Per Capita Solid Waste Generation and Characterization in Makurdi Metropolis, Nigeria

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ARTICLE INFO	ABSTRACT
	This study is aimed at ascertaining the per capita generation and characterization of waste in Makurdi metropolis. The study population consists of all the residents in the households of the selected study areas. Sample sizes of 60 households were selected purposively from three (3) residential areas in Makurdi metropolis which includes Wadata (low income areas), High Level (medium income areas), and Judges Quarters (high income areas). Field observations, secondary data and key informant interviews were also used. Simple random sampling and analysis of solid waste from specific sources (Households) was used for waste characterization whereas house-to-house weight analysis method was used to quantify the waste. The solid waste generation rate in the areas which the survey was conducted revealed that a total sample waste load of 1185.95 Kg was weighed for the three areas. From the analysis of the primary data gathered on the samples of solid waste generated, the order of waste generated is as follows; organic waste (81.30 %) > ash/sand (5.86 %) > Paper (2.78 %) > Metal/Tin (2.03 %) > Bag/Shoes (1.84 %) > Leather (1.74 %) > textiles (1.47 %) > Plastic (1.24 %) > glass/ceramics (0.41 %). The average per capita generation rate was also estimated to be 0.45 kg/ capita/ day with an average household size of 6 persons.

	ÖZ
Anahtar Kelimeler: Katı atık, Kişi başı atık üretimi, Karakterizasyon, Makurdi.	Bu çalışmada Makurdi metropolünde kişi başına atık üretimi ve karakterizasyonu amaçlanmıştır. Çalışma popülasyonu, seçilen çalışma alanlarındaki hanelerde yaşayan tüm sakinlerden oluşmaktadır. Makurdi metropolündeki Wadata (düşük gelirli alanlar), High Level (orta gelirli alanlar) ve Judges Quarters 'ı (yüksek gelirli alanlar) içeren üç (3) yerleşim alanından 60 hane örneklem büyüklüğü seçilmiştir. Saha gözlemleri, ikincil veriler ve kilit bilgi verici görüşmeler de kullanılmıştır. Atıkların karakterizasyonu için basit rastgele örnekleme ve belirli kaynaklardan (hane halkı) gelen katı atık analizi kullanılırken, atıkları ölçmek için evden eve ağırlık analizi yöntemi kullanılmıştır. Anketin gerçekleştirildiği alanlardaki katı atık üretim oranı, üç alan için toplam 1185,95 Kg örnek atık yükünün tartıldığını ortaya koymuştur. Üretilen katı atık örnekleri üzerinde toplanan birincil verilerin analizine göre, üretilen atıkların sırası şu şekildedir; organik atık (% 81.30) > kül / kum (% 5.86) > Kağıt (% 2.78) > Metal / Kalay (% 2.03) > Çanta / Ayakkabı (% 1.84) > Deri (% 1.74) > tekstil (% 1.47) > Plastik (% 1.24) > cam / seramik (% 0.41). Kişi

başına ortalama üretim oranının da, ortalama 6 kişi hanehalkı büyüklüğü ile 0.45 kg / kişi / gün olduğu tahmin edilmektedir.

1. Introduction

It is obvious that many cities in Nigeria have developed over time without proper planning, thus, resulting to the presence of open/indiscriminate dumping of solid waste especially on undeveloped areas [1]. The problem of solid waste generation and management is a global phenomenon that is not just peculiar to Nigeria alone but cuts across the entire universe [2]. This problem is such that it has forced the adoption of frameworks that can effectively handle waste especially in developed countries of the world. According to Giusti [3] the practices of solid waste management may not be uniform across countries (i.e. both developed and developing). However, some very advanced frameworks that enhance solid waste management practices include the waste hierarchy, which is the 3Rs of waste management; Reduce, Reuse and Recycle have been adopted. In this practice, waste characterization is dependent on their desirability in terms of waste minimization.

Municipal solid waste management is considered a complex concept because it often affects the lifestyle of the people together with factors such as rapid development and under-estimated contributors and stakeholders [4]. According to Kum et al. [5], most urban settlements are not without waste generation and they are generated from residential, commercial, industrial, and institutional areas. A high proportion of these wastes are solid in nature. Municipal solid waste (MSW) consists of degradable items such as paper, textiles, food waste, straw and yard waste, partially degradable items such as wood, disposable napkins and sludge, sanitary residues and non-degradable items such as leather, plastics, rubbers, metals, glass, ash from fuel burning like coal, briquettes or woods, dust and electronic waste [6]. These wastes are produced from the economic activities and consumption patterns in a particular locality. The amount and characterization of these wastes vary from place to place and mostly influenced by the population density and level of income. For instance, industrialized countries are expected to generate higher amount of waste, while low-income countries with lesser commercial activities are expected to produce lower waste [5].

UNU-WIDER in 2010 [7], opinionated that organic fractions of municipal solid waste (OFMSW) generated in developing countries is about three times what is generated in developed countries. For us in this part of the world (i.e. Nigeria), OFMSW constitute up to 50 percent of solid waste generated. On a general note, the component of municipal solid waste is considered to be dependent on factors such as source and age of the waste characterized. In Nigeria today, the most seen solid waste sample can be obtained directly from source namely: households, offices, market stores and stalls. This study is aimed at obtaining the quantity of waste generation per head in Makurdi metropolis.

2. Material and Method

2.1. Area of Study

Makurdi is the capital of Benue State which is located along River Benue with coordinates 70.43'50"N and 80.32'10"E having an estimated population of over 600,000 as at 2006 [8] and still growing. It has an Average annual temperature of about 31°C and relative humidity of 66% annually. The town is divided by River Benue into North and South banks, which are connected by two bridges (Old and New brigde). The southern part of the town is made up of several wards which includes the Old GRA, Ankpa Ward, Wadata Ward, High Level, Wurukum (Low Level), New GRA, etc.

2.2. Population of the study

The study population consisted of all the residents in the households of the selected study areas. Sample sizes of 60 households were selected purposively from the three (3) residential areas of Makurdi metropolis which includes Wadata (low income areas), High Level (medium income areas), and Judges Quarters (high income areas).

2.3. Data collection technique

Data collection was initiated by informing selected households of the aim of carrying out such a study and to receive feedback on their willingness to participate in the study. Copies of the prepared questionnaires were administered to them in order to meet the objectives of the study. It was explained to the various residents in the selected households in the three (3) study areas selected for the research that on a daily basis, their garbage would be collected for a period of 7 days. On that basis, trash bags were provided for each household in the study areas in order t allow for collection of all

their solid waste products generated within the period of the study. And the samples were collected at the end of the week and given a label according to the perception of the income levels of the households, i.e. High, Middle and Low.

2.4. Data Analysis

The weekly waste collected from the various households across the study areas were moved to the laboratory, after which analysis was carried on the weights of each trash bags as well as the characterization of the wastes. In other words, the wastes were sorted into specified categories, which were then bagged, weighed, and recorded. The data gathered for each household was analyzed, using the weighted average technique. And a composition table was drawn, showing the percentage generation rate, as well as the rate in Kilogram generated per household. Charts were also presented to show the analysis on the composition of solid waste generated within the study period as well as the population of the generators. The data was analyzed by Microsoft excel software. The raw data was inputted into the software and related charts were generated.

3. Result and Discussion

3.1. Combined Composition of Waste Generated for the selected Zones

It is usual for municipal solid waste to be characterized by materials such as, paper and paperboard, yard trimmings, food scraps, plastics, furniture, and clothing [9]. Thus, the municipal solid waste (MSW) collected in the study was analyzed. The municipal solid waste generated was because of items used and thrown away by the generators. A total sample waste load by weight of 1185.95 Kg was weighed. The details regarding the overall composition of household solid waste sampled over the study period for the three selected communities is presented in Table 1.

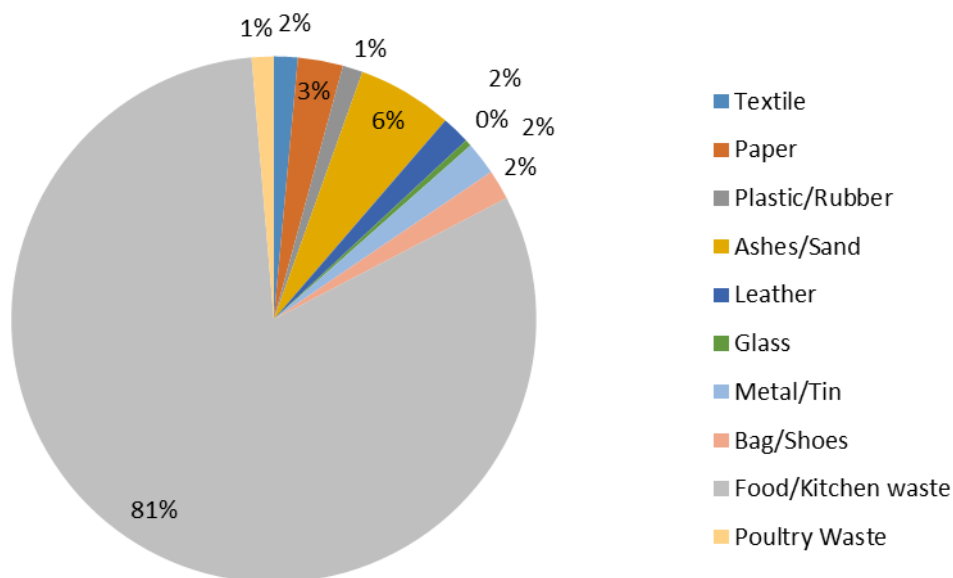**Table 1.** Overall composition of waste generated

WASTE COMPOSITION	WASTE GENERATED (KG)	WASTE GENERATED (%)
Paper	32.96	2.78
Plastic	14.71	1.24
Leather	20.59	1.74
Ashes/Sand	69.48	5.86
Textile	17.4	1.47
Glass	4.82	0.41
Bag/Shoes	21.76	1.84
Food/Kitchen Waste	964.16	81.30
Poultry Waste	16	1.35
Metal/Tin	24.04	2.03
TOTAL	**1185.9 kg**	**100%**

From the analysis of the primary data gathered on the samples of solid waste generated, the order of waste generated is as follows; organic waste (81.30 %) > ash/sand (5.86 %) > Paper (2.78 %) > Metal/Tin (2.03 %) > Bag/Shoes (1.84 %) > Leather (1.74 %) > textiles (1.47 %) > Plastic (1.24 %) > glass/ceramics (0.41 %). The chart showing the percentage composition generated for the three communities is presented in Figure 1.

3.2. Composition of Waste Generated for the selected Zones

Raw data was collected from different socioeconomic class which includes low, middle and high income earners

within the selected residential areas in the municipality. The composition of waste generated at the different zones is presented in Table 2.

Figure 1. Composition of Municipal Solid Waste

Table 2. Composition of waste generated by the different zones

Waste Composition	Low Income Earners	Middle Income Earners	High Income Earners
Paper	5.96	18	9
Plastic	2.1	6.41	6.2
Leather	5.99	6.1	8.5
Ashes/Sand	24.68	22.2	22.6
Textile	3.6	2.4	11.4
Glass	0	4.82	0
Bag/Shoes	0	6.4	15.36
Food/Kitchen Waste	402.55	260.6	301
Poultry Waste	0	0	16

Metal/Tin	1.6	10.2	12.24
TOTAL	446.48 Kg	337.13 Kg	402.3 Kg

Wadata Community (low income): Wadata was classified under low income residential area in the municipality with sampled total household size of 112 and total waste generation of 446.48 Kg from a sample size of 20 households. The per capita waste generation rate for the low income earning residential area was 0.569 Kg / person / day and an average household size of 5 persons.

High Level (middle-income): High level was classified under middle income earners residential area. It had sampled total household size of 102 and total waste generation of 337.13 Kg from sampled size of 20 households. The per capita waste generation rate was 0.430 Kg / person / day and an average household size of 5 persons.

Judges Quarters (high income): Judges Quarter was classified as a high-income earners residential area. It had a total household size of 115 and total waste generation of 402.3 Kg from a sample size of 20 households. The waste generation rate of this residential area was 0.5178 Kg / person / day with an average household size of 6 persons. The average per capita waste being generated in the study area is estimated to be 0.45 kg/capita/ day. Authors such as Samuel et al. [10] hinted that the per capita waste generation for different cities in Nigeria such as Lagos (0.63 kg/ capita/ day), Kano (0.56 kg/ capita/ day), Ibadan (0.51 kg/ capita/ day), Kaduna (0.58 kg/ capita/ day), Port Harcourt (0.60 kg/capita/day), Onisha (0.53 kg/capita/day), Nsukka (0.44 kg/capita/day) and Abuja (0.66 kg/capita/day) have been obtained. Solomon [11] quoted 0.49 kg/capita/day for average Nigerian communities with household and commercial centers. Therefore, the per capita generation rate as revealed in the study is 0.45kg/capita/ day and is in line with previous studies. Figure 2 shows the population densities of the selected zones as well as their generation rates.
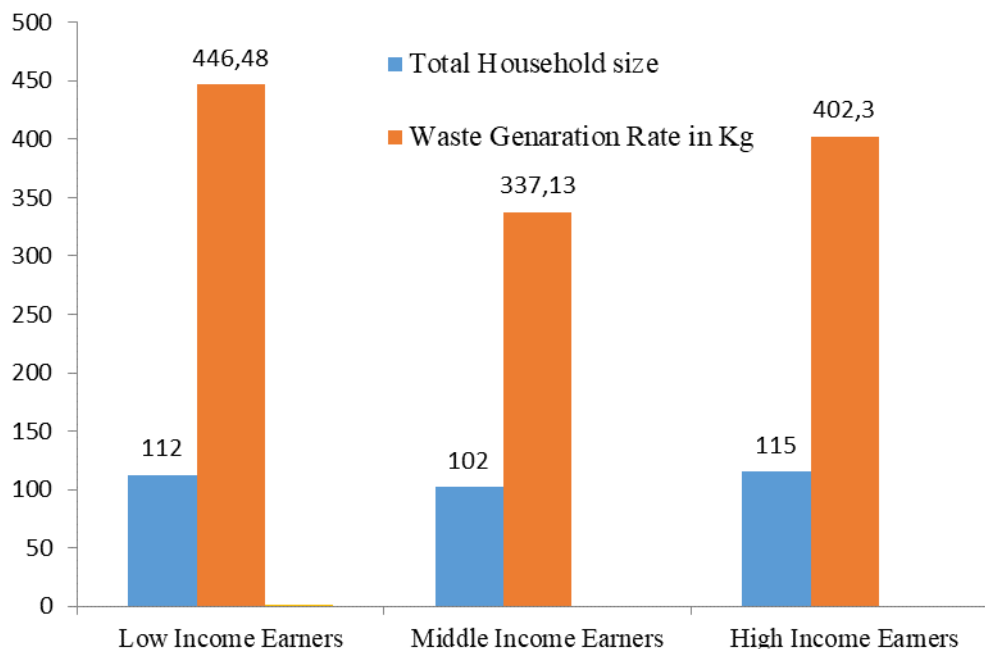
Figure 2. Population Density for selected Zones and their waste generated

The population densities for the three zones and their solid wastes generated is present in Figure 2. This study reveals that population density of a particular municipal area can greatly influence waste generation rate as this is seen by the estimated fractions of household waste generated from the three different locations. The middle income earners

residential area (High Level) and the High income Earners residential area (Judges Quarter) was estimated to have generated the lowest amount of solid waste, while the low income earners residential area (Wadata), generated the highest amount of solid waste. This trend is undoubtedly influenced by income and the socio economic activity and population density.

3.3. Percentage composition of waste collected from the selected zones

The Table below (i.e. Table 4.3) shows the percentage of solid waste generation rates for each of the selected zones. The constituents of these solid wastes are mostly organic solid waste and hazardous waste in different quantities. And the highest percentage of solid waste constituents is Food/Kitchen waste. High Income Earners consumes more of packed products of which give rise to a higher percentage of non-Biodegradables (inorganic materials) like metals, glass/ceramics, and plastics as higher percentage of inorganic materials were influenced by their income rate.

Table 3. Composition of waste generation of the zones in percentage

WASTE COMPOSITION	LOW INCOME EARNERS	MIDDLE INCOME EARNERS	HIGH INCOME EARNERS
Paper	1.34	5.34	2.24
Plastic	0.47	1.90	1.54
Leather	1.34	1.81	2.11
Ashes/Sand	5.53	6.59	5.62
Textile	0.81	0.71	2.83
Glass	0	1.43	0
Bag/Shoes	0	1.9	3.82
Food/Kitchen Waste	90.16	77.29	74.82
Poultry Waste	0	0	3.97
Metal/Tin	0.36	3.03	3.04
TOTAL	100%	100%	100%

3.5. Storage of Solid Waste in the Home

The study also revealed from the questionnaire distributed to the various households that there were variations in the temporary storage of solid waste at home, based on their socioeconomic status. Out of the 20 sampled households of the low-income earners 8 used polythene bags, 9 used broken buckets, and 3 used 120 liters plastic bin. Their solid wastes generated are usually dumped at a nearby heap of indiscriminate dumps. Most of the residents lived in rented apartments.

Ten (10) members of the middle-income class used small bins for waste storage as Ten (7) of them used rubber bucket without cover and three (3) members used polythene bags for waste storage. The wastes generated, are sometimes collected by mechanized trucks, and are dumped at designated points.

15 households of the high-income earners sampled used purposely manufactured large volume plastic bins of 240 liters in storing their solid waste and 5 households, 120 liters plastic bins. The compactor truck usually collects the

waste directly and empties them into their own trucks. Although the wastes generated are sometimes dumped at the refuse heap/dumps nearby. Most of the residents in this zone live in apartments owned by them.

4. Conclusion

This study has been able to evaluate the per capita waste generated in some selected zones within Makurdi metropolis. The findings from the study states thus: A total sample waste load of 1185.95 Kg was weighed for the three communities. From the computation of the primary data gathered on the sample solid waste, the ratio of the broad composition/characteristics of solid wastes generated shows that the dominant solid waste of the selected zones which the study was carried out is organic waste which accounts for 81.30%, followed by ash/sand with 5.86%, Paper with 2.78%, Metal/Tin with 2.03%, Bag/Shoes with 1.84%, Leather with 1.74%, textiles with 1.47%, Plastic with 1.24%, glass/ceramics with 0.41%. The average per capita generation rate was also estimated to be 0.45kg/capita/day for an average household size of 6 persons. Also, it was discovered that income generation level of households influences the quantum and type of waste generated.

5. References

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