Sapientia Foundation Journal of Education, Sciences and Gender Studies (SFJESGS), Vol.4 No3 September, 2022; pg. 173 – 186
ISSN: 2734-2522 (Print); ISSN: 2734-2514 (Online)

AN ASSESSMENT OF SOLID WASTE MANAGEMENT SYSTEM IN LOKOJA METROPOLIS

[1]HAUWA OPALUWA
[1]Kogi State Sanitation and Waste Management Board,
Lokoja, Kogi State Nigeria

&
[2]SAMUEL IBBI IBRAHIM
[2]Department of Geography Federal University,
Lokoja, Kogi State Nigeria

Corresponding e-mail: samuel.ibrahim@fulokoja.edu.ng

ABSTRACT

Increasing population poses serious challenges in municipal waste management especially in the developing metropolitan cities of Nigeria. This study seeks to assess the management system of solid waste in Lokoja metropolis to profound measures for adequate management. Systematic sampling was adopted in sampling five areas in Lokoja town and structured interview was conducted on the operational heads of Kogi State Sanitation and Waste management Board (KSWMB). Information on adequate working equipment, staff and solid waste handling concept were acquired, while data on the monthly volume of waste generated and collected from 2013 to 2018 were obtained and analysed. It was revealed that open dumping is the predominant method and practice of disposing solid waste; there are no landfill sites and incinerators in Lokoja, Kogi State. The results revealed that the highest volume of waste was recorded in July and August being the period of harvesting of some farm produce. The statistics showed that there is no significant difference in the level of waste generated and collected between each consecutive year at 95% significant level. Meanwhile, the minimum and maximum waste collected yearly stand at a constant value of 2240 and 2576 tonnes respectively. The difference in yearly waste collection from 2013 to 2018 was assessed from the pattern of change in the value of percentage waste collected which fell significantly from about 80% in 2013 to about 68% in 2018. Inadequate manpower and equipment were found to be the greatest challenges militating against the Board and inefficient method in treating solid waste in the metropolis. Conclusively, the amount of waste collected is perpetually behind that generated and that the management concept has no program for recycling of recyclable wastes. There is need to involve an approach that will allow for implementation of waste management hierarchy with less cost and maximum benefits to the State, by designation of sanitary landfill so that state government will allow for proper waste management in the municipal area. They should also involve the methods of converting waste to wealth in making bricks for building and waste dugs to fertilizers for crops cultivations. They should allow private sector to participate in waste management as well.

Keywords; Open dumping, Landfill sites, incinerators, solid waste and recyclable wastes.

1. Introduction

The generation of waste in any society is a combination of some factors which include population, lifestyle of the people, socio-cultural background and composition of materials for usage by the households. Therefore, solid waste generation is mainly driven by population growth, technological advancements and economic development globally (Singh et al., 2014). Furthermore, El-Fadel and Maalouf (2019) observed that over 2 billion tons (BT) of solid waste are generated annually in large cities with projections to reach 3.4 BT by 2050 worldwide. This is particularly so in developing economies where waste generation rate is expected to increase by three folds by 2050 (Kaza et al., 2018). Consequently, increasing population poses serious challenges in municipal waste management especially in the developing countries where waste handling facilities are inadequate and rate of waste generation surpasses collection and disposal by relevant agencies.

The delay in handling of solid waste has a wide range of environmental implications such as generation of methane emissions from landfills contributing to global warming, littering and various types of pollution caused by leaching from landfills or emissions from waste treatment facilities. Paper and plastic materials are often major components of solid waste that could be easily converted to fertilizer or bricks for building houses (Akinbode, 2010). They contain substances which are hazardous to health which may cause skin disease, respiratory problems, carcinogenic, neurological disease, low birth weight, chemical poisoning through inhalation. The main factors for the environmental impact of solid waste are absence of source separation programmes, lack of technical expertise and institutional arrangements, improper collection, segregation, transportation and disposal methods, the person's attitude towards waste management, lack of awareness, insufficient funds, and community involvement.

The usage of polythene bags has become the order of the day. These synthetic materials are not biodegradable and contributed to littering of the municipal area. Thus, accumulation of indiscriminately disposed solid waste in all nooks and crannies of Lokoja has become detrimental not only to the environment but posed serious health hazards to the populace as it creates a favourable breeding environment for diseases vectors to thrive (Remigios and Wiseman, 2012; Siji, 2015). Furthermore, wastes are dumped indiscriminately; streets are littered with waste and heaps of solid wastes are seen as you walk across the metropolis and any available vacant plots are fully utilised as dumpsite by the nearest neighbourhood for instance in Figure 1.

Figure 1: Indiscriminate waste dump by 500 Housing units, Ganaja road (Left image) and designated dump site at Gadumo area, Ganaja road (Right image); Lokoja. Sources: Author's Fieldwork, 2019.

Although, Siji (2015) has performed an assessment of the state of municipal solid waste management (MSWM) in Lokoja but the study focussed more on optimization of solid waste collection, towards recommending routes for waste evacuation. An in-depth analysis of the system of solid waste generation, collection and disposal in Lokoja metropolis is not adequately stressed. Therefore, this paper seeks to assess the solid waste handling and collection system in Lokoja, Kogi State.

2. Municipal Solid Waste Generation and Management

The levels of urbanisation, industrialization, and intensity of agricultural activities couple with variation in wealth of communities have given rise to different waste management problems. The design and operation of a functional element in the management of solid waste is a function of the knowledge on the sources of solid waste along with data on the composition and rates of generation which form the basis to the design (Agbu, 2012).

Therefore, solid waste is a matter of place and time, because what is a waste can become resources at another place and at different time. The function of reuse and recycle implies that waste especially solid waste can be reuse and recycle so as to generate another set of useful material for human need. Another point is that waste from developed counties can turn out to be useful in the developing world. For example, the many products such as cars, fridges, clothing materials that have be used in developed world are been transported to the poor countries as a product that are been sold to people to use. The use of fairly used cars from America and Europe has gained prominence in sub-Sahara Africa. Some people believed that those materials are better than brand new ones (Agbu, 2012). According to World Health Organisation (WHO), the low-income countries generate approximately 0.5 kg to 3 kg of total health care waste per year by an individual.

Nowadays, E-waste is considered as one of the most rapidly growing types of waste with average ratio of 1% in solid waste and reached 2% in 2010 and is expected to increase more in the future (Baldé et al., 2017). The per capita solid waste generation in developed countries like Canada, Switzerland, France, United Kingdom and USA varies between 0.9 – 2.7kg per day and in the developing countries like India, Sri Lanka and Thailand generates 0.3-0.65kg,

0.4-0.85kg and 0.5-1kg per day (I-Korner, 2003 and 2006). From the total quantity of waste generated in Canada, nearly 50% is municipal solid waste. A report from the US Environmental Protection Agency (USEPA) showed that 56.9% of total waste generated in the USA is disposed of in landfills, 27% is material recycled and 16.1% is incinerated (Kuniyal, 2010). However, the issue of value cannot be ruled out completely since we still have waste materials which can be recycled while others can be reused.

In Nigeria municipal solid waste generation varies from one state to another depending on the population and economic activities. Ibadan is ranked as the world number one dirtiest city while Lagos ranked the fourth dirtiest in the world (Adeyemi, 2011). Research and statistics revealed that the population growth rate in Nigeria as at 2006 population census was 3.2% and that urban growth rate was about 5.3% per annum while average waste generation rate is put at 0.49 kg per person per day (Adewole, 2009). Lagos generated about 4 million tons of waste in 1995 (Solomon, 2009). Kano metropolis generated approximately 3000 tonnes per day (Nabegu, 2010). It was also found that each person generated approximately 0.53 kg/day in Onitsha (Ogwueleka, 2009). Likewise, in Oyo state, 50.90 tons of solid waste was generated in 2005 and 55.20 tons per day in 2008 (Okewole, 2010). UNDP/NISEPA reported in 2009 that Minna the Niger State capital generates about 90 tons of solid waste per day. Records also indicated that Abuja generates 300 tons of waste per person per day (Adeyemi, 2011).

Unfortunately, there are no records, documents and data on waste generation per person/capita/day. However, in Nigeria, the measurement of generated waste is between 0.44 and 0.66 kg/cap/day in cities (Ogwueleka, 2009) as against 0.7-1.8 kg/cap/day in industrialised nations. Generally, the amount of waste generated in a municipality is a function of the inhabitant's income. Table 1 shows the density and size of waste been generated by different cities in the six geo-political zones of Nigeria. Waste weight and liquid content are much higher in under developed nations which call for appropriate techniques and management systems. The weight of solid waste in Nigeria is within 250 kg/m^3 and 370 kg/m^3 based on studies which cut across some cities in the six geo-political zones of Nigeria. The weight of waste determines the storage and collection system available.

Table 1: Municipal Solid Waste Generation in Nigerian cities

City	**Population**	**Agency**	**Tonnage per month**	**Density kg/m^3**	**Kg/cap/ day**
Lagos	8,029,200	Lagos Waste management Authority	255,556	294	0.63
Kano	3,248,700	Kano State Environmental Protection Agency	156,676	290	0.56
Ibadan	307,840	Oyo State Environmental Protection Commission	135,391	330	0.51
Kaduna	1,458,900	Kaduna State Environmental Protection Agency	114,433	320	0.58
Port Harcourt	1,053,900	Rivers State Environmental Protection Agency	117,825	300	0.60

Makurdi	259,000	Benue State Urban Development Board	24,242	340	0.48
Onitsha	509,500	Anambra State Environmental Protection Agency	84,137	310	0.53
Nsukka	100,700	Enugu State Environmental Protection Agency	12,000	370	0.44
Abuja	159,900	Abuja Environmental Protection Agency	14,785	280	0.66

Sources: Ogwueleka (2009).

The difference in the waste generated by these cities is due to population size, land use extent, industrialization, economic prosperity, and the habit of the inhabitants. The availability of large expanse of land and poverty have made the people of the North Central Region to have lower waste generation because of low standard of living compared to other part of the country. However, the National Bureau of Statistics revealed in their annual report of 2010 that Lagos and South western Nigeria have the lowest poverty level and most industrialised, therefore, generates more waste than any part of the country, as well as having the best form of waste management in the country (NBS, 2010).

3. Materials and Method

Lokoja is located between latitude 7° 45′ N-7°51′N and longitude 6°41′E -6° 45′E and lies at an altitude 45-125 meters above sea level. It is the capital city of Kogi State, situated close to the confluence of Niger-Benue rivers (Alabi, 2009), border at the Northeast ward by Koton-Karfi and FCT southwardby Dekina/Bassa plains, westward by Kabba plains and eastward by Confluence of Niger and Benue Rivers. The study area is shown in Figure 1.

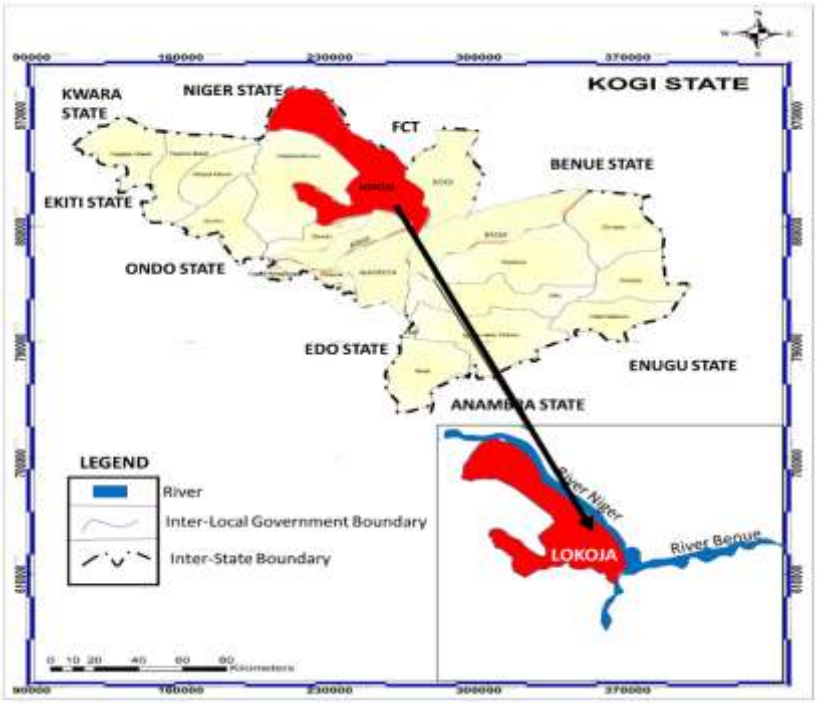

Figure 1: Administrative Map of Kogi State showing the Study Area

The state experiences two seasons, dry and wet season. The wet season sets in from March-April and reaches its climax by August- September and by October the dry season sets in till March of the following year. Its average annual rainfall is between 1016mm and 1524mm with mean annual temperature of about 27.7^{o} C and a population of 195,261 (NPC, 2006). The terrain of the region comprises of dissected undulating plains on one hand and lofty hill masses on the other. Mount Patti is the dominant physical feature of the town coupled with a number of intermittent valleys and streams criss-crossing the breadth of the town. The primary data were collected directly from field through field visitation and inspection. The data formats of this phase are basically field observation reports and personal interview with the officials of KSWMB.

Field inspection was carried out for first-hand information on waste management concept in Lokoja Municipal area. Observation was based on the following two components:

(i) Waste generation which involves waste gathering at designated location and the collection of same from those points to disposal locations in the city.
(ii) Waste handling which encompasses waste treatment such as sorting, recycling etc. either at collection points or disposal points and the final disposal such as burning, surface dumping, incineration, burying etc.

In order to obtain further information that could aid proper evaluation of solid waste handling by the Board, a structured interview was prepare in form of questionnaire which was answered by the Board management through its operational heads. Questions bothering on adequacy of working equipment, staff etc. as well as the challenges faced by the Board in the course of its duty were asked. Other information obtained during this session include, detail procedure adopted by the Board for solid waste management in Lokoja. These include: the level of yearly waste generation and collection in Lokoja municipal area by the Board (from 2013 to 2018), method of waste collection, handling and disposal; etc.

The information obtained from field and other sources were sorted and arranged in the form that could enhance assessment. All pictures taken during site inspection were used for analyses, while information from the interviews were extracted and prepared into tables and graphical formats for analysis, while Microsoft excel was used for further data manipulation and presentations.

4. Results and Discussion

Detail discussions of findings from field inspection, results from other data sources as well as the analysis of the findings are presented in this Section. From field inspection and the structured interview, the major waste materials being produced within Lokoja municipal area as observed are: food remnants, roughages and packages, bottles, aluminium scraps, metal scraps, papers, nylon bags, vegetative matters and others.

It was found from the study that there are 25 designated central collection points provided by KSWMB. In addition, there are several community-based and non-designated dumping sites seen across the city, there are 5 of such sites in Kabawa area, 2 in Adankolo, as well as Lokogoma community and Felele.

It was noticed from the field observation that the use of fixed containers system is practiced for the collection of waste in Lokoja. The containers are usually drums (Figure 2) placed at strategic locations (commonly on open spaces randomly selected either at the end of a street or road junctions) where these wastes are generated. The wastes after collection from these designated and non-designated spots are transported to permanent disposal site by the Board trucks.

Figure 2: Waste Drums provide for house hold waste collection at Lokongoma Phase I Housing Estate Lokoja. Sources: Author's Fieldwork, 2019.

In some neighbourhood in Lokoja, wastes are left unattended for days or weeks before collection for disposal (see Figure 3); this creates not only unhygienic dumping but also causes resistance from residents close to the collection points, thereby disrupting the whole operation.

Figure 3: Uncollected Overfilled Waste Drums at Adankolo Junction (Left) and Lokongoma community (Right) in Lokoja.Sources: Author's Fieldwork, 2019.

In order to better understand the level of waste generation and collection, information on the monthly volume of waste generation in Lokoja for the period of six years (2013 to 2018) as extracted from the interview response is depicted in Table 2.

Table 2 Monthly volume of waste generation (in tonnes) in Lokoja from 2013 to 2018.

	VOLUME (tonnes)					
MONTH/YEAR	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
JAN	3116.31	3216.03	3318.95	3425.15	3534.76	3647.87
FEB	2915.26	3008.55	3104.82	3204.17	3306.71	3412.52
MARCH	3116.31	3216.03	3318.95	3425.15	3534.76	3647.87
APRIL	3015.79	3112.29	3211.88	3314.66	3420.73	3530.2
MAY	3116.31	3216.03	3318.95	3425.15	3534.76	3647.87
JUNE	3015.79	3112.29	3211.88	3314.66	3420.73	3530.2
JULY	3116.31	3216.03	3318.95	3425.15	3534.76	3647.87
AUG	3116.31	3216.03	3318.95	3425.15	3534.76	3647.87
SEPT.	3015.79	3112.29	3211.88	3314.66	3420.73	3530.2
OCT.	3116.31	3216.03	3318.95	3425.15	3534.76	3647.87
NOV	3015.79	3112.29	3211.88	3314.66	3420.73	3530.2
DEC	3116.31	3216.03	3318.95	3425.15	3534.76	3647.87
TOTAL (tonnes)	**36792.59**	**37969.92**	**39184.99**	**40438.86**	**41732.95**	**43068.41**

Sources: Author's Fieldwork, 2019.

While the monthly volume of waste collected over the same period of time is detailed in Table3.

Table 3: Monthly volume of waste collection (in tonnes) in Lokoja from 2013 to 2018

	VOLUME (tonnes)					
MONTH/YEAR	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
JAN	2576	2464	2352	2352	2464	2576
FEB	2352	2240	2240	2240	2240	2240
MARCH	2352	2464	2576	2576	2464	2352
APRIL	2464	2464	2352	2352	2352	2464
MAY	2464	2352	2352	2464	2576	2576
JUNE	2352	2464	2464	2464	2352	2240
JULY	2576	2576	2464	2352	2464	2576
AUG	2352	2352	2464	2576	2576	2464
SEPT.	2464	2464	2464	2464	2352	2352
OCT.	2576	2464	2352	2352	2576	2576
NOV	2240	2352	2464	2464	2464	2352
DEC	2576	2576	2576	2464	2464	2464
TOTAL	**29344**	**29232**	**29120**	**29120**	**29344**	**29232**

Sources: Author's Fieldwork, 2019.

During harvesting seasons, Agricultural waste becomes prevalent in most of the dump sites but due to their bio-degradable nature, they get decayed with time; the highest volume was recorded in July and August.

Furthermore, wastes are dumped in the open space on the street at close proximity to the houses and public places and some were dumped very close to the river (Figure 5). Others are dumped right into the river, especially in the suburban zones. Disposal of solid waste into water bodies may be detrimental to aquatic organisms because bacteria like Ecoli often lead to depletion of the dissolved oxygen thereby endangering the survival of aquatic habitats (Nabegu, 2010).

Figure 4: Waste dump beside Meme stream Adankolo (Left image) and House of Assembly Quarters (Right image) Lokoja Sources: Author's Fieldwork, 2019.

Transportation of wastes from collection point to disposal location is very critical in waste management, therefore, the adequacy of the transport equipment at KSWMB was also evaluated and it was found that there are two compactor trucks available for waste services (see Figure 5) along with two haulage trucks, two tractors and one pale-loader in Lokoja.

Figure 5: One of the Compactors available in Lokoja
Sources: Author's Fieldwork, 2019.

It was further found that the only two haulage trucks available are used for Government house, Deputy Governor's office wastes and some other few selected offices. Also, some individuals leaving close to disposal sites provide supplementary transport on self-service basis. The providers of this service evacuate waste from individual houses often using simple hand push trucks from places where orthodox tools cannot access. This arrangement as affirmed by Nwaka (2005), could also delivers the ample desirable occupation for the jam-packed youth of the town.

As regards waste handling, it was observed from investigation conducted those wastes are not sorted in Lokoja. The total wastes generated and collected from all the designated and non-designated dumpsites are transported to the disposal sites by KSWMB; co-mixing organic with inorganic wastes as well as wet and dry wastes (Figure 6).

Figure 6: A waste dump site in Kabawa; Lokoja showing the complexity of co-mixed waste system. Sources: Author's Fieldwork, 2019.

As obtained from KSWMB, there are ten plots approved as designated final disposal sites in Lokoja. Waste that are collected from different neighbourhoods and public places in the town are transported into these various sites for disposal. Generally, waste burning in open dumpsite is a common practice in most of Nigerian urban centres due to the inefficient waste collection and disposal system (Ukpong and Udofia, 2011). Open dumping is the predominant method and practice of disposing solid waste; there are no landfill sites and incinerators in Kogi State. Remigios (2010) stated that since there is no landfill, open dumps become the most desirable method of waste disposal. Therefore, the open dump approach is employed in Lokoja, the weight of the cumulative waste is then reduced by open air burning (see Figure 7) and the remains are then buried in very deep trench using the pale-loader.

Figure 7: The final dump site at Felele; Lokoja.Sources: Author's Fieldwork, 2019.
Similar findings were reported by El-Fadel and Maalouf (2019) for the city of Lebanon.

4.2 Discussion

In order to evaluate the level of yearly waste generation and collection in Lokoja municipal area by KSWMB, data on volume of waste generated and collected in Lokoja was analysed. This is to further assess the performance of the responsible agency in ensuring clean environment in Lokoja municipal area. There are different volumes of waste being generated in the months and based on the population. It was observed that the highest volume of waste was recorded in July and August because that is the period when the harvesting of farm produce generates more waste. The descriptive statistics was used to evaluate the level of waste generation and collected by the Board from 2013to 2018. This is represented in Table 4.

Table 4: Comparative statistics of Waste Generation and Collection by KSWMB in Lokoja Municipal Area

	Waste generated (in tonnes)			**Waste collected (in tonnes)**			**Percentage**
Year	**Amount**	**Min**	**Max**	**Amount**	**Min**	**Max**	**waste collected**
2013	43792.41	3412.52	3790.87	33984	2564	2784	77.602
2014	41735.01	3315.26	3796.33	33998	2576	2776	81.462
2015	43648.01	3466.03	3786	32057	2340	2764	73.444
2016	44081.99	3584.82	3815.95	31336	2240	2576	71.086
2017	44237.35	3584.66	3895.45	31337	2240	2576	70.838
2018	44870.75	3650.73	3984.72	31628	2340	2576	70.487

Sources: Author's Fieldwork, 2019.

From Table4 above, it was observed that the volume of waste generated increases progressively while the volume collected fluctuates inconsistently for the six years period evaluated in this study. Because the two data sets are of equal sizes, the two-sample equal variance t-test was performed on the mean yearly volumes of solid waste generated and collected. The two-tailed ϱ value is less than 0.0001 which suggests that there is extremely statistically significant difference between the volume of waste generated and the volume collected at 95% confidence interval. This is further depicted graphically in Figure 8.

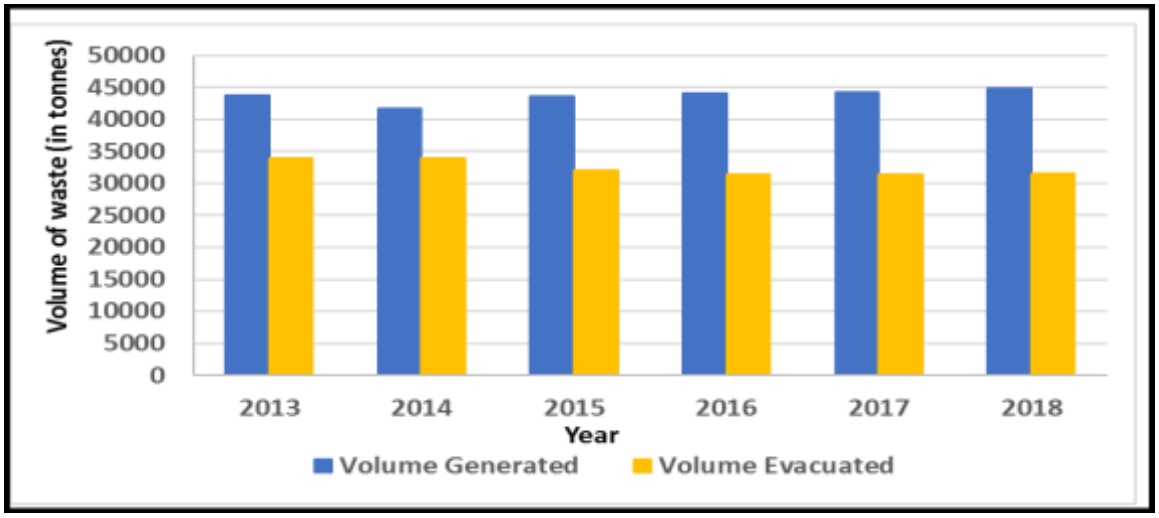

Figure 8 Waste generated and collected by KSWMB between 2013 and 2018Sources: Author's Fieldwork, 2019.

The difference in yearly waste collection from 2013 to 2018 can be clearly seen from the pattern of change in the value of percentage waste collected which has fallen gradually from about 77% in 2013 to about 70% in 2018.This shows that the rate of waste collection is perpetually behind that of generation. This could be due to a number of factors such as the negligence of waste at collection points due to (i) lack of commitment on the part of the personnel of the KSWMB and (ii) the strength of manpower available to KSWMB. For instance, the personal interview conducted at the Board indicated that the nominal roll of the agency has about 4 management staff, 132 operational staff, 4 drivers and 8 waste collectors. Ferronato and Torretta (2019) observed that such situation encourages unsustainable practices.

Therefore, the adoption of the open dumping (Figure 6) and burning (Figure 7) approaches in addition to the inadequacy of waste bins could be the reasons for high level of indiscriminate dumping of waste in Lokoja. This practice of indiscriminate dumping does not take into considerations leach ate which is the washing away of this waste water into the earth, this has negative consequences on ground water supply. For instance, Olanrewaju *et al.* (2012) examined the trace metal concentration in leachates from some selected dumpsites in Lokoja, they observed that the leachates from those sites contain very high concentration of iron, manganese, zinc, lead and copper are much higher than Federal Environmental Protection Agency (FEPA) and World Health Organisation (WHO) standards. This is a danger signal to public health as affirmed by Ramachandra et al. (2018).

The negligence of waste at collection points may not only be due to personnel commitment but may also be largely due to insufficiency of the equipment. For instance, only two tippers for entire Lokoja are inadequate for the job and to worsen the situation, the trucks were reserved for institutional wastes.

5. Conclusion and Recommendations

Assessment of solid waste management system in Lokoja metropolis has been discussed in this paper. the level of yearly waste generation and collection in Lokoja municipal area by KSWMB were evaluated by analysing data on volume of waste generated and collected in

Lokoja. Also,the waste handling mechanism which encompasses waste treatment such as sorting, recycling and was analysed. The study revealed that the amount of waste collected is perpetually behind that generated; this could be due to the inadequate manpower and equipment available to the Board. Meanwhile, the management concept as found from KSWMB has no program for recycling of recyclable wastes and as such does not fit into the contemporary waste management concept such as the Reduce, Recycle and Reuse (3Rs) concept which is the globally accepted contemporary approach. Nevertheless, global best practice in sanitation and sustainable urban environment demands that modern handling approaches are inculcated into urban waste management strategies. In addition, there is very low presence of private operators in the waste management system in the city. Therefore, it can be concluded from the study that the waste management system adopted by KSWMB is grossly inadequate and does not meet the standard for sustainable urban environment. Thus, we recommend from the findings of this study that an approach that will allow for implementation of waste management hierarchy with less cost and maximum benefits to the State should be evolved. There should be provision of designated sanitary landfill by the state government to allow for proper waste management in the municipal area while, waste sorting, reduction, and treatment should be in place to avoid causing ground water pollution. This can be easily achieved by enhancing the activities of scavengers (rag pickers).Sorted solid waste can be properly mixed cement to mould bricks for construction and the sewage collected from it could be used as raw material for making organic and non-organic fertilizers.

References

Adewole, T.A. (2009): Waste Management towards Sustainable Development in Nigeria: A case study of Lagos State. International Non-Governmental Organization (NGO) Journal. 4(4). 173-179.

Adeyemi, O.B (2011): Waste Management in Contemporary Nigeria: The Abuja example. International Journal of Politics and Good Governance. 2(2).

Agbu, E. (2012): The Role of Scavengers in Municipal Solid Waste Handling in Jalingo Town. An unpoblished M.Sc Thesis, Faculty of Built Environment, Universiti Teknologi Malaysia.

Akinbode, F. (2010): Solid Waste Handling Procedure in Nigeria. Environmental Health. Walden University: PUBH-6165-4.

Alabi, M. O (2009): Urban Sprawl, Pattern and Measurement in Lokoja, Nigeria. Theoretical and Empirical Researches in Urban Management 4(13) / November.

Baldé, C.P., Forti V., Gray, V., Kuehr, R., Stegmann,P. (2017): The Global E-waste Monitor– 2017, United NationsUniversity (UNU), International Telecommunication Union (ITU) & International Solid Waste Association(ISWA), Bonn/Geneva/Vienna.

El-Fadel, M., and Maalouf, A. (2019): Challenges of Waste Management in a Developing Context: Lessons from Lebanon.DOI: 10.4018/978-1-7998-0198-6.ch007 IGI Global.

Ferronato, N. and Torretta V. (2019): Waste Mismanagement in Developing Countries: A Review of Global Issues. Int. J. Environ Res Public Health. 16(6): 1060, doi: 10.3390/ijerph16061060.Published online 2019 Mar 24.

Kaza, Silpa; Yao, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank. (2018): What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development; Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/30317 License: CC BY 3.0 IGO.

Kuniyal, J. C. (2010): Solid Waste Management in the Sensitive Hills of the North-western Himalayas. In J. Singh, R. AL, J. Singh, and R. AL (Eds.), Solid Waste Management - Present and Future Challenges (p. 260). Kullu-Manali: I.K International Publishing House Pvt Ltd.

Nabegu, A.B. (2010): Analyses of Municipal Solid Waste in Kano Metropolis. Nigerian. Journal of Human. Ecology. 31(2). 111-119.

National Population Commission (2006): National Population Census: Population Figure 2006. Presidency, Abuja. Federal Republic of Nigeria.

Nigerian Bureau of Statistics (2010): National Bureau of Statistics annual report of 2010.

Nwaka, G.I. (2005): The Urban Informal Sector in Nigeria: Towards Economic Development, Environmental Health and Social Harmony. Global Urban Development Magazine. 1(1).

Ogwueleka, T.Ch (2009): Municipal Solid Waste Characteristics and Management in Nigeria. Iran. Environ Health, Sci. and Eng. 6(3). 173-180.

Okewole, A. and Afon, A.O (2007): Estimating the Quality of Solid Waste Generation in Oyo State, Nigeria. 25(4), 371-379.

Olanrewaju, G.O., Sa'id, M.D. and Ayodele, J.T. (2012): Trace Metal Concentrations in Leachates from Open Dumpsites in Lokoja, Kogi State, Nigeria. Bayero Journal of Pure and Applied Sciences, 5(2): 143 – 147. Doi: http://dx.doi.org/10.4314/bajopas.v5i2.28.

Ramachandra T.V., Bharath H.A., Kulkarni G., Han S.S. (2018): Municipal solid waste: Generation, composition and GHG emissions in Bangalore, India. Renew. Sustain. Energy Rev.82:1122–1136. doi: 10.1016/j.rser.2017.09.085.

Remigios, M.V. (2010): An Overview of the Management and Practice of Solid Waste Disposal Sites in African Cities and Town. Geography and Environmental Studies, Zimbabwe Open University, Zimbabwe. Journal of Sustainable Development in Africa, 12(7): 233-239.

Remigios, V. M., and Wiseman, M. (2012): The Management, Practice and Environmental Health Implications of the Municipal Solid Waste Dump Site in Alice, South Africa. Online Journal of Social Sciences Research. ISSN 2277-0844; Volume 1, Issue 5, pp 125-131.

Siji, J. (2015): Optimization of Municipal Solid Waste Collection and Disposal for Lokoja, Nigeria. M Sc Thesis University of Nigeria, Nsukka.

Singh, J., Laurenti, R., Sinha, R., and Frostell, B. (2014): Progress and challenges to the global waste management system. Waste Management & ResearchVol. 32(9) 800 –812.

Ukpong, I.E. and Udofia, E.P. (2011): Domestic Solid Waste Management in a Rapidly Growing Nigerian City of Uyo. Department of Geography and Planning, University of Uyo, Akwa Ibom State, Nigeria. Journal of Hum. Ecol. 36(3): 229-235.