumber, and shingles, plumbing, heating and electrical parts.
5.	Special wastes	Wastes such as street sweeping, roadside litter, catch-basin, debris, dead animals, and abandoned vehicles are classified as special wastes.
4.	Treatment plant wastes	The solid and semi-solid wastes from water, waste water and industrial waste facilities are included in this classification.

Income and economic growth have impact on the composition of waste. (Oyebode, 2013). According to Abila and Kantola (2013), there is a continuous increase of municipal solid waste production by households, educational institutions etc. From field work, it was observed that in Lagos State of Nigeria, sources of municipal solid wastes include (1) Residential (single family and multifamily dwellings, low, medium, and high rise apartments etc), (2) Commercial (stores, restaurants, industries, markets, office buildings, hotels, motels, print shop, auto repair shops, electrical and electronics repair shops, construction and demolitions sites, medical facilities and institutions etc.) and (3)

open areas (streets, alleys,   park, vacant lots, play grounds, beaches, highways, recreational areas etc.).

Table 2: Description of the direct activities and the functional elements of a solid waste management (Peavy *et al., 1985*).

Direct activities and functional elements	Description
Waste generation	Those activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal.
On site handling, storage, processing and collection.	Those activities associated with the handling, storage and processing of solid wastes at or near the point of generation.
Transfer and transport.	Those activities associate with (a) the transfer of wastes from the smaller collection vehicle to the longer transport equipment and (b) the subsequent transport of the waste, usually over long distance to the disposal site.
Processing and recovery.	Those techniques, equipment and facilities used both to improve the efficiency of the other functional elements, conversion of products or energy from solid waste.
Disposal.	Those activities associated with ultimate disposal of solid waste, including those waste collected and transported to a handful/dump sites, semi-solid wastes (sludge) from waste water treatment plants incinerator residue, compost, or other substances from the various solid waste processing plants that are of no further use.

The quantity and composition of waste generated vary from urban areas to rural areas likewise from State to State in Nigeria (Adeoye *et al.*, 2011). The rate of waste generation is directly proportional to population, socio-economic status and level of urbanization; hence the composition of waste generated varies from State to State (Adewole, 2009). Also the composition of waste generated per State is a function of the socio economic status, industrialization and commercialization (Olanrewaju and Ilemobade, 2009).

Efficient management of waste is a global concern requiring extensive research, and development works towards exploring newer application for a sustainable and environmental sound management (Bari *et al.,* 2012). According to Abila and Kentola (2013), the problem of waste management is a primordial and present issue in developing countries in Africa, particularly Nigeria. Municipal waste management

problems in Nigeria cut across concerns for human health, air, and water pollution among others. The analysis of the problems affecting the efficient management of municipal waste is critical for evolving a workable solution in an emerging economy like Nigeria.

Different approaches and interventions have been developed in the past of tackle municipal waste concerns with little or no progress (Adewole, 2009 and Adeoye *et al.*, 2011). Managing municipal waste requires intensification and application of knowledge management tools that guarantee sustainable environment and socio economic growth. Municipal solid waste management is an important part of urban infrastructure that ensures the protection of environment and human health (Aliyu, 2010).This research work aims at evaluating the current municipal solid waste management strategies, the current challenges and to recommend sustainable solutions to the problems of municipal solid waste management in Lagos State, Nigeria.

2.0   Methodology

Extensive literature search questionnaire, interviews, field works and observations were employed in the course of this research. Thirteen Local Government Areas were covered out of the Twenty Local Government Areas (LGAs) of Lagos State, Nigeria. The study was performed from January to August 2016 covering Alimosho LGA, Ajeromi – Ifelodun LGA, Kosofe LGA, Mushin LGA, Oshodi – Isolo LGA, Ojo LGA, Surulere LGA, Agege LGA, Ifako-Ijaye LGA, Shomolu LGA, Amuwo-Odofin LGA, Lagos Mainland LGA, and Lagos Island LGA of Lagos State Nigeria. Two hundred (200) well-structured and designed questionnaire were administered in each of the Local Government Areas (LGAs) studied. The data collected were analysed and discussed.

3.0   Results and Discussion

3.1   *Number of Respondents and Their Distribution by Gender, Age, and Level of Education.*

There are Twenty Local Government Areas (LGAs) in Lagos State, Nigeria. A total of 2600 questionnaires were distributed in Thirteen Local Government Areas of Lagos State. There were 1950 respondents to the questionnaire as shown in Table 3. The respondents consist of male and female of various age categories and educational level as shown in Tables 4, 5 and 6.

Table 3: Number of questionnaires distributed and the number of respondents

S/N	Local Government Areas (LGAs) Studied	Total Number of Questionnaires Distributed	Total Number of Respondent	
			Frequency (f)	Percentage (%)
1.	Alimosho LGA	200	134	67
2.	Ajeromi –Ifelodun LGA	200	162	81
3.	Kosofe LGA	200	148	74
4.	Mushin LGA	200	170	85
5.	Oshodi –Isolo LGA	200	138	69
6.	Ojo LGA	200	156	78
7.	Surulere LGA	200	130	65
8.	Agege LGA	200	172	86
9.	Ifako-Ijaye LGA	200	142	71
10	Shomolu LGA	200	166	83
11.	Amuwo-Odofin LGA	200	156	78
12.	Lagos Mainland	200	141	70.5
13.	Lagos Island	200	135	67.5
	Total	**2600**	**1950**	**75.00%**

Table 4: Distribution of respondents by gender

Gender	Frequency (f)	Percentage (%)
Male	1272	65.23
Female	678	34.77
Total	**1950**	**100**

Table 5: Distribution of respondents by age

Percentage (%)	Age categories (Years)	Number of respondents (f)
20.51	< 30	400
27.59	31 – 40	538
35.18	41 – 50	686
16.72	51 and above	326
100	**Total**	**1950**

Table 6: Educational level of the respondents

Age categories (Years)	Frequency (f)	Percentage (%)
No formal education	104	5.33
Primary school	391	20.05
Secondary school	615	31.54
Tertiary Education	840	43.08
Total	**1950**	**100**

3.2　Factors That Affects Waste Generation Rate

In the course of this research, it was observed that some factors affect solid waste generation rate in Lagos State, Nigeria. These factor include; geographical location, season of the year, collection frequency (affects amount collected), characteristics of the populace, extent of salvage and recycling, public attitudes and legislation. This concurs with the findings of Adoye *et al.*, (2011), Abel, (2009), Babayemi and Dauda (2009), Olanrewaju and Ilemobade (2009) and Adewole, (2009).

Factors influencing the solid waste generation in Nigeria include lack of advance technology, facility for separation at source, strength of solid waste management policy and enforcement, environmental education and awareness, and income status of individuals among others are factors affecting solid waste scenario in Nigeria (Babayemi and Dauda, 2009). Able (2009) showed that education, income and social status are important factors influencing per capita solid waste generation in Ogbomoso, Oyo State, Nigeria. Waste generation is directly proportional to population, socio-economic status and level of urbanization (Adeoye, et al, 2011, Adwole, 2009 and Olanre Waju and Ilemobade, 2009).

3.3　Waste Collection Systems Used In Lagos State

Table 7 shows the state collection system used in different part of Lagos. According to Peavy *et al.,* (1985), collection systems in which the containers used for the storage of wastes remain at the point of waste generation, except when moved for collection are defined as stationary container systems. Collection systems in which the containers used for the storage of wastes are hauled to the processing, transfer or disposal site, emptied and returned to either their original location or some other location are defined as hauled container systems. House to house collection system is the type in which the wastes are collected from houses. The waste are bagged and placed in front of each house by tenants and house hold members.

According to Ogwueleka (2009), the collection of solid waste is conducted by the State and Local Government environmental protection agencies. Informal solid waste collection operations exist in parallel with government agencies and registered waste contractors in Lagos State, Nigeria.

Table 7: Types of waste collection systems used in Lagos State

Types of waste collection systems	Frequency (f)	Percentage (%)
Stationary container systems and on-site storage	586	30.05
Hauled container systems	168	8.62
House to house systems (waste bagged and placed in front of each house by tenants and household members)	1196	61.33
Total	**1950**	**100**

3.4   Sectors Involved In Solid Waste Management In Lagos State

Table 8 shows the percentage involvement of the formal sector and the informal sector in municipal solid waste in Lagos State. According to Abila and Kantola (2013), in Lagos State the main government institutions responsible for environmental protection are the Lagos State Waste Management Authority and the Lagos State Ministry of Environment.

Table 8: Sectors involved in solid waste management in Lagos State

Sector	Frequency (f)	Percentage (%)
Formal sector (Lagos State Waste Management Authority, Lagos State Ministry of Environment, registered waste contractors and registered waste recycling firms).	1204	61.74
Informal sector (cart pushers, scavengers, waste resource merchants, etc).	746	38.26
Total	**1950**	**100**

3.5   Solid Waste Transfer Means And Methods

Table 9, shows the solid waste transfer means and methods currently used in Lagos State. The motor vehicles are the major means followed by the cart pushers.

Table 9: Solid waste transfer means and method

Transfer means and methods	Frequency (f)	Percentage (%)
Cart pushers (Informal sector)	514	26.36
Motor vehicles (Registered waste containers & Government Agencies)	1436	73.64
Rail roads	0	0.00
Ocean – going vessels	0	0.00
Total	**1674**	**100%**

3.6 *Waste Processing Techniques Used In Lagos State, Recovery Systems and Registered Waste Recycling Companies.*

Tables 10 and 11 show the waste processing techniques used in Lagos State, and the level of awareness of recovery systems and existence of registered waste recycling companies in Lagos State, Nigeria. Processing techniques are used in solid waste management systems to improve the efficiency of solid waste disposal to recover resources (useable materials), and to prepare materials for the recovery of conversion products and energy (Peavy *et al.*, 1985).

Table 10: Waste processing techniques used in Lagos State

Waste processing techniques	Frequency (f)	Percentage (%)
Mechanical system	686	35.18
compaction	587	30.10
Thermal volume reduction (incineration)	359	18.41
Manual separation of waste components	318	16.31
Total	**1950**	**100**

Table 11: Awareness of recovery systems and existence of registered waste recycling companies.

Response	Frequency (f)	Percentage (%)
Yes	1146	58.77
No	804	41.23
Total	**1950**	**100**

According to Ogwueleka (2013), there is no formal recycling of resource and recovery programmes in Nigeria. Currently, recovery and recycling operations are carried out by informal sector. The informal sector comprises of unregistered and unregulated waste management activities carried out by individuals, families, group or small enterprise. The sector is labour intensive and it provides employment opportunities for large group of people (Ogwueleka, 2009).

3.7   *Factors Affecting Municipal Solid Waste Management*

According to Abila and Kantola (2013), the problems militating municipal waste management in Nigeria are diverse and numerous. Agunwamba (1998), has it that these problems are related to economical, technological, psychological and political aspects in Nigeria. In Lagos State these problems vary from poor funding, legislation and poor implementation of policies, poor monitoring and evaluations, limited infrastructure and lack of trained professionals, level of awareness, poor recovery and recycling programme and disposal techniques (Dauda and Osita, 2000, Haapalainen and Pusa, 2012, and Ogu, 2000).

This research identified similar problems facing municipal solid waste management in Lagos State, Nigeria. Poor funding is one of the major problems constraining the waste management sector (Ogu, 2000). According to Abalia and Kantola, (2013), incapability of purchasing new waste collection trucks, limited staff, poor vehicle maintenance, obsolete waste storage containers, inability to purchase equipment among others are all attributed to shortage of capital. Actualizing sustainable waste management strategies require funding from government and donor agencies to effectively analyse, plan and implement result oriented policies, effective monitoring and evaluation strategies.

This research also identified poor recycling and disposal techniques as critical problems militating against sustainable waste management in Lagos State. The legislation and policies on waste management in Lagos State are strong but they are poorly implemented. The monitoring and evaluation of these policies are also poor.   The training and retraining policies of professionals and staff members of the waste management agencies and organizations are poorly implemented. Inadequate on site storage and handling facilities and inappropriate location, design, operations and maintenance of dump site/landfill were also observed among the factors militating against municipal solid waste management in Lagos State, Nigeria. These factor increase the transfer and disposal cost.

4.0   Conclusion and Recommendations

4.1   Conclusion

In Lagos State, Nigeria house to house waste collection systems, and stationary container systems are the major types of waste collection system used. The formal sector (government agencies, regulatory agencies and the registered waste contractors) are major players in solid waste management in Lagos State, Nigeria. The inability of the formal sector to adequately cope with the up-surge in the volume of municipal solid waste generated led to the creation of vacuum in the collection, transportation, recovery and disposal of solid waste in Lagos State. This vacuum was filled by the informal

sector (cart pushers, scavengers, unregistered waste contractors and recyclers). Both the formal and informal sectors play important roles in Lagos State solid waste management activities.

4.2   Recommendations

The following recommendations were made at the end of this study.

i.   The Lagos State Government and researchers should carry out an investigation into the effect of improper municipal solid waste management on public health.

ii.   The roles of the informal sector in municipal solid waste management and in on-site handling and processing of waste should and must be captured in the analysis, planning, design, implementation, monitoring, evaluation of sustainable waste management strategies in Lagos State.

iii.   Lagos State Government and regulatory agencies should regulate and implement effectively policies that will ensure sustainable waste management in Lagos State.

iv.   Staff members of the registered waste contractors, recycling firms and relevant government agencies should be trained and retrained regularly. Lagos State Government should invest in human capital development that guarantees sustainable waste management.

v.   To avoid serious environmental disaster in Lagos State, priority should be given to sustainable waste management strategies.

vi.   Relevant agencies of the Federal Government of Nigeria, Lagos State Government, international organisations and the National Orientation Agency in partnership with relevant professional bodies, donor agencies and research centres should organise regular enlightenment campaigns, seminars, conferences and workshops for all players in the municipal solid waste management on the need to adhere to waste management policies, standards, strategies, legislations, and safety measures in the course of their activities.

vii.   Land fill/dump sites should be properly located, designed and maintained.

vii.   Guidelines and manuals on housing near landfills and open sites should be developed and enforced.

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