

# Characterization of Municipal Solid Waste and Evaluation of Dumpsite Acceptability in Southwestern Nigeria.

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## ABSTRACT

*Increase in Population, rapid urbanization and changing in consumption patterns in Ado-Ekiti have significantly increased the amount and complexity of municipal solid waste generated in the town. This study examines the composition of the solid waste generated, and evaluates the level of societal acceptance of the Ilokun waste dumpsite in Ado-Ekiti. Respondents were sampled strategically based on the three residential stratifications of Ado-Ekiti. A total of 110 structured questionnaires were administered across the identified strata, comprising low-, middle- and high income earners within the study area. Waste were collected and characterized using standard sorting techniques and gravimetric methods. Parameters such as public acceptance, size of the house hold, waste composition, waste generation, disposal methods, population estimate and biodegradable fractions were determined. The results from the field survey revealed a predominance of organic waste, indicating high biodegradable wastes. The results obtained from the Questionnaire analysis showed that 67.3% of the dwellers (74 out of 110) supports rehabilitation of the dumpsite. This is an indication that the dumpsite should be environmental friendly. The waste deposited at Ilokun dumpsite is made up of 18.6% Food and other putrescible waste; 18.2% Plastic, nylon, rubber and polythenes; 7.5% Metal and aluminum; 13.8% Broken bottles and glass; 9.0% Wooden Materials; 14.8% Rags and Textile materials; 6.6% Ash and Soil Fines; 11.5% Paper and cardboard. The low percentage of Ash is as a result of non-regular Bunning of waste due to smoke emission.*

**Keywords—** Acceptability, Assessment, Characterization, Dumpsite, Municipal Solid Waste

## I. INTRODUCTION

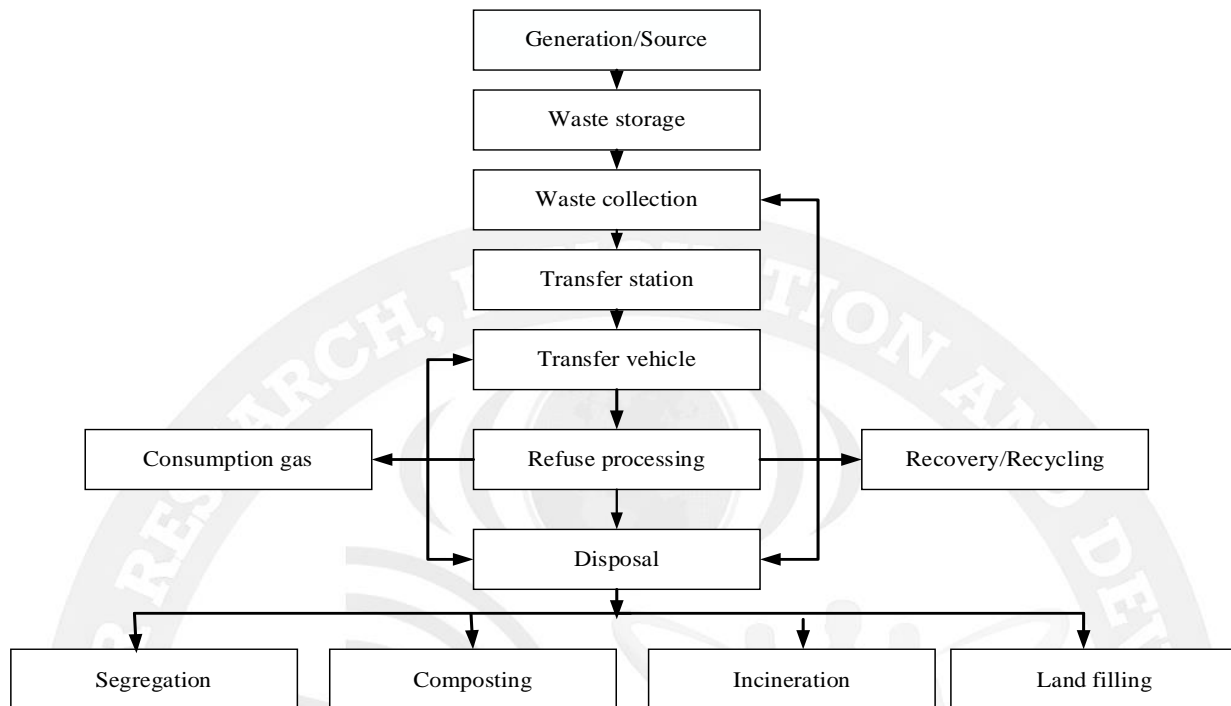
Municipal solid wastes management remains a major environmental challenge in most developing countries, particularly in rapid urbanizing areas. Increased in commercial, industrial, and agricultural activities have led to increase in waste generation rates. Solid waste management refers to a branch of public health engineering associated with the control of generation, storage, collection, transfer, transportation, processing and disposal of solid waste in a manner that is in accordance with the best

principles of public health, economic engineering, conservation aesthetic effects and other environmental considerations. Solid waste management includes administrative, financial, planning and engineering functions involves in the whole spectrum of solution to the problems of solid waste. Solid waste management consists of unit operations and unit processes which are performed to sanitarly eliminate refuse from the generating premises. Open dump sites are commonly used for waste disposal, in Ado Ekiti, like many other developing cities, often without proper environmental controls. This practice poses significant risks, including soil contamination, groundwater pollution, air quality degradation, and the spread of diseases [11], [12].

Municipal solid waste (MSW) management through open dumping is a common practice in developing countries [4]. Managing Municipal solid waste (MSW) is a serious environmental and public health concern worldwide. However, inadequate management of MSW can result in environmental pollution, health risks and economic losses. Managing MSW has been a complex issue that requires a multidisciplinary approach. In Nigeria, Managing MSW is a major challenge, with many cities struggling to provide adequate waste management services resulting into various environmental and health risk.

According to World Health Organization, it was observed that inadequate MSW management is a major contributor to environmental pollution and health risks in Nigeria. Improper disposal of municipal solid waste can create unsanitary conditions, and these conditions can result into pollution of the environment and outbreaks of vector-borne disease (diseases spread by rodents/insects) and water borne disease. Rapid increase in population and urbanization has greatly increase solid waste generation in Nigeria and Ado-Ekiti is not an exception as the state is growing rapidly on a daily basis and this has created a major challenge in the management of solid waste in the state. Previous research attributed this rapid increase in developing countries to opportunities, education and health facilities available in urban areas [15]. According to United Nations, more than 55% of the World's populations are currently living in urban areas with estimation of 68% to be in urban area by 2050 with increasing challenges of managing the waste generated from the source [14]. The Functional elements of solid waste management from the point of generation to the point of disposal of the waste is shown in Fig. 1.

According to the World Bank, Nigeria generates approximately 32 million tons of solid waste annually [14]. The Ministry of Environment estimates that the country's urban areas generate about 0.65kg/capita/day of municipal solid waste.



**Fig. 1: Functional Elements of Solid Waste Management.**

## II. MATERIALS AND METHODS

### A. Area Description

Ilokun is situated in Ado-Ekiti, Ekiti-State, Nigeria, its geographical coordinates are 7°15'N and longitude 4°51' E. It falls within the rainforest zone of average rainfall mean of 1334 per annum with a significant variation in relative humidity and a mean annual temperature of 27°C. The Ado Ekiti people are members of the Ekiti ethnic group in the southwestern Nigeria. However, the increase of the local population mainly from the establishment of different institutions has resulted in the increase in solid waste generation. Previous research has shown that Ado-Ekiti generates a total estimate of 150-200 tons of solid waste per day and 0.5kg/cap/day [10.] The per capita waste generation rate in Ado-Ekiti is approximately 0.43kg per person per day according to Ekiti State Waste Management Agency report in 2020. Waste on the site is dominated by food remains (fruits, vegetables), rags, papers, metals and plastics, etc. Ilokun

Dumpsite is situated along Ekiti- State University, Ifaki Road at approximately Km 10. It is the principal municipal dumpsite in Ado-Ekiti, managed by Ekiti State Management Authority. The facility has been in operation for over 20 years and occupies an estimated land area of approximately 24.7 hectares. The site

is characterized by highly variable topography in elevation across the area. According to the 2006 population census, Ekiti State has a population of 2,384,212 with a population of 308,621 people residing in Ado making it the most populous local government among others in the state. [7].

#### *B. Public Acceptance of the Dumpsite*

Public acceptance refers to the degree of view on the dumpsite by the residents living close to the dumpsite and opinion of the community at large. One hundred and ten (110) self-administered questionnaire was randomly distributed among the people residing around Ilokun dumpsite and its environs. The responses obtained from the questionnaire were represented by charts and frequency tables.

#### *C. Waste Collection and Classification*

250kg of freshly deposited waste was taken from four (4) different locations on top of the soil and sorted into various (MSW) constituent. The physical composition of the MSW was determined from the relationship between the different masses of the constituents. The waste components were sorted into the following categories stated as follows: plastics, nylon, rubber and polythenes and other putrescible waste, broken bottles and glass, rags and textile materials wooden materials, metals and aluminium, ash and soil like waste. The overview of the dumpsite and sorting of waste at the dumpsite is shown in Fig. 2a and Fig 2b.

#### *D. Population Estimate and Waste Generation*

*(i) Population estimates of Ado -Ekiti was calculated using Geometrical increase method of population based on estimated growth rate.*

$$P_f = P_o(1 + r)^n \quad (1)$$

Where,  $p_f$  is the projected population

$P_o$  is the base year population

$r$  is the Growth rate taken as 3.14%

$n$  is the number of years covered

*(ii) Waste Generation was calculated using Geometrical increase method based on estimated growth rate from the literature.*

$$W_f = W_o(1 + r)^n \quad (2)$$

where,  $w_f$  is the volume of waste to be generated in the future

$w_o$  is the volume of waste generated presently

$r$  is the Growth rate

$n$  is the number of covered years



**Fig. 2a: Overview image of the dumpsite**



**Fig. 2b: Sorting of waste in the dumpsite**

(iii) Waste generated (in tons) per year was estimated using the formula.

$$Wg = (WrX Pf) \quad (3)$$

Where, Wg is the waste generated

Wr is rate of waste generation (kg)

P is the present population

iv. Waste generated (in ton) per day was estimated using the formula in Equation 4

$$\frac{(WXPf) X 10^{-3}}{365} X 0.70 \quad (4)$$

70% (0.70) of waste gets to landfill while the 30% is assumed to be lost due to recycling waste burning at source, indiscriminately disposal in the drains and waste that does not get to landfill as a result of poor waste management system [17].

v. Estimation of growth rate of waste generated was calculated from existing available data

$$(1 + r) = t_i \sqrt{(w_2/w_1)} \quad (5)$$

Where, r is the estimated growth rate

t is the time interval of years

w<sub>2</sub> is the waste generated in last available year

w<sub>1</sub> is the waste generated in fist available year.

vi. Waste generated was calculated using Geometrical increased method based on the calculated estimated growth rate

$$W_t = w_o (1 + r)^n \quad (6)$$

Where,  $W_f$  is the future volume of waste generated

$W_o$  is the present volume of waste generated

$r$  is the Growth rate

$n$  is the (t initial – t final) interval in years

vii. *Biodegradable fraction of waste generated in Ilokun dumpsite of Ado-Ekiti is calculated using Equation 7.*

$$\Sigma 0.70Wb \quad (7)$$

### III. RESULTS AND DISCUSSION

#### A. Respondents Profile

The size of household, waste composition, waste generation and Disposal methods of the respondents that fill the questionnaire are shown in Tables 2-5 respectively. Table 2 shows the frequency and the valid percentage of the household. The study revealed that 2-4 household has highest valid percentage of 29.1 around the study area. Table 3 shows that food and other putrescible waste materials has highest valid percentage with a frequency of 56 for the total waste mass and this constitute the largest portion of waste fill. This trend corresponds to the research work of [10], [12]. Table 5 shows the method of waste disposal where open dump has the highest valid percentage of 25.9 with a frequency of 30 and this is in line with the previous research work of [1], [3], and [9] follow by a valid percentage of 24.1 with a frequency of 28. [5].

#### B. Public Acceptance of the Dumpsite

The results obtained from the feedbacks by the residents on dumpsite consideration is shown in Table 6 while Table 7 shows the frequency analysis of action to be taken on the dumpsite respectively. The results obtained from the frequency Table of the feedback in Table 6 on what should be done to the dumpsite showed that residents support that the dumpsite should be environmentally friendly (Rehabilitation). The frequency analysis from the Table 7 on the Dwellers concern and suggested option on Ilokun dumpsite is shown on the chart in Fig. 3.

**Table 1 shows the Statistical estimation of waste generated in tones in Ado-Ekiti from 2020 – 2024.**

Year	Waste Generated	Waste Collected	Waste Recycled	% Recycled
2020	105,000	21,000	1,470	7
2021	135,000	27,000	2,450	9
2022	167,000	33,000	3,300	10
2023	189,000	45,000	4,950	11
2024		34,697		

*Source: Ekiti State Waste Management Authority. (2024)*

**Table 2: Size of the household of the residents**

Size of household	Frequency	Valid Percent
1-2	16	14.6
2-4	32	29.1
4-6	30	27.2
6-8	17	15.6
8-10	2	1.8
>10	10	9
Void	3	2.7
Total	110	100

**Table 3: Waste composition of the residents**

Waste composition	Frequency	Valid Percent
Food and other putrescible	56	50.9
Plastic, nylon and other polythenes	31	28.2
Paper and cardboard	13	11.8
Aluminum and other metals	6	5.5
Glass	1	0.9
Rag and textile materials	1	0.9
Wooden materials	2	1.8
Ash and Soil fines	0	0
Total	110	100

**Table 4: Waste Generation by the Residents**

Waste Generation (kg)	Frequency	Valid percent
1-5	47	42.7
5-10	27	24.6
10-15	21	19.1
15-20	8	7.2
>20	7	6.4
Total	110	100

**Table 5: Method of waste Disposal by the Residents**

Disposal Method	Frequency	Valid percent
Open burning	30	25.9
Disposal inside bush	20	17.2
Disposal inside drains/stream	12	10.4
Local Dumpsite	21	18.1
Composting	5	4.3
EKSWMA	28	24.1
Total	116	

### C. Waste Composition at Ilokun Dumpsite

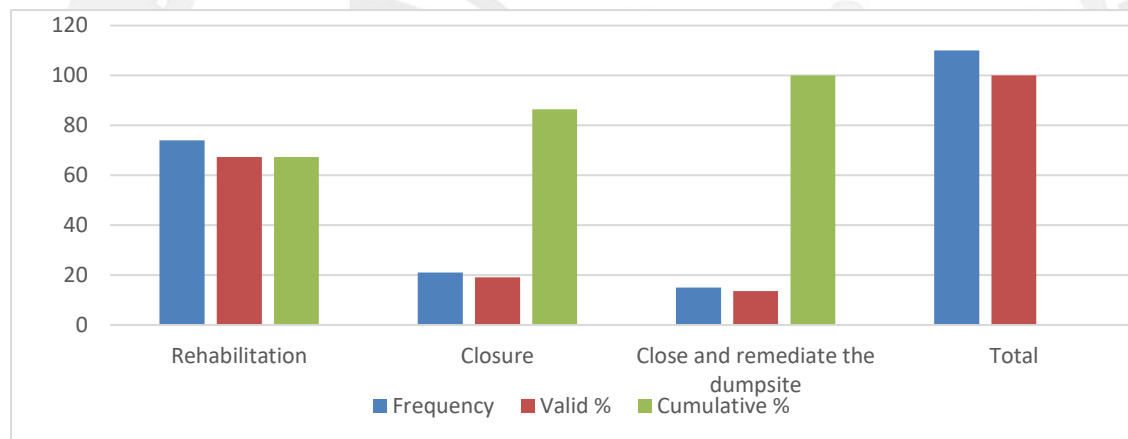
The food and other putrescible waste materials has 18.6% of the total waste mass and this constitute the largest portion of waste fill, followed by plastic, nylon, rubber and polythenes with 18.2%. The high percentage of food and other putrescible waste shows that biodegradation of the solid waste at the dumpsite will be very high. During precipitation, the organic matter will infiltrate into the underlying soil layer as a result of decomposition by bacterial. The relative low percentage of ash and soil fines (6.6%) can be attributed to the unregularly open burning of the waste deposited at the site because of the smoke emission. Similarly, the relative high percentage of paper (11.5%) and cardboard (11.5%) can be attributed to the extensive use of paper by students for academic activities, as well the widespread use of paper materials by traders for packaging and wrapping goods within the community. The proportion of waste generated is in line with the previous research work of [2], [9]. Also, the predominance of biodegradable organic fractions and daily waste tonnage align with the research work of [6], [8] who studied Ado-Ekiti's waste composition. The composition of waste at the Ilokun dumpsite is represented by pie chart (Fig. 4) and shown in Table 8.

**Table 6: Feedback on Dumpsite Consideration by Residents**

S/N	Location consideration	Rehabilitation	Closure	Closure & Rehabilitation	Total
1	Yes	74	21	15	110
2	No	0	0	0	0
	Total	74	21	15	110

**Table 7: Frequency Table of Action to be taken on the dumpsite.**

Validity	Frequency	Valid %	Cumulative %
Rehabilitation	74	67.3	67.3
Closure	21	19.1	86.4
Close and remediate the dumpsite	15	13.6	100
Total	110	100	

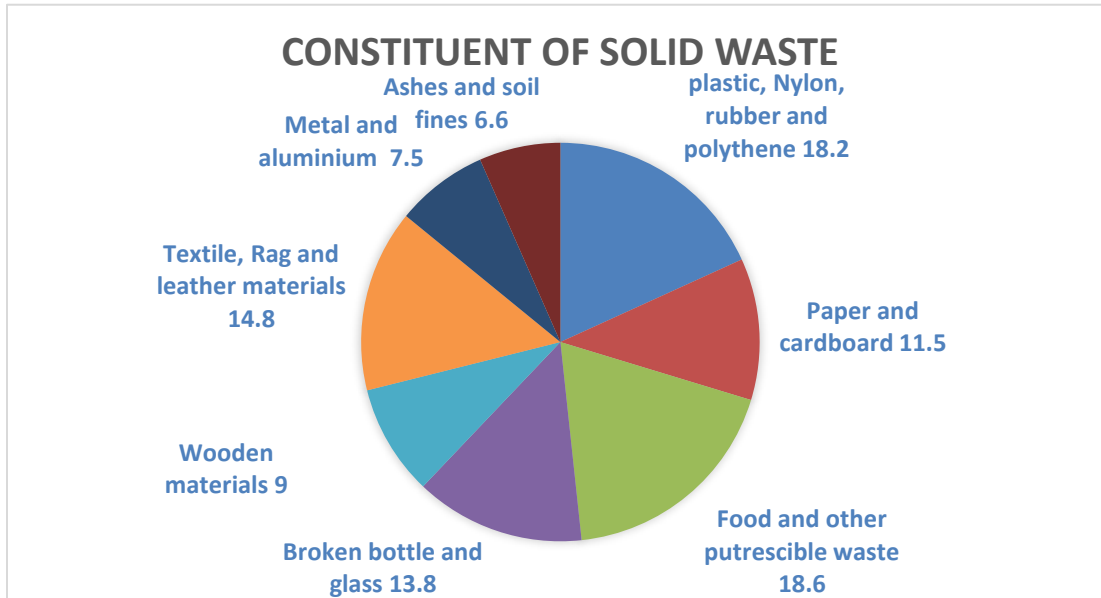


**Fig. 3: Dwellers concern and suggested action on Ilokun dumpsite**

**Table 8: Municipal Solid Waste Composition at Ilokun Dumpsite.**

S/No	Constituent of solid waste	Pt A (kg)	Pt B (kg)	Pt C (kg)	Pt D (kg)	Total (kg)	% (kg)
1	Plastic, nylon, rubber and polythene	9.3	12.4	9.6	13.8	45.1	18.2
2	Paper and cardboard	5.4	6.2	7.6	9.2	28.4	11.5
3	Food and other putrescible waste	13.1	10.6	16.2	6.2	46.1	18.6
4	Broken bottles and glass	2.8	6.3	12.6	12.4	34.1	13.8
5	Wooden Materials/plant materials	5.6	3.8	6.2	6.7	22.3	9.0
6	Textile, Rags and leather materials	12.3	8.1	6.3	9.8	36.5	14.8
7	Metal and aluminum	3.4	4.2	5.8	5.1	18.5	7.5
8	Ashes and Soil Fines	3.2	5.2	5.2	2.6	5.3	6.6
	<b>Total</b>	<b>55.1</b>	<b>56.8</b>	<b>66.9</b>	<b>68.5</b>	<b>247.3</b>	<b>100</b>

Note: Pt: Points A, B, C, D



**Fig. 4: Pie chart of Municipal Solid Waste Composition at Ilokun dumpsite**

*D. Population Estimate and Waste Generation*

*(i) Estimation of Ado-Ekiti Population*

Using Geometrical increase population method in Equation 1.

Therefore,  $P_{2025} = P_{2006}(1+0.0314)^{19}$

$308,621 (1 + 0.0314)^{19}$

546,676 persons.

It is expected that the population of Ado-Ekiti would have risen to 546,676 persons by 2025 based on the calculation with a growth rate of 3.14%.

*(ii) Estimation of waste at site in tons*

i. Total waste generated according to Ekiti State Waste Management Board (ESWMB) as at 2020 is estimated to be 21,000 tons and as at 2024 is estimated to be 34,675 tons therefore expected waste generated by 2025 based on the increase in population is calculated using Equation 5.

$24\sqrt{(34675/21,000)}, r = 0.213$

ii. Waste generated was calculated using Geometrical increased method based the calculated estimated growth rate using Equation 6.

$34,675(1 + 0.213)^{25}$

4330,561tons

(iii) Estimation of quantity of waste disposed by day (tons/day) is calculated using Equation 6

According to EKSMB (2020) waste generated per person per day in Ado-Ekiti was given as 0.431kg.

Therefore, Waste disposed by day =  $546,676 \times 0.431\text{kg} = 235,069.82\text{kg}$

It was reported that only 70% (0.70) total waste gets to the land fill while 30% is assumed to be lost due to recycling, burning of waste at the source, indiscriminate dumping of waste in the drains and waste not getting to the landfill due to poor coverage by waste management authorities [16].

$$= 235,069.82 \times 10^{-3} \times 0.70$$

$$= 165 \text{ tons/day}$$

(iv) Estimation of biodegradable components of waste

The biodegradable fraction of waste at the site was estimated by summation of biodegradable components of waste generated in Table 9.

**Table 9: Biodegradable fraction of MSW Composition at Ilokun Dumpsite.**

S/No	Constituent of solid waste	Percentage (kg)
1	Plastic, nylon, rubber and polythenes	18.2
2	Paper and cardboard	11.5
3	Food and other putrescible waste	18.6
4	Broken bottles and glass	13.8
5	Wooden Materials/plant materials	9.0
6	Textile, Rags and leather materials	14.8
7	Metal and aluminium	7.5
8	Ashes and Soil Fines	6.6
Total	% of Biodegradable waste	60.5

Biodegradable fraction of waste generated in Ilokun dumpsite of Ado-Ekiti is calculated by Equation 7

$$60.5 \times 0.70 = 42.42$$

#### IV. CONCLUSION

The results obtained from the frequency of the feedback showed that 67.3% of the dwellers (74 out of 110) supports rehabilitation of the dumpsite. This is an indication that the dumpsite should be environmental friendly. The common method of waste disposal practiced by the residents, which they considered most effective, was open waste burning, accounting for 25.9% of respondents with frequency of 30. The waste deposited at Ilokun dumpsite is made up of: 18.6% Food and other putrescible waste; 18.2% Plastic, nylon, rubber and polythene; 7.5% Metal and aluminum; 13.8% Broken bottles and glass; 9.0% Wooden Materials; 14.8% Rags and Textile materials; 6.6% Ash and Soil Fines; 11.5% Paper and cardboard. The low percentage of Ash is as a result of non-regular Bunning of waste due to smoke emission. The projected population of Ado-Ekiti is 546,676 by 2025, as result of population increase and total waste generated as 4330,561tons and 165tons per day.

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