ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

On the Assessment of Solid and Hazardous Waste Management in Port Harcourt, Nigeria

Arimieari, L.W.[1*], Sangodoyin, A. Y.[2] and Joe, T.[3]

[1,3.] Department of Civil Engineering, Rivers State University of Science and Technology, Port Harcourt, Nigeria

[2.] Department of Agricultural and Environmental Engineering University of Ibadan, Ibadan, Nigeria

luvi4real@yahoo.com

Abstract

This study examines the management of both solid and hazardous waste constituents in Port Harcourt, Nigeria. For this purpose, the study area was divided into four zones and were further classified into low, medium and high income groups. For effective analysis, the frequency of refuse collection from various location and waste disposal methods were also considered. Results in general indicate that there are no organized pattern of wastes disposal. Indiscriminate dumping of waste into open drains was prevalent among the low income group. The waste composition analysis indicate that metals constitute over 20% of the major component of waste from the low and medium income group while garbage accounts for 23% of the solid waste in the high-income group. Food waste such as fruits, remnants and other similar material are commonly found in the high-income group while their low-income counterparts litter the surroundings with such waste materials.

Keywords: Solid Waste, Hazardous Waste, Assessment, Management.

Introduction

It is often said that a clean city is a healthy city. This implies that the health status of a people can be evaluated from their cleanliness and this is underpinned by proper management of waste in the environment. The proper assessment of solid waste generation and management in relation to urbanization, hazardous nature, sources, treatment and disposal systems is vital for creating a clean and healthy environment.

In developing countries such as Nigeria, open dumping of solid wastes on the roadways, drains and borrow pits is a prevalent form of disposal. This practice has resulted in the littering of highways, road areas and the cities at large. Apart from this being an eyesore, the wastes are left to rot and serves as a breeding place for flies, rats and other pests. Due to inept and improper management of solid wastes, other hazards have been reported. The devastation of lives and property frequently experienced in Ibadan City, Nigeria, following flood events, is attributed to solid wastes, which blocked river channels, sewers and gutters [5].

Poor and unwholesome approach to solid waste management from the point of storage, collection, transportation and final disposal can create favourable conditions for the breeding of vectors or disease carrying agents. The indiscriminate roadside dumping of waste and the spread of waste of a landfill onto access roads undoubtedly prevents the free flow of human and vehicular traffic at such locations, thereby unnecessarily waste man hour in a bit to bypass such nuisances [6].

Every year, major health problems result from hazardous wastes. Improper management and disposal of hazardous waste components have caused an increasing amount of health problems. A focus on hazardous waste constituents such as insecticide cans, empty drug containers and even fluorescent tubes have stressed a need for proper storage and disposal as they are common contributors of hazardous waste in most cities in Nigeria. The lack of knowledge and certainty about hazardous constituents of wastes reduces the possibilities of restricting their use.

Food waste constitute the highest percentage of 26.3% in Covenant University, Ota, Nigeria [3]. The study on food and polythene/ plastics constitutes about 20 and 16% respectively in Lapai, Niger State, Nigeria [2]. The study observed a dysfunctional local government sanitation agency which is responsible for the management of waste. The characteristics of household solid waste in Sabon-gari area of Kano in Northern Nigeria as well as solid waste per capita and bulk density were examined. The study noted that about 57% of the solid waste generated in the area is

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

made up of food/putrescible and vegetable matter while 18 and 3% were plastics and metals respectively. The per capita waste generated was put at 0.31kg/h/day while the average bulk density was 259kg/m^3. These observations led to the recommendation that a formal composting and recycling facilities be established within the community, and that private firms be involved for efficient and effective solid waste management [1].

Physical characterization of solid wastes in North Central Nigeria showed that wood, leaves, metal, plastic and paper are the main constituents but in varying proportions [4]. Average daily municipal solid waste generation was found to be about 1.23 kg/h/day and this figure is greatly influenced by population density and commercial activities.

The objectives of this study are to assess the generation of solid and hazardous wastes within Port Harcourt area, Nigeria; use the data to develop an efficient and safer environmental hygiene program and provide suggestions aimed at improving the level of sanitation in the study area.

Materials and methods

Port Harcourt is a coastal city located in the Niger Delta region of Nigeria. It covers an area of about 2600 km² with a population of 1,382 592 according to the 2006 Nigerian census.

The annual mean temperature ranges from 22ºC to 32ºC. The alternate effects of the tropical maritime and continental air mass produce two distinct seasons namely, wet and dry. The hot and humid tropical climate promotes bio-degradation of wastes.

Both solid and hazardous waste investigation was approached from three perspectives viz: Household units, Commercial outfits and Industrial ventures. Formal interview, questionnaire administration and facilities investigation formed the primary source of information.

Official records from the Rivers State Ministry of Environment and the Waste Management Authority were also reviewed.

For effective analysis and interpretation, the study area was divided into four zones: namely Borokiri, Main town, Diobu and Government reserved areas (Old GRA). The zones were further divided into low, medium and high income groups. Three households were selected for waste collection and composition analysis in each of the identified income groups. The factors taken into consideration are the management system, amount of waste generated, frequency of collection and disposal methods. Three commercial centres were investigated on the problems of hazardous wastes. These include printing shops, laundries and hair dressing salons. Questionnaires were administered to other outfits. The industrial venture is undoubtedly the primary source of hazardous wastes. However, only one industrial unit gave valuable information on the chemicals being used as well as their concentration of hazardous components.

Following the collection of raw data, statistical analysis was done using a frequency distribution tally. The formation of the frequency distribution table led to pictorial representation in form of a histogram, which is used to illustrate the efficiency of refuse collection for a period of two months.

The quantity of both solid and hazardous wastes generated from the household units and from various income groups were presented in form of a histogram. Storage facilities available to the dweller within and around the study area as well as disposal approaches were observed and presented in Tabular form.

Results and discussion

From the frequency distribution histogram presented in Fig 1, it is obvious that the frequency of waste collection vary from one zone to another. Some zones have waste collection patterns that are well co-ordinated while in others they appear to be irregular.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

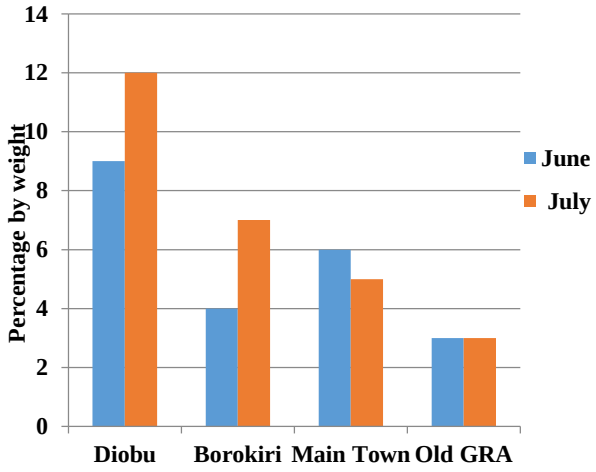

Fig.1 Refuse collection in Port Harcourt area for the months of June and July 2013.

The frequency distribution data can be further classified into: Very high (>12), High (8-11), Average (4-7), Low (2-3) and very Low (1).

Following the collection of raw data, statistical analysis was done using a frequency distribution tally. The formation of the frequency distribution table led to pictorial representation in form of a histogram, which is used to illustrate the efficiency of refuse collection for a period of two months.

The quantity of both solid and hazardous wastes generated from the household units and from various income groups were presented in form of a histogram. Storage facilities available to the dweller within and around the study area as well as disposal approaches were observed and presented in Tabular form.

In Diobu, the high rate of refuse removal is attributed to the fact that the depots were located in a densely populated area. Most of the depots in the area are quickly filled even before the refuse collection period. Depots with a monthly waste collection rate ranging from 4 to7 such as Borokiri and Main town districts are classified as average. The characteristic feature of these areas include few market places, commercial outfits and is less populated compared to Diobu. Most dwellers are civil servants, petty traders and entrepreneurs.

Depots having a monthly refuse collection rate of 2-3 are classified as low disposal points. This area (Old GRA) is sparsely populated and mostly occupied by the upper-class.

The waste composition analysis shown in Table 1, indicate that metals constitute over 20% of the major component of waste from the low and medium income group while garbage accounts for 23% of the solid waste in the high-income group. The characterization also indicates consumption pattern and usage of paper like materials in different households. Food waste such as fruits, remnants and other similar material are commonly found in the high-income group, while their low-income counterparts litter the surroundings with such waste materials.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

Table1: Solid waste composition in Household classified on the basis of income, in Port Harcourt, Nigeria (percentage by weight)

	INCOME GROUPS		
COMPONENT	LOW	MEDIUM	HIGH
Paper	18.3	19.1	16.3
Garbage	7.7	11.2	23.0
Polythene	16.6	13.7	11.1
Tins & Metals	21.3	23.2	5.4
Glasses	1.4	2.0	3.1
Leaves	17.3	19.1	22
Ashes	0.5	1.7	1.4
Rags	3.5	1.8	6.5
Bones	2.2	3.1	2.3
Cardboard/Cartons	11.2	5.1	8.9

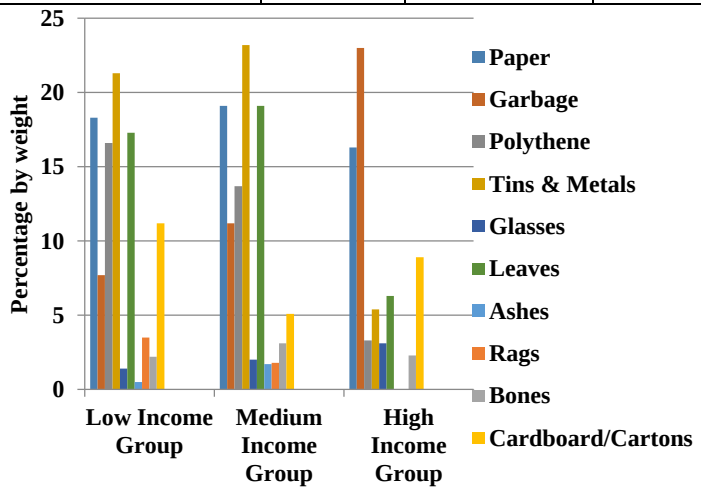

Fig.2: Graphical representation of Solid waste composition in household classified on the basis of income, in Port Harcourt, Nigeria.

Table 2 focuses on hazardous constituents of the solid waste such as insecticide cans, empty drug containers, paint containers, household cleaners, waste oil etc. Over 30% by weight of hazardous waste in the low income group is the insecticide cans which are commonly used on a daily basis. It was noted that children's exposure to environmental hazards in most homes of the low-income group appears to be high due to frequent usage of such insecticides. The insecticide cans are known to contain chemical compounds that are dangerous to both the environment and human health as they appear to be very toxic and may cause long term adverse effects.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

Table 2: Hazardous constituents of Household waste classified on the basis of income, in Port Harcourt, Nigeria (percentage by weight) .

	INCOME GROUPS		
COMPONENT	LOW	MEDIUM	HIGH
Old batteries	2.5	1.7	1.4
Electric bulbs	3.3	2.9	6.1
Waste oil	19.1	8.3	12.1
Fluorescent tube	5.0	5.0	2.5
Empty drug containers	24.2	8.8	3.5
Insecticide cans	38.1	12.1	6.6
Paint container	1.5	31.9	23.5
Automotive	2.0	4.0	13.1
Household cleaners	3.1	15.4	15.9
Others	1.2	9.9	15.3

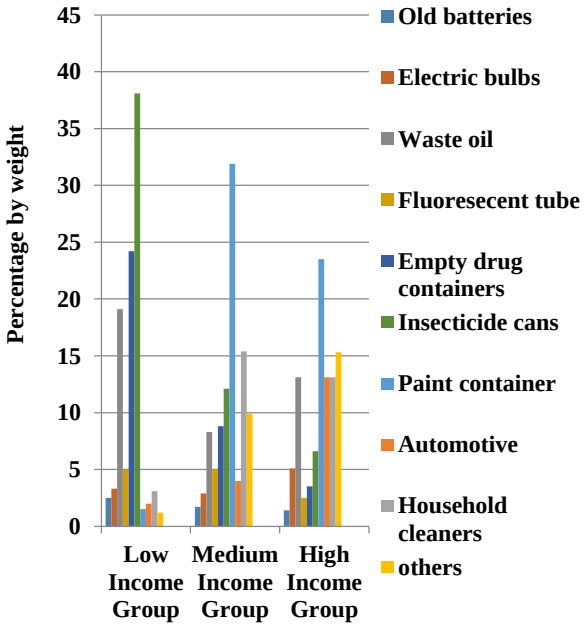

Fig. 3: Graphical representation of Hazardous constituents of household waste, in Port Harcourt, Nigeria.

The return rate of questionnaires on commercial ventures wastes was discouragingly low. However, observation reveals that wastewaters from most commercial outfits (Hair dressing salon) are thrown to open space in front of shops or roadway. Such systems are linked with the open drain and the chemical constitutes can contaminate both surface and ground water. The printing offices generate solid wastes which are commonly contaminated with ammonia. Currently there are no organized systems of disposing these wastes.

Industrial wastes constitute most of the hazardous and toxic waste. However, little or no information was obtained from most of the industries within the study as they try to protect their identity.

The information on the concentration of some toxic substances in an oil servicing firm is shown in Table 3 as well as WHO guidelines.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

Table 3: Concentration of toxic substances in one industrial waste sample in Port Harcourt, Nigeria.

PARAMETERS	OIL SERVICING FIRM	WHO GUIDELINE
pH	6.7	6.5 – 8.5
Pb	0.01	0.01
Zn	1.3	5
Cu	0.11	0.5
Mg	ND	_
Na	456.1	NS

ND- Not determined NS- No Specification

The waste material from the industry included metal scraps, plastics, cartons, liquid (chemical) effluents, gaseous emission and papers. However, an organized system of waste management is in operation.

On the average, the solid waste storage containers used in the study areas are sub-standard with the exception of Old GRA district. Most of the storage containers used in the other locations is exemplified (Table 4, & Fig.4).

Table 4: Types and state of solid waste storage Containers used in premises.

	LOCATION			
CONTAINER TYPE	BOROKIRI	MAIN TOWN	DIOBU	OLD GRA
Containers with cover	25	40	12	72
Containers without cover	75	60	88	28
Leak-proof containers	16	28	08	50
Labeled containers for different kinds of waste	00	00	00	00
Handled containers	07	11	05	48
Stationary containers	00	05	00	00

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

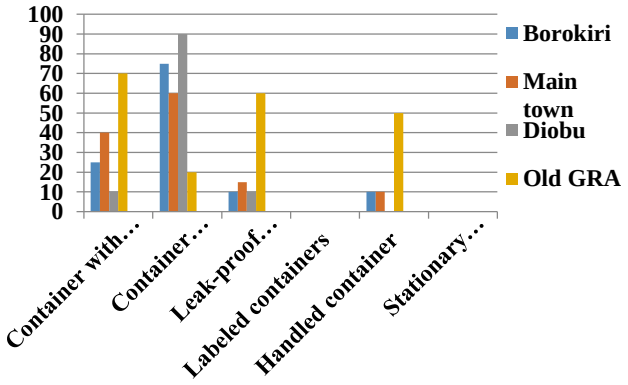

Fig. 4: Graphical Presentation of types and state of solid waste storage containers in the study area.

Containers with cover are reasonably provided in the Old GRA district, basically due to affluence of people living in that area. There are no labelled containers for different kinds of waste in the entire location to segregate waste at generation and collection points, thus making sorting, processing, treatment, and recycling of waste a bit difficult. The response from the interviews also reveal ignorance of an ideal collection and storage facility as any container is used to gather waste for disposal.

The practice of reducing or disposal of solid waste through burning is minimal in the study area. Recycling or reuse of waste was not adopted except sorting and collection of waste by informal sector waste pickers. Generally, the widely adopted method was the collection and transportation of solid waste with trucks at transfer stations for disposal at landfill or designated open dump sites. Table 5 and Fig. 5 show recent findings on waste disposal methods from various locations.

Table 5: Solid waste disposal patterns in Port Harcourt, Nigeria (percentages).

	LOCATION			
Waste Disposal Method	Borokiri	Main Town	Diobu	Old GRA
Dumping into drainages	0.5	30	59	0.0
Dumping into river channels	60	15	20	15
Dumping on vacant plots	45	15	30	0.5
Dumping on public spaces	0.5	30	60	15
Dumping at river banks	65	20	25	0.5
Burning of waste	10	0.2	15	0.3
Recycling or reuse of waste	0.2	0.5	0.5	0.0
Transfer for final disposal	40	80	80	95

Source: Official Records from Rivers State Ministry of Health.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

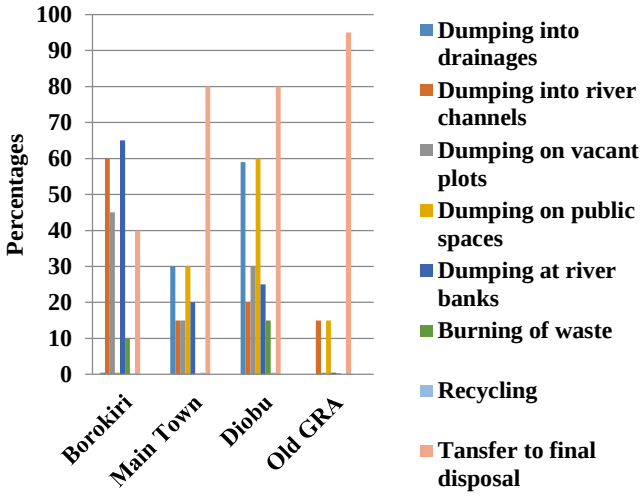

Fig. 5: Graphical representation of solid waste disposal patterns in the study area.

Conclusion and recommendations

The results in general reveal that no attention and efforts has been made to arrest inadequate sanitation and proper management of waste within the study area. It was also evident that there are no well constructed confined transfer stations. The open space transfer stations are arbitrarily designated at unused vacant plots and land which in most cases are at the middle of access roads. These cause vehicular and human traffic jam thereby posing difficulty to road users. For collection and transfer of solid waste to final disposal sites, compactor trucks are used. Most solid waste management contractors use open trucks, which on many occasions are not covered, allow the spread of wind-blown litters all along the route to disposal sites and increase the nuisance level in the environment. The neglect by solid waste contractors and government agencies to collect and dispose waste from slums and squatter areas of the suburbs of the study area is evident. Thus, solid waste in drainages, river channels, vacant plots, public spaces and river banks are a common occurrence.

The following recommendations will help better solid and hazardous waste disposal problems in Port Harcourt:

- The formation of an environmental control system should be encouraged to manage and maintain some degree of cleanliness in the study area.
- More equipment and vehicle should be made readily available to facilitate efficient waste disposal at the various refuse depots.
- The government should develop enlightenment campaigns to help create public awareness on the risks of environmental hazard and improper waste management.
- The location of refuse depots must be taken into consideration by urban development agencies so as to avoid indiscriminate dumping of refuse into open drain and along the roadways.
- Proper monitoring and effective collection methods of waste generated in the various locations should be practiced by sanitary authorities.
- Collection schedule with sufficient frequency should be made regular to avoid accumulation and overflow of waste.
- Facilities or bins should be provided for storage to ease handling, transfer and transportation of waste.

Waste Agency should encourage separation of different kinds of waste materials at the point of generation, so that the collection points do not become sorting points for informal sector waste pickers.

Acknowledgements

The authors thank the Rivers State Ministry of Health for their help and support and for providing the records on several parameters that are routinely measured.

References

1. *Bichi, M.H., Amatobi, D.A. "Characterization of household solid wastes generated in Sabon-gari area of Kano in Northern Nigeria" American JournalofResearch Communication, Vol 1, No.4 pp.165-171, 2013.*

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

2. *Ejaro, S.P. and Jiya, S.N., "Source Specific Quantification, Characterisation and Management of Solid Waste in Lapai, Niger State, Nigeria" Ethiopian Journal of Environmental Studies and Management, Vol. 6, No. 5 pp 561- 569. ,2013.*
3. *Okeniyi, J. O. and Anwan, E. U. "Solid Wastes Generation in Covenant University, Ota, Nigeria: Characterisation and Implication for Sustainable Waste Management " J. Mater. Environ. Sci., Vol. 3, No. 2 pp 419-424, 2012.*
4. *Oumarou, M. B. Dauda, M. Abdulrahim, A. T. Abubakar, A.B., "Characterization and Generation of Municipal Solid Waste in North Central Nigeria" International Journal of Modern Engineering Research(IJMER), Vol.2, No. 5 pp 3669-3672, 2012.*
5. *Sangodoyin, A.Y.," Domestic Waste Disposal in Southwest Nigeria" Environmental Management and Health, Vol.4 No.3, pp: 20-23, 1993.*
6. *Tamunobereton-ari, I., Omubo-Pepple,V. B. and Igbani, G. N., "Solid Waste Management Approach in Port Harcourt Municipality, Rivers State, Nigeria:The Effects on Public Health and the Environment" Asian Journal of Science and Technology ,Vol. 4, No.12, pp. 042-054, 2012.*