FUDMA Journal of Engineering and Technology
ISSN: 3092-9385
https://sites.google.com/fudutsinma.edu.ng/fjet
Volume 1, Issue 2, 2025, 535-541

Waste Management in Bauchi Metropolis: Solid Measure and Characterization in Municipality

Samaila J. EL-PATEH[1*], Ibrahim IDRIS[2]

[1*]Bauchi State Ministry of Water Resources, Bauchi, Bauchi State, Nigeria
[2]Kano State Ministry of Water Resources, Kano, Kano State, Nigeria

[1*]jadorima@gmail.com, [2]idrischiri29@gmail.com

Abstract

The research examined waste management in order to prevent diseases in the Bauchi city, Bauchi local government in Bauchi state of Nigeria by technical and scientific approach to utilized generated solid of waste; that is physical composition of refuse dumped out of small, medium enterprises and communities. The study exhausted more than twelve-week when conducting questionnaire, interviews and survey that employed in the collection of the required data. According to National Population Commission (2006) population of Bauchi metropolis and its environs has growth rate of 3.2% annually which identified different percentage embedded to solid waste disposals; composition of dirt, ash and other unidentified objects was 20.2%, paper/cardboard 14.1%, nylon and polythene 16.4%, garden leaves 13.5%, food waste 11.6% while tin cans/metals were 5.1%, textile/fabrics 6.2%, plastic/rubber 6.8% and lastly glass and ceramics waste 6.1%. Over 80% of the waste fraction has the potential for recovery into other products; with this, 42.4% could be recycled and 51.56% suitable for biological conversions such as composting and anaerobic digestion, expected solid waste accumulated in Bauchi capital city daily was 0.30 kg/cap/day, the solid waste management studies may guide stakeholders to pick positive decisions on waste management options.

Keywords: *Solid waste, waste characterization, waste components, household waste.*

1.0 Introduction

Human activities are attached to the liquid and solid waste disposals whereby the study interested in solid waste; the analysis realized that inflection to population contributes to the use of goods later to have more discarded substances as solid waste; they are produced either as a by-product of production process or arises from municipal or domestic activities, industry/manufacturing, agriculture, construction, hospitals/medical and tourism sectors [3]. Municipal solid waste constitutes environmental challenges globally, especially in developing countries, due to increasing waste generation, population growth, inadequate infrastructure, lack of data and poor planning [4].

It is simply any material at the wrong place which can be segregated, transported, recycled and reused with great financial and environmental benefit; they are produced in households, commercial, public and private institutions and industries. Currently, inefficient waste management leads to loss of valuable resources as significant quantities of Municipal Solid Waste (MSW) that leads to increased pressure on the environment and human health. Especially in developing countries where there is lack of advanced technology for processing and treatment of the waste. Another aspect is the current trends in MSW generation. Generation of waste is directly related to economic growth and population income. Along with economic growth and changes in developing countries are bound to result in increased of production and consumption patterns, waste generation has steadily increased and according to estimations will continue to increase during the next few decades [6].

2.0 Scope and Methodology of the Study

According to Bauchi State Environmental Protection Agency (BASEPA) there are thirty-eight (38) solid waste dump sites within Bauchi metropolis after the research made observations six out of them were selected as a sample. Namely: Commercial Area (Muda-Lawal market, Green Light), Low-income area (Masakar Makafi), High-Income Area (State Low-Cost, Wunti Multi-Purpose), Institutional Area (General Hassan Usman College Bauchi), Industrial Area (Railway Quarters), Medium Density (Emir's Palace). The following is mapping as in Figure 1:

Received: 26/07/2025; Revised: 01/08/2025; Accepted: 04/08/2025; Published: 24/09/2025

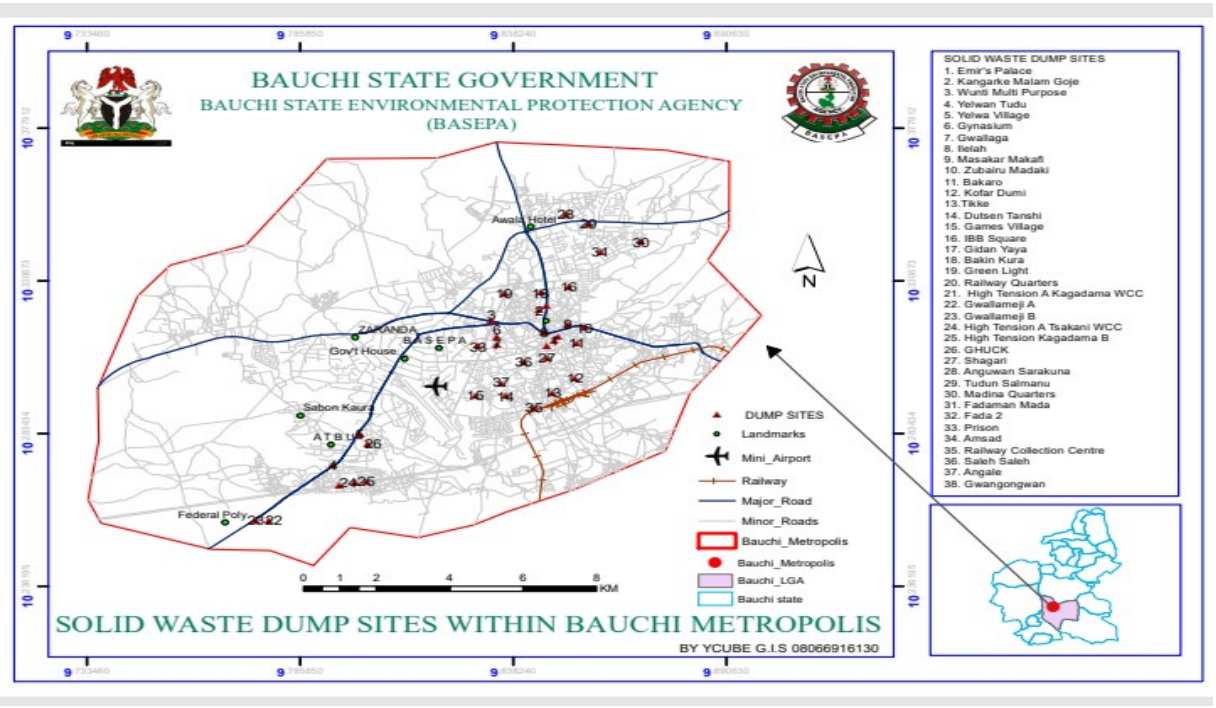

Figure 1: Mapping

The research employed laborers as assistant for sorting solid waste and each person was assigned to handle a particular material (waste) out of: food remnants, textiles, nylon/polythene, plastics, garden trimmings/leaves, paper/cardboards, glass/ceramics tin cans/metals and dirt/ ash.

Also used electronic computing price scale MJ-PEPS-002 weigh waste sample loads; the scale has a capacity to measure up to 300kg/100g. The separated components were compacted tightly to simulate the conditions in the storage container (waste bin) from which they were collected. The percentage distribution of each component by mass and the as-discarded density were determined,

Density = Mass/volume (kg/m³) (1)
Quartered weight (M) = 188kg
Percentage (%) component of waste = Density/M (kg) x 100 (2)

The six selected locations of solid waste measures as in the percentage distributions except that the waste was not compacted in above previous experiment. The preserved (kg/m³) analyzed as:

$$\text{Preserved } \varrho = \frac{W_2 - W_1}{V_1} \quad kg/m^3 \tag{3}$$

Where: - W_1 = Weight of container, W_2 = Total weight of waste sample plus the container, V_1 = Total volume

Population and economic status dippers that affects result of solid waste studied when calculated in selected locations; Masakan makafi representing low income with high population density area, State low-cost estate representing the middle class and New GRA representing high income elite's residential area.

Solid waste was allowed to be collected after seven days from thirty household in containers using personnel's from BASEPA whose routine job was to empty waste containers daily in minimum of two weeks. The accumulated waste materials were collected in large nylon bags for subsequent weighing at the Industrial Development Centre (IDC), Zango, Bauchi. Using the electronic computing price scale MJ-PEPS 002 weighing balance.

3.0 Results and Discussion

The results of the field work and laboratory analysis conducted and the data obtained from measurements of relevant parameter were also discussed and interpreted as follows:

3.1 Physical Composition of Wastes Analysis

Figure 2 is the composition of the wastes and its classification into food waste, textile, nylon/polythene, garden trimmings/leaves, papers/cardboard, plastics, glass/ceramics, metals/cans and dirt/undifferentiated waste, etc. and the data gotten was analyzed. Consider Figure 2:

Received: 26/07/2025; Revised: 01/08/2025; Accepted: 04/08/2025; Published: 24/09/2025

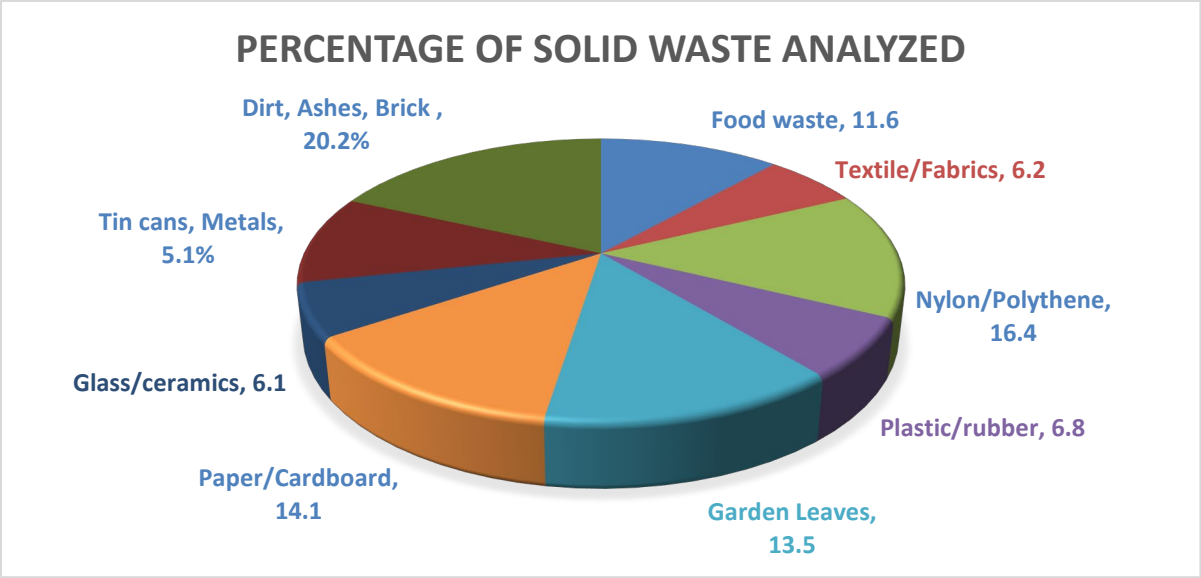

Figure 2: Percentage of solid waste analyzed

Above are observed solid waste average collected in the study consists as follows: 20.2% + 16.4% + 13.5% + 14.1% +11.6% + 5.1% + 6.8% + 6.2% + 6.1% = 100%. The research discovered the factors responsible for the percentage of solid waste;

a.	Dirt and ash:	20.2%	= Cooking with traditional materials
b.	Nylon and polythene:	16.4%	= Packaging of consuming items
c.	Paper and Cardboard:	14.1%	= Schools disposals
d.	Garden Leaves:	13.5%	= The view of the trees that were planted to prevent desert encroachment and those that beauty the environment.
e.	Food Waste:	11.6%	= Consumption of daily meals
f.	Plastic and Rubber:	6.8%	= food stuffs and soft drinks disposals
g.	Textile and Fabrics:	6.2%	= Tailoring craft disposals
h.	Glass and Ceramics:	6.1%	= constructions
i.	Tin Cans and Metals:	5.1%	= Soft drinks disposals

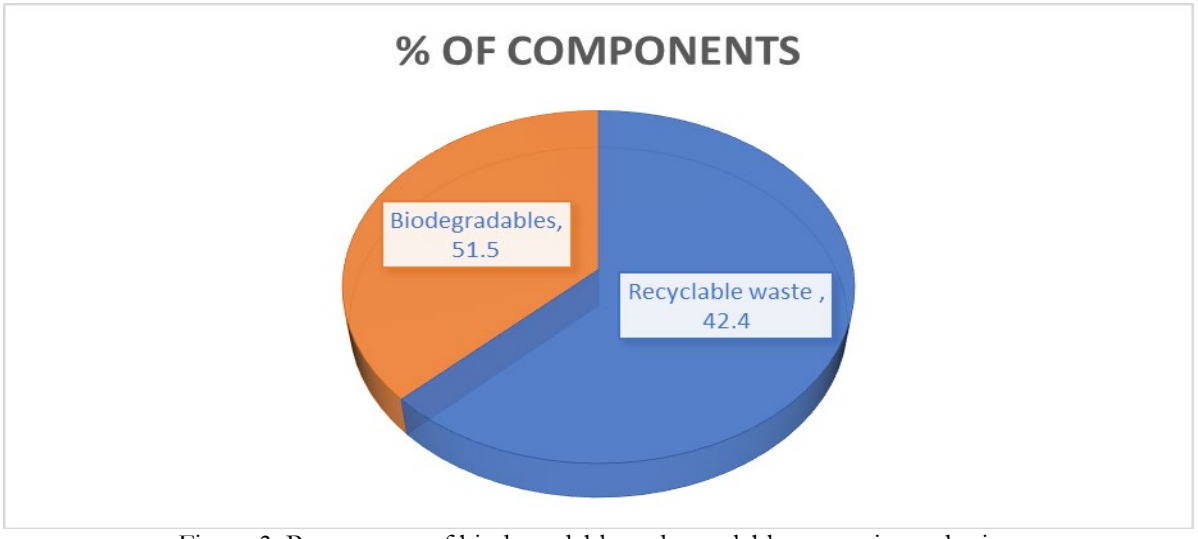

Figure 3: Percentages of biodegradable and recyclable wastes in study sites

Received: 26/07/2025; Revised: 01/08/2025; Accepted: 04/08/2025; Published: 24/09/2025

Table 1: Percentage of biodegradable and recyclable wastes in study sites

S/N	Recyclable waste	%	Biodegradables	%
1	Tin cans, Metals	5.1	Food waste	11.6
2	Plastic/rubber	6.8	Garden Leaves	13.5
3	Paper/Cardboard	14.1	Textiles	6.2
4	Nylon/Polythene	16.4	Dirt/ash	20.2
Total		42.4		51.5

3.2 Bulk density of municipal waste in selected study sites

Figure 4. analyzed the bulk density of the same waste collected for waste composition. Waste collected at the commercial area (Muda-Lawal market "Green Light") has the highest bulk density of 304.8kg/m^3 with the lowest of 174.7kg/m^3 in the institutional areas (General Hassan Usman College Bauchi respectively. The food waste which normally contains much water may be responsible for the high bulk density around the market. Therefore, the average bulk density of the study area is 227.6kg/m^3. This finding was also supported by [14] who found the bulk density of Sabon Gari area of Kano state to be 259kg/m3. Bulk density is important for the selection of waste collection equipment. For example, compactor trucks are most effective if the waste has a low bulk density.

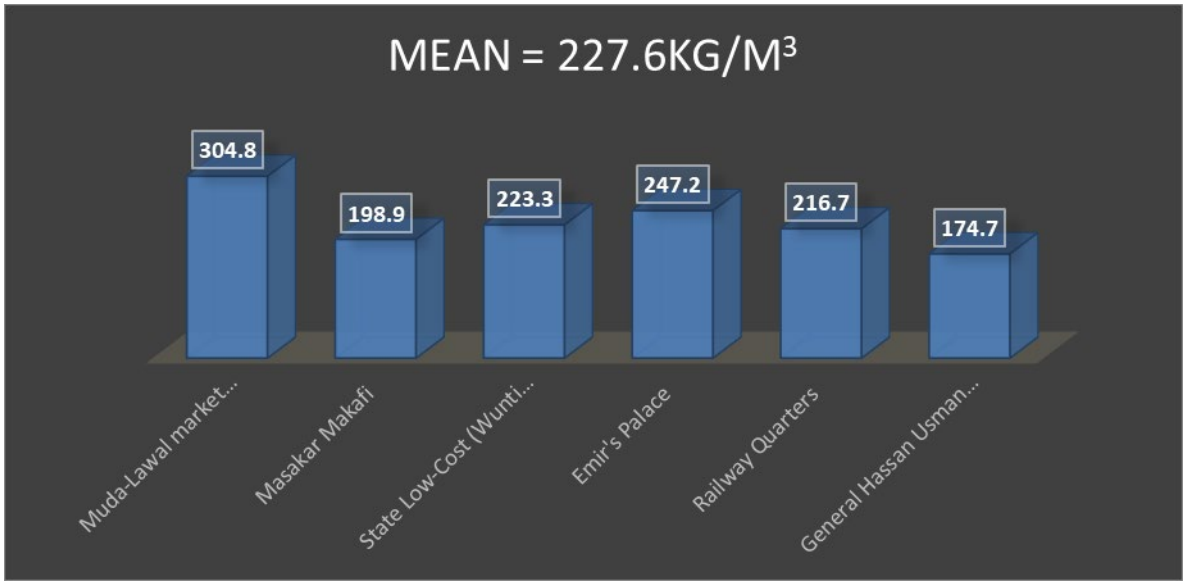

Figure 4: Bulk Density of waste in some designated areas in Bauchi Metropolis

3.3 Identification of Household to Waste in Bauchi metropolis

In next figure the study displays the result of the per capital household waste generation obtained from field assessment in some selected study area. Waste generation in study area showed variation among category of residence. The per capita house hold waste generated in the Low-income areas is 0.26 kg/c/day, 0.35 kg/c/day in the Middle-class areas and 0.42 kg/c/day in the High-income areas. Furthermore, from the locations of the waste collection points 65% of the points are in the Low-income areas while the Middle income and High income make up 25 and 10% respectively. The differences could either be as a result of income level, socio-economic distribution, consumption habit, or disposal habits of people [16]. This can be linked to the life style and culture of the people of the area.

Received: 26/07/2025; Revised: 01/08/2025; Accepted: 04/08/2025; Published: 24/09/2025

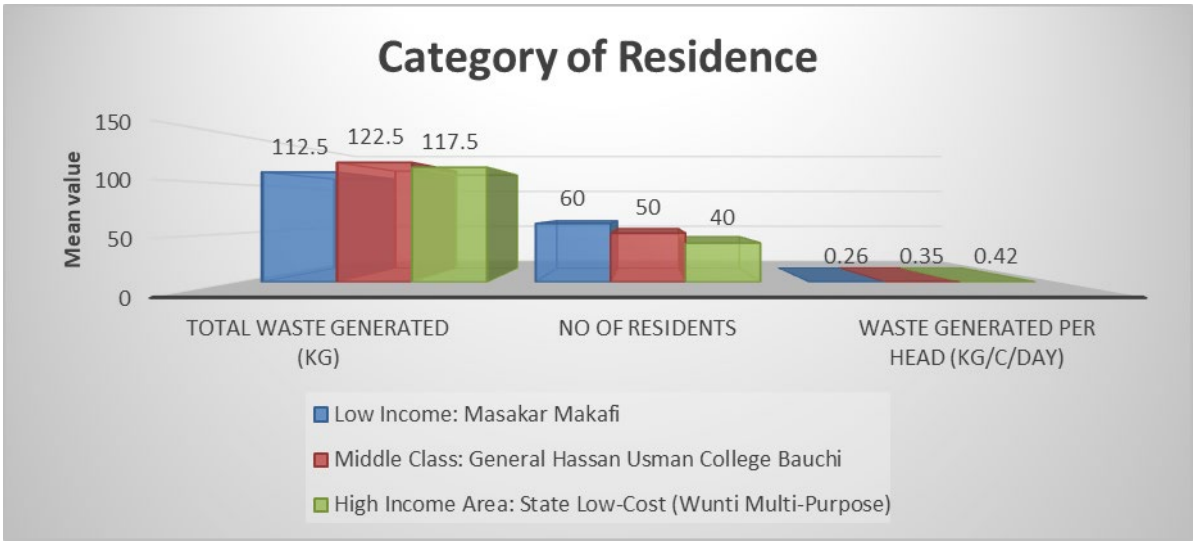

Figure 5: Category of residence

Bauchi State Environmental Protection Agency (BASEPA) estimated that, the quantity of waste to be generated in Bauchi city daily is 345,478.9 kg which a volume of 764m^3 were collected daily by the sanitation agency.

3.4 Strategy for Management of Shortfall

The strategy for waste management that will be sustainable in Bauchi city is pivoted on the 51.5% components of the bio waste and 42.4% of the recyclables generated daily (Figure 3). Waste producers must be advised to segregate waste from source into color polythene bags before taking them to the collection points. The Bio waste can be collected in black bags whiles other recyclables in white bags.

The Bio wastes which are separately collected shall be treated in an anaerobic digester (Compost Plant) and the other major recoverable fractions are centrally collected and transferred to a built facility where user industries and manufacturers can source for their raw materials. In order to implement this plan, it is essential to have recipient facilities and transfer stations built within reasonable distances from Bauchi metropolis. This plan is cost effective and shall also generate reasonable revenue for Government.

4.0 Conclusion and Recommendations

4.1 Conclusion

From the results obtained, it was discovered that the average percentage weight of dirt, ash and other unidentifiable decomposable was 20.2%, paper/cardboard 14.1%, nylon and polythene 16.4%, garden leaves 13.5%, food waste 11.6% while tin cans/metals were 5.1%, textile/fabrics 6.2%, plastic/rubber 6.8% and lastly glass and ceramics waste 6.1%. According to the physical waste characterization 42.4% of the wastes generated were recyclables while 51.5% are biodegradable waste. This was determined by grouping the waste components into the two types of wastes and summing up their percentage compositions. The mean bulk density of the waste from the project area is 227.6kg/m^3. The time taken for a waste bin of 11 m^3 capacity to fill is 24 hours around the markets and residential areas while a record of 2-3 days takes the bin to be filled in institutional areas and some low-income residential areas of the city. The research recorded a per capita household waste generation of 0.3kg/day in Bauchi metropolis. With a 0.01 % increase in the rate of per capita waste generation, in five years, by 2029, the waste generated in Bauchi metropolis shall be 152,529,485 kg and 356,860,467 kg by 2039. Only 50.3% of the total waste generated daily is being collected leaving the other half unattended to hereby causing serious environmental hazards in the city.

4.2 Recommendations

The following are some recommendations that will effective and efficient waste management in Bauchi metropolis:

i. The Bauchi State Environmental Protection Agency and Other Matters Law needs to be more cogent and in depth on waste management issues as well as have adequate powers to enforce the law without obstacles. The law should make BASEPA an independent waste management authority which should function more as a private business corporation, this will enhance its efficiency because it will aspire to break even and at the same time try to live up to expectations.
ii. BASEPA should as well establish waste segregation facilities where waste sorting, reduction, material recovery and collection are done. Otherwise, the activities of waste scavengers at the waste dump sites

Received: 26/07/2025; Revised: 01/08/2025; Accepted: 04/08/2025; Published: 24/09/2025

should be officially organized by Government. This will create a good number of jobs for our teeming unemployed youths especially where ready markets and good prices can be sourced for their salvaged materials.

iii. With about 25.1% of the waste generated in Bauchi metropolis been bio- degradable, more evaluation for potential waste streams and feasibility for establishing a Compost Plant should be done, this can be achieved through a collaboration between BASEPA and the Ministry of Agricultural Services, this investment may assist the Government in realizing the huge capital needed for effective and efficient management of waste.

iv. Eradicate open space waste collection and indiscriminate dumping by providing waste collectors/bins in more areas of the metropolis and acquire at least three sites for scientific waste disposal (Sanitary landfill).

v. With the huge capital required for an effective and efficient waste management, the Bauchi State Government should begin to develop a framework to licensed private waste companies who can invest in solid waste collection, treatment and disposal or consider recapitalizing BASEPA for the real task ahead. Government can adopt the producer responsibility and polluter pays principle. Those who produce the waste or contaminate the environment should pay the full cost of their actions.

References

[1] Uduak, B., Abasi-ofon, T., Udemeobong, O., Mbetobong, J., Maja, S., Ayoge, B., Uduak, L. and Satyanarayana, N. (2024). Characteristics and management of municipal solid waste in Uyo, Akwa Ibom state, Nigeria. Scientific Reports. https://doi.org/10.1038/s41598-024-61108-0

[2] Collins, O., Ugwu, a., Chigbogu G., Ozoegwu a,c, Paul, A., Ozor a. (2020). Solid waste quantification and characterization in university of Nigeria, Nsukka campus, and recommendations for sustainable management. Heliyon, 6(04255), Published by Elsevier Ltd. ISSN: 2405-8440. PP. 1-9. https://doi.org/10.1016/j.heliyon.2020.e04255

[3] Shekarau, J. A., Muhammed, D. Z., and Yunusa, Z. L. (2019). Household Solid Waste Generation and Characterization for the Determination of Waste Management Option in Chikun Local Government Area, Kaduna State, Nigeria. African Scholar Journal of Env. Design & Construction Mgt. African Scholar Publications & Research International. ISSN: 1896-6783. 15(4). PP. 317-330.

[4] Ishmael, O., Dexter, V. L.H. and Ian, J. (2024). Transitioning towards Circular Economy through Municipal Solid Waste Analysis and Characterisation using SowaCLINK Software. Fronties in Sustainability. Doi.10.3389/frsus.2024.1321329

[5] Abet, O.A. (2009) An Analysis of Solid Waste Generation in a Traditional African city: The example of Ogbomoso, Nigeria. Environment and Urbanization, SAGE Journals, 19(2): PP. 527-537.

[6] UNDP. (2000) Human Development Report, Oxford University Press 2001

[7] Abubakar, I. R., Maniruzzaman, K. M., Dano, U. L., AlShihri, F. S., AlShammari, M. S., Ahmed, S. M. S., et al. (2022). Environmental sustainability impacts of solid waste management practices in the global south. Int. J. Environ. Res. Public Health 19(19): PP. 12717. doi: 10.3390/ijerph191912717

[8] United Nations Environment Programme (2024). Beyond an age of waste. Global Waste Management Outlook 2024. International Solid Waste Association (ISWA). ISBN: 978-92-807-4129-2, DOI: https://doi.org/10.59117/20.500.11822/44939

[9] Seshie, V. I., Obiri-Danso, K. and Miezah, K. (2020). Municipal Solid Waste Characterization and Quantification as a Measure towards Effective Waste Management in the Takoradi Sub-Metro, Ghana. Ghana Mining Journal, 20(2), PP. 86-98. https://dx.doi.org/10.4314/gm.v20i2.10

[10] Agunwamba, J.C., (1998). Solid Waste Management in Nigeria: Problem and Issue. Environmental Management, 22(6), PP. 849-856. doi:10.1007/s002679900152

[11] Adeniran, A.E., Nubi, A.T., and Adelopo, O.A., (2017). Solid Waste Generation and Characterization in the University of Lagos for a Sustainable Waste Management. Waste Management 67, PP. 3-10. DOI: 10.1016/j.wasman.2017.05.002 http://www.sciencedirect.com/science/article/pii/S0956053X17303045

[12] Okeniyi, J.O., and Anwan, E.U., (2012). Solid Wastes Generation in Covenant University, Ota, Nigeria: Characterisation and Implication for Sustainable Waste Management. Journal of Materials and Environmental Science. 3(2). ISSN: 2028-2508. PP. 420-424

[13] Adogu, P.O.U., Uwakwe, K.A., Egenti, N.B., Okwuoha, A.P. and Nkwocha, I.B. (2015). Assessment of Waste Management Practices among Residents of Owerri Municipal Imo State Nigeria. Journal of Environmental Protection, 6(5), PP. 446-456. http://dx.doi.org/10.4236/jep.2015.65043

[14] Bichi, M.H., Amatobi D.A., (2013) Characterization of Household Solid Wastes Generated in Sabon Gari Area of Kano in Northern Nigeria. American Journal of Research Communication ISSN: 2325-4076, 1(4) PP. 166-168

[15] Shekarau, J. A., Muhammed, D. Z., and Yunusa, Z. L. (2019). Household Solid Waste Generation and Characterization for the Determination of Waste Management Option in Chikun Local Government Area,

Kaduna State, Nigeria. African Scholar Journal of Env. Design & Construction Mgt. African Scholar Publications & Research International. ISSN: 1896-6783. 15(4). PP. 317-330.

[16] Ogwueleka, T.C. (2013). Survey of household waste composition and quantities in Abuja, Nigeria, Resources, Conservation and Recycling, 77, pp. 52–60.

[17] Dauda, M. and O. O. Osita, O.O (2003). Solid waste management and re-use in Maiduguri, Nigeria. Towards the Millennium Development Goals. 29th WEDC International Conference.

[18] Igbinomwanhia, D.I. and Olanikpekun J. (2011). Municipal solid Waste Management Practice in Lagos Metropolis - A Case study of Domestic - Solid Waste in Mushine Local Government Area, Nigerian Journal of Biomedical Engineering, Nigerian Institute of Biomedical Engineering. 9(1) Pp 49-56.

Received: 26/07/2025; Revised: 01/08/2025; Accepted: 04/08/2025; Published: 24/09/2025