Solid Waste Characterization at Classified Solid Waste Dumpsites in Port Harcourt, Nigeria

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Abstracts: **Background: Municipal or household wastes are often generated from several sources where variable human activities are encountered. This study is to conduct waste characterization survey at solid waste dumpsites around markets, Semi- industrial and residential areas**

***Materials and Method*: On the spot site waste segregation with the use of human scavengers was conducted at each of the fifteen (15) waste dumpsite. The major equipment used are: 25liters plastic bucket, medium size weighing scale of 0 to 150kg range and hand shovel, Data were obtained in percentages of the total solid waste at each of the dumpsites. The mean percentages as per each classified dumpsite were graphically analyzed.**

Results: **At Market dumpsites, dominant waste constituents were: Plastic bottles and food/organic > Polyethylene nylon > paper > glass bottles. Whereas in the semi- industrial areas: Plastic bottles >Polyethylene nylon > food waste > Paper. In the residential area, the major constituents were: Food/organics 30% > Polyethylene nylon 25% > Plastic bottles 22% > paper 15% > Glass 5%.**

Conclusion: **Waste characterization survey shows that Food/organic, paper, plastics, polythene are the major constituencies at all solid waste dumpsites. Batteries and bulbs also occur but small in quantity.**

Keywords: **Solid Waste, Characterization, Markets. Semi-industrial, Residential Dumpsites**

I. INTRODUCTION

Municipal or household wastes are often generated from several sources where variable human activities are encountered. Several studies indicate that much of the municipal solid waste from developing countries are generated from households (55–80%), followed by commercial or market areas (10–30%) with varying quantities from streets, industries, institutions among others (Nabegu 2010, Nagabooshnam 2011, Okot-Okumu, 2012). Waste from these sources are highly heterogeneous in nature (Valkenburg et al. 2008.) and have variable physical characteristics depending on their sources; notably in their composition are food waste, yard waste, wood, plastics, papers, metals, leather, rubbers, inert materials, batteries, paint containers, textiles, construction and demolishing materials and many others which would be difficult to classify. The **characterization of waste** by **manual sorting** consists of separating the different fractions that compose it to determine the nature of each fraction, in what percentage it is found. This type of study provides objective knowledge and data on that waste. Its results allow us to define the monetary return to entities according to the degree of separation at source, to carry out quality controls, to evaluate the performance of separation equipment, to orient the campaigns to increase sensitivity, define action plans and even predict the need for large infrastructures depending on the fractions managed in large urban areas. The knowledge of the fractions that make up a specific type of waste is a very important indicator of the degree of awareness of the population regarding recycling. In summary, the data in this report can be used in local planning to: Develop approximate estimates of total MSW generation in an area, check locally developed MSW data for accuracy and consistency, account for trends in total MSW generation and the generation of individual components, help set goals and measure progress in source reduction and recycling (including composting).

Fig. 1 below highlighted schematically the classification of municipal solid waste generated

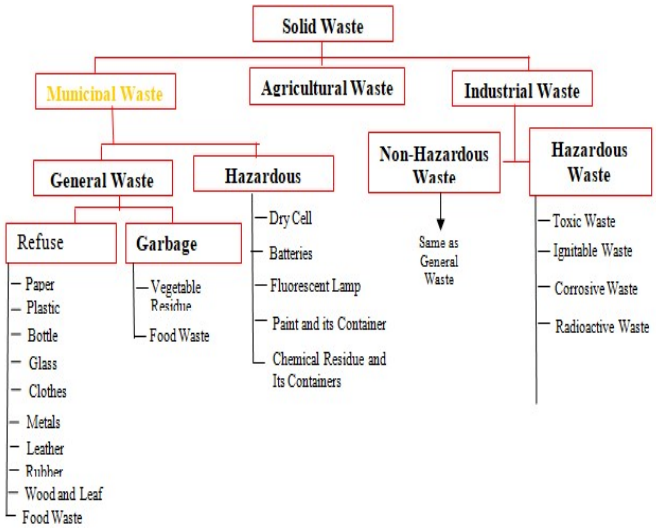

Figure. 1: Schematic Diagram Showing Constituents of Solid Waste

Source (What A Waste: Solid Waste Management in Asia. Hoornweg, Daniel with Laura Thomas. 1999. Working Paper Series Nr. 1. Urban Development Sector Unit. East Asia and Pacific Region. Page 5. And United Nation UNESCAP Journal https://www.unescap.org/sites/default/files/CH08.PDF Chapter8)

Table 1: Components of Solid Wastes

No.	Waste Component	Contents
1	Organics	Food Wastes
2	Paper	Newspapers, Magazines
3	Cardboard	Cardboard bourns
4	Bulky cardboard	-
5	Plastics	Plastics except for PET
6	Glass	Jars, colorful and colorless glasses
7	Metals	Iron metals, cans and aluminum materials
8	Bulky metals	-
9	Electrical equipment	Phones, radios, PC equipment
10	Hazard wastes	Batteries and accumulators, paint burns
11	Garden Wastes	Wood and other garden wastes
12	Other non-combustibles	Rubber etc
13	Other combustibles	Combustible materials (diapers, shores, bags, textile, carpets)
14	Other bulky combustibles	Furniture etc.
15	Other non-bulky combustibles	-
16	Other	-
17	Ash	Ash, Stone, Rock, etc

Some solid waste called ''garbage'' dumped at waste dumpsites contain heavy metals that are harmful to human beings, the soil microbial communities and environment. There is need to properly identify these solid waste containing heavy metals, identify the heavy metal contents and conduct relative impact assessment and prefer solution for removal of these harmful metals from the solid waste before dumping at waste sites.

Salamatu et al. (2017), work on the characterization and composition analysis of Municipal solid waste in Kano metropolis, reported that light plastic had the highest mean values of 8.63 kg/50kg sample, Organics 7.22kg/50kg, Heavy plastic 4.15kg/50kg, Fabric 3.91kg/50kg, paper 2.70kg/50kg, metal 2.05kg/50kg, glass 1.89kg/50kg, Bone 1.47kg/50kg, styrofoam 0.19kg/50kg, others 1.06kg/50kg and wood - 0.25kg/50kg. There was significant correlation between estimated population and volume of trash collected.

Samson et al. (2011), in study on the Physical Composition of Solid Wastes in Selected Dumpsites of Ogbomoso land, South-Western Nigeria, in about 40 major dumpsites stated overall average composition using the main classes of wastes were found to be food; 68.4%, metals; 7.2%, textile; 4.6%, papers; 4.4%, plastic; 3.9%, glass; 3.6%, wood; 3.1%, and miscellaneous; 4.8%. Putrescible materials dominated the waste composition of the study area. The components of wastes in the city revealed a higher standard of living when compared with those of the residents in the environs. Rural residents generate denser wastes when compared with the urban centers and as such are prone to leachate pollution emanating from these organic wastes.

II. STUDY AREA

Port Harcourt is the capital and largest city of Rivers State, Nigeria. It lies along the Bonny River and is in the Niger Delta. As of 2016, the Port Harcourt urban area has an estimated population of 1,865,000 inhabitants, up from 1,382,592 as of 2006. The urban area (Port Harcourt metropolis), on the other hand, is made up of the local government area itself and parts of Obio-Akpor and Eleme accordingly. Port Harcourt, which is the current capital of Rivers State, is highly congested as it is the only major city of the state.

The area of study is in Port Harcourt metropolis, Rivers State. The area is bounded geographically by latitudes 4°46'N to 5°00'N and longitudes 6°55' E to 7°03' E. Open dump sites are the most common waste disposal methods in Port Harcourt and many cities in Nigeria. Open dump sites are found in several residential, Markets and semi – industrial locations around the city, for example, Rukpokwu village, Rumuokoro, Rumuomasi, Diobu, Marine base, and Borokiri, to mention a few. The fifteen (15) dumpsites that were used within the study area and the locations of all the sampling points were chosen from Port Harcourt North, Central and South. Five dumpsites located in Markets, Five dumpsites located in Semi-industrial arears and Five dumpsites located in Residential areas all total of fifteen were selected and the locations were recorded from the map grid and fully register and labeled with the aid of a Garmin Global Positioning System (GPS) equipment. Residential, Markets & Industrial dumpsites used are as stated and coded below in Table 2

Table 2: Survey Locations

S/no		Location Name	Codes	GPS
1	Market Areas (MA)	Okija Market	MA01	N 04° 47' 50.5''
				E 006° 59' 54.6''
2		Creek Road Market	MA02	N 04° 45' 31.5''
				E 007° 01' 33.0''
3		Rumokuta (Market area)	MA03	N 04° 51'' 58.2''
				E 007° 00' 02.8''
4		Water side (Creek road)	MA04	N 04° 45' 31.2''
				E 007° 01' 27.4''
5		Mile 1 Market	MA05	N 04° 47' 37.2''
				E 006° 59' 43.8''
6	Semi Industrial area. (SIA)	Trans Amadi	SIA01	N 04° 49' 22.7''
				E 007° 02' 22.1''
7		Stadium road	SIA02	N 04° 49' 30.9''
				E 007° 01' 29.2''
8		Odili Road	SIA03	N 04° 48' 14.2''
				E 007° 02' 57.7''

9		Elekohia	SIA04	N 04° 49' 07.8''
				E 007° 01' 35.0''
10		D/Line	SIA05	N 04° 48' 10.1''
				E 007° 00' 00.8''
11	Residential Areas (RA)	Borokiri	RA01	N 04° 44' 47.4''
				E 007° 02' 29.5''
12		Marine base	RA02	N 04° 46' 17.4''

				E 007° 01' 29.0''
13		Elekohia Residence	RA03	N 04° 49' 06.2''
				E 007° 01' 49.4''
14		Diobu residential	RA04	N 04° 47' 33.6''
				E 007° 00' 03.0''
15		Rukpokwu village	RA05	N 04° 54' 11.7''
				E 006° 59' 19.0''

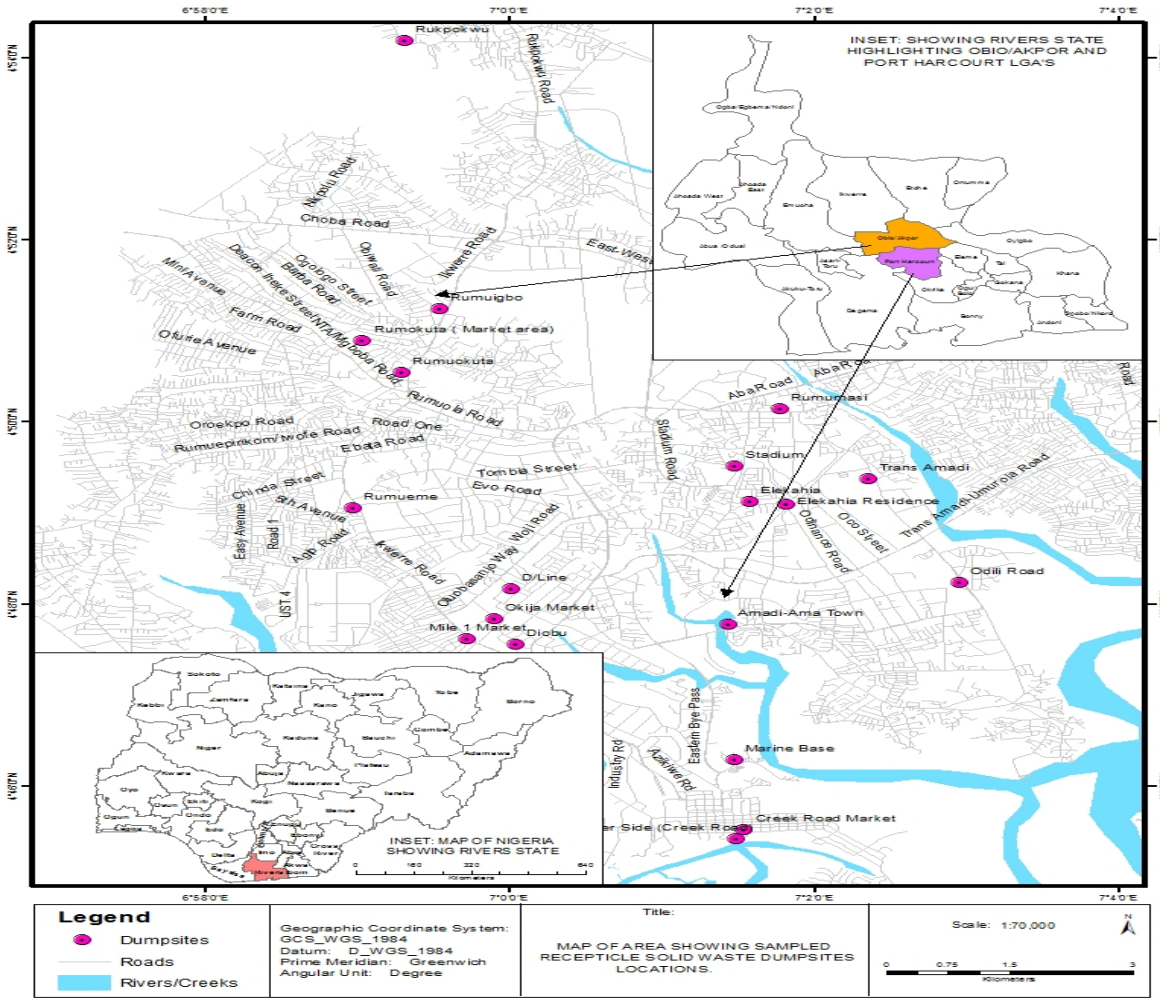

Figure 2: Map of study area, Port Harcourt City, Nigeria

III. METHODOLOGY

Methodology, which is site-specific, sampling, sorting, and weighing the individual components of the waste stream is used. This methodology is useful in defining a local waste stream, especially if large numbers of samples are taken over several seasons. Results of sampling also increase the body of knowledge about variations due to climatic and seasonal changes, population density, regional differences, and the like. In addition, quantities of MSW components such as food scraps and yard trimmings can only be estimated through sampling and weighing studies.

On the spot site waste segregation with the use of human scavengers was conducted at each of the waste dumpsite. The major equipment used are: 25liters plastic bucket, medium size weighing scale of 0 to 150kg range and hand shovel. The empty bucket was first weighed on the scale to know the weight as X_0 kg. Each of the waste segregated according to the respective component was loaded inside a 25liters plastic bucket one after the other and weighed to give weight as X_1,

X_2, X_3 …….. X_n. The weight (in kg) for each component was then estimated as:

$X_{component\ Final} == [X_{component\ 1} + X_0] - X_0$ ---------- (1)

Where X_0 is the weight of the empty bucket (kg)

$[X_{component} + X_0]$ is the combined weight of the waste component and the bucket (kg)

$X_{component\ Final1}$ is the final weight (kg) of the component being weighed

The Total weight of all the solid waste components at each of the dumpsites is derived by the addition of all the $X_{component\ Finals}$. Example:

TOTAL Weight (kg) of all Component at each dumpsite $=\{X_{component\ final\ 1} + X_{component\ Final\ 2} + \ldots X_{component\ final\ n}\}$ ---------- (2)

For each component to be recorded in percentages: The net weight of each component is divided by the total weight of all the components

$$\frac{\text{Weight of } X_{componemt\ final\ n}}{\text{Total weight of all components}} \times 100 \text{ --------- (3)}$$

Each waste component is a representative in the major dumpsite composition.

IV. RESULTS

The result of this study for waste characterization are presented in Table 3 & 4. and are graphical represented Fig. 3.

Table 3 shows the general percentage components of the waste at each of the fifteen dumpsites. Polyethylene nylon had the highest percentage range of 20.0 – 30.0%, followed by plastic bottles of range 15.0 – 33%, food/organic waste with range 15.0 – 33%, and paper waste with range 5.0 – 15% of the waste constituents across all sites. The highest Food waste percentage of 33% is recorded at a dumpsite located in market. The highest plastic bottle waste percentage of 33% is also recorded at a dumpsite located on Market .However polyethylene nylon highest percentage of 30% was obtained at a dumpsite located in Residential area) while paper waste of 15% is recorded at one dumpsite located on each of the market, semi-industrial and residential areas. Other significant waste types were food glass bottles with range 2 – 7%, Grass/Vegetables with range 0.5 – 10%, Batteries, bulbs with range 0.5 – 5%.

On Table 4 shows the overall average of each of the components at dumpsites located Markets, Semi- industrial and Residential areas.

The dumpsites located in Market areas has 24.2% of the Polyethylene nylon, 23% are Plastic bottles, food/organic waste constitute 21% while paper, Grass/ vegetables, glass bottles are 8.4%, 6.4%, and 4.2% respectively. Other waste components are withing the range of 0.8% - 2.7%.

In the semi- industrial area dumpsites,23.4% are Polyethylene nylon, Plastics bottles is 21.2%, Food / organic waste is 16% while Paper waste is 16.4%. Glass bottles is 7.8% while metal containers are 4.1%. Other waste components are withing the range of 1.5- 2.6%.

In the residential area dumpsite, 24% is Polyethylene nylon, 23% is food/ organic waste, 17% is plastic bottles while paper is 8.6%. Metal containers, Batteries, and glass bottles are 7.2%, 5.2%, and 4.4% respectively. Other components range between 0.8 – 2.2%.

Five major waste types were identified to majorly constitutes the higher percentage of solid waste at all the dumpsites and these are polyethylene nylon, Plastic bottles, Food/ Organic waste , paper waste and glass bottles.

Fig 3. Is the graphical representation of the calculated average percentage values of each components in the each of the classified dumpsites : markets, Semi- Industrial and Residential

Table 3: Waste components percentages calculated from each of the selected solid waste dumpsite.

			Market Area					Semi - Industrial					Residential				
			Okija Market	Creek Road Market	Rumokuta (Market area)	Water side (Creek road)	Mile 1 Market	Trans Amadi	Stadium Road	Odili Road	Elekohia	D/Line	Borokiri	Marine Base	Elekohia	Diobu	Rukpokwu village
S/no			MA001	MA002	MA003	MA004	MA005	SIA001	SIA002	SIA003	SIA004	SIA005	RA001	RA002	RA003	RA004	RA005
1	Food/ Organic		15.0%	17.0%	20.0%	20.0%	33.0%	17.0%	15.0 %	20.0 %	15.0%	15.0%	30.0 %	20.0%	20.0%	25.0%	20.0 %
2	Paper		15.0%	5.0%	7.0%	10.0%	5.0%	10.0%	15.0 %	15.0 %	10.0%	15.0%	8.0%	5.0%	10.0%	15.0%	5.0 %
3	Plastics(Bottles/ others)		20.0%	33.0%	25.0%	22.0%	15.0%	20.0%	27.0 %	17.0 %	22.0%	20.0%	20.0 %	22.0%	15.0%	15.0%	15.0 %
4	Glass(bottles/ others)		7.0%	5.0%	3.0%	5.0%	1.0%	10.0%	5.0 %	7.0 %	10.0%	7.0%	5.0%	5.0%	5.0%	2.0%	5.0 %

5	Polythene. Lylon	23.0%	20.0%	28.0%	25.0%	25.0%	21.0%	24.0 %	24.0 %	25.0%	23.0%	20.0 %	23.0%	22.0%	25.0%	30.0 %
6	Rubber/leathers	1.0%	1.0%	2.0%	2.0%	0.0%	3.0%	1.0 %	1.0 %	2.0%	1.0%	1.0%	2.0%	2.0%	1.0%	1.0 %
7	Wood	1.0%	1.0%	0.0%	2.0%	2.0%	2.0%	1.0 %	1.0 %	2.0%	1.0%	1.0%	1.0%	2.0%	1.0%	1.0 %
8	Grass/vegetables	4.0%	10.0%	8.0%	5.0%	5.0%	0.5%	0.5 %	1.0 %	5.0%	4.0%	1.0%	2.0%	5.0%	2.0%	1.0 %
9	Batteries (big& small)	5.0%	0.5%	1.0%	2.0%	1.0%	2.0%	2.0 %	2.0 %	2.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0 %
10	Bulbs	5.0%	2.0%	1.0%	0.5%	1.0%	2.0%	1.0 %	1.0 %	0.5%	5.0%	1.0%	1.0%	1.0%	1.0%	1.0 %
11	Metal containers	1.0%	1.0%	2.0%	2.0%	5.0%	7.5%	5.0 %	5.0 %	2.0%	1.0%	5.0%	8.0%	10.0%	5.0%	8.0 %
12	Ashes/Dust	1.0%	1.0%	1.0%	0.5%	1.0%	2.0%	1.0 %	2.0 %	0.5%	1.0%	2.0%	4.0%	1.0%	1.0%	2.0 %
13	Cloths/textiles	0.0%	1.0%	1.0%	1.0%	1.0%	2.0%	1.5 %	3.0 %	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.0 %
14	Electronic Waste	2.0%	2.5%	1.0%	3.0%	5.0%	1.0%	1.0 %	1.0 %	3.0%	2.0%	1.0%	2.0%	2.0%	2.0%	2.0 %
		100.0%	100.0 %	100.0%	100.0 %	100.0 %	100.0%	100. 0%	100. 0%	100.0%	100.0%	100.0 %	100.0%	100.0%	100.0 %	100. 0%

Source (derived from waste characterization from selected Portharcourt dumpsites June (2020)

Table 4: Average composition of waste components in Port Harcourt's market, semi-industrial and residential dumpsites.

	GROUPS		
	Market	Semi- Industrial	Residential
Food/Organic	21.0%	16.4%	23.0%
Paper	8.4%	13.0%	8.6%
Plastics(Bottles& Others)	23.0%	21.2%	17.4%
Glass(Bottles& Others)	4.2%	7.8%	4.4%
Polythene Nylon	24.2%	23.4%	24.0%
Rubber/Leather	1.2%	1.6%	1.4%
Wood	1.2%	1.4%	1.2%
Grass/Vegetables	6.4%	2.2%	2.2%
Batteries(big & Small)	1.9%	2.6%	5.0%
Bulbs	1.9%	1.9%	1.0%
Metal Containers	2.2%	4.1%	7.2%
Ashes/Dust	0.9%	1.3%	2.0%
Cloths/ Textiles	0.8%	1.5%	0.8%
Electronic	2.7%	1.6%	1.8%
TOTAL	100%	100%	100%
Source: calculated from Table 3			

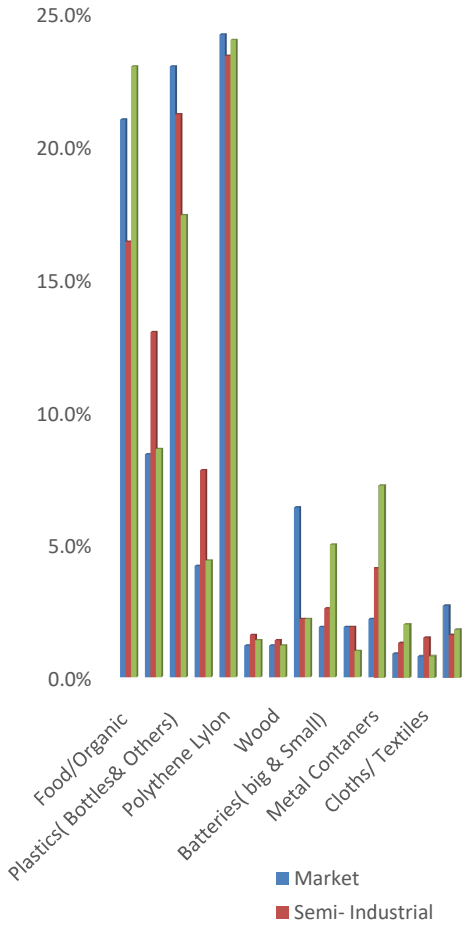

Figure 3: Group mean value of waste components at market, semi-industrial and residential Dumpsite in Port Harcourt

V. DISCUSSION

The study shows that Market dumpsites has the highest percentages of polyethylene nylon, plastic bottles and also high percentage of Food/organic and grass/ vegetables. These wastes are mostly generated for the fact that the market is a commercial meeting place for buying and selling of food stuffs. Morealso the more human population and high activities takes place in the market place This also agrees with the work of this Nabegu, *et.al.,* (2010). The smaller percentages of metal containers bulbs and electronic waste are being generated by the shops of offices.

The residential dumpsites have the highest percentages of food/ organic waste and very high percentage of polyethylene nylon. These are part of household waste generated daily especially when there are social activities.

The Semi- industrial sites are high in percentage of polyethylene nylon, Plastics bottles and food / organic waste. It is alos noted that metal containers, batteries and bulbs are also observed in considerable quantities.

Generaly the presence of biodegradable solid waste such as vegetables and other organic waste couple with other minor waste such as, batteries bulbs and electronic waste are major source of Heavy metals and Polycyclic Aromatic Hydrocarbons after decomposition. The composition of most of the components in this study are slightly differ from the work of Salamatu, et al., (2017) and Samson, et al., (2011) since this characterization was done at receptacle dumpsites while theirs were conducted at major solid waste dumpsites. However, the components are the same. Paper, plastics, polythene are also majorly constituencies at all receptacles solid waste dumpsites. Batteries and bulbs are small in quantity. The results on table 4 clearly indicates that domestic wastes are major constituencies of solid waste in all the dumpsites located at the market, semi- industrial and residential areas.

VI. CONCLUSIONS

Waste characterization survey shows that Food/organic, paper, plastics, polythene are the major constituencies at all solid waste dumpsites. Batteries and bulbs also occur but small in quantity. However, Variations in economic activity, affect waste generation in both the residential and the commercial sectors. The presence of hazardous waste such as toxic chemicals, and radioactive waste are discovered in this study.

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