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AN APPRAISAL OF NATURE AND MANAGEMENT PRACTICES OF SOLID WASTES GENERATED IN A TERTIARY INSTITUTION IN NIGERIA

I. O. Akinjogbin*[1], M. K. C. Sridar[2], A. O. Coker[3]

[1]Building Technology Department, Federal Polytechnic, Ede, Nigeria.

[2]Department of Health Sciences, Faculty of Public Health, University of Ibadan, Ibadan, Nigeria.

[3]Civil Engineering Department, University of Ibadan, Ibadan, Nigeria.

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***Corresponding Author**
I. O. Akinjogbin
Building Technology Department, Federal Polytechnic, Ede, Nigeria.

ABSTRACT

Municipal solid Waste (MSW) generation has increased in Nigerian tertiary institutions due to increase in students' admission rate and daily activities of the institutions. Managing the institutional wastes like any other municipal solid wastes had created a lot of environmental challenges. Some common waste management methods like sanitary landfill, incineration and open burning cause additional harm to the environment including greenhouse gas emissions (GHG. The MSW generated in Federal Polytechnic, Ede were assessed. A thorough one session monitoring of the waste characteristics and management practices of the various sectors of the institution were carried. Through these assessments, the quantity and quality of wastes generated and deposited at the dump site of the institution and Carbon Dioxide (CO_2) emissions resulting from the generated wastes in the institution were determined. The major shortcomings observed in respect of source generation, storage and management practices of the Institutions MSW were poor storage facilities in the commercial areas, non-segregation of different waste constituents in all areas and uncontrolled dumping and burning at the designated institution's dump site daily, 747.5 kg of MSW is being generated. The current non-conventional management practices were responsible for emission of about 25,746.70kg/t of CO_2 emissions into the environments.

KEYWORDS: Environmental challenges, dump site, Open Burning, carbon dioxide, GHG.

1. INTRODUCTION

Both developed and developing countries face many environmental challenges including waste management. Waste has been a major environmental issue everywhere since the industrial revolution. Haury (1976), opined that waste could be anything which may not be directly useful or needed by man. Waste was also defined as materials of solid or semi- solid character that the possessor no longer considers of sufficient value to retain (Pfafflin, Ziegler and Lynch, 2008). Besides the waste created at home, school and other public places, there are also those from hospitals, industries, farms and other sources (eSchooltoday, 2015). Generally waste can be categorized into the following types: municipal waste (including household and commercial waste), industrial waste (including manufacturing), hazardous waste, construction and demolition waste, mining waste, waste from electrical and electronic equipment, biodegradable municipal waste, packaging waste, and agricultural waste. Solid wastes can be solid, liquid as leachate, and semi-solid or containerized gaseous material. The sources of wastes may be residential, industrial, commercial, institutional, construction and from demolition activities; municipal services, manufacturing process and/or agriculture.

Municipal Solid Waste (MSW) may be refuse from households, nonhazardous solid waste from industrial, commercial and institutional establishments (including hospitals), market waste, yard waste, and street sweepings. (Adeniyi, 2014). MSW are more commonly known as trash or garbage—consists of everyday items commonly used and then thrown away, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. MSW is generally made up of paper, vegetable matter, plastics, metals, textiles, rubber, and glass (Liu, Ren, Lin and Wang, 2015; EPA, 2016). Most of this rubbish ends up in dumpsites or in landfills and may potentially be reused, recycled and composted (Edu, 2003).

Waste generation is closely linked to population, urbanization and affluence; SPREP (2009), observed that waste generated everyday contains readily biodegradable organic matter such as kitchen waste, garden waste and paper, which on average accounts for about 58% of the total weight of waste generated. In some cases, the amount of organic waste accounts for almost 70% of the total waste generated.

Globally, irrespective of state of economic development with increasing population, prosperity and urbanization, wastes remains a major challenge for municipalities to collect, recycle, treat and dispose of increasing quantities of solid waste and wastewater. Some of the challenges faced include the collection process, impact on climate, public attitude, nature of waste, and transportation condition. Furthermore, refuse handling and disposal are other major environmental problems that developing countries are faced with; of the waste that is being generated, only 30% goes to the disposal ground, to the dump sites, incineration, recycling, shipping and home garbage disposal units have been used in different societies (Edu, 2003; Nwigwe, 2008).

Methods of Waste Management

There are several methods of managing different types of waste based on the type of constituents, nearby land uses practices and available ares. The common waste management methods are sanitary landfill which is the disposal of waste material or refuse by burying it in natural or excavated holes, depressions; incineration to ashes. There is also the compost heaps where the refuse is left to degrade by aerobic microorganism and its used as fertilizer, then the resource recovery, a process of recovering energy and reusable materials from solid waste before decomposition or landfill. Some of these methods cause additional harm to the environment, but not doing anything is not an option but a scenario (Adeniyi, 2014).

The problem of solid waste Management

MSW generation has increased in Nigerian tertiary institutions due to increase in students' admission and daily activities of the institutions which are multi-dimensional. The increase in the number of departments and creation of extra campuses, automatically result in increased students and staff population which directly increased the MSW being generated in the school. The disposal of these wastes is one of the most serious environmental problems facing many cities in Nigeria. Waste management plays an integral part in human activities (Awosusi, 2010). In most developed and developing countries with increasing population, prosperity and urbanization, it remains a major challenge for municipalities to collect, recycle, treat and dispose of increasing quantities of solid waste and wastewater.

2. METHODOLOGY

This research work examines the Municipal Solid Waste management in The Federal Polytechnic Ede in order to assess its implications on a clean and hygienic environment.

Study Area

The Federal Polytechnic, Ede is a Nigerian tertiary institution that was established in 1992. It is located in Ede, a town in Osun State, Southwestern Nigeria. It is a National Diploma and Higher national awarding institution. The polytechnic has two campuses tagged North and South Campuses with a total population of 1243 with a breakdown of staff and student's population of 11340 of which residential population is about 500. The South campus is occupied by two schools/faculties; the School of Engineering Technology (SET) and the School of Environmental Studies (SES) while the North campus houses the remaining two schools, School of Applied Sciences (SAS) and School of Business Studies (SBS). The Administrative block, Bursary, Medical center, Students' Affairs office, Works Department, Sports Facilities, Mini Market and Students' Hostels, There are total of twenty departments each with Head of Department (HOD) office and minimum of five offices for lecturers. The residential area i.e. the students' hostel was built for male and female students separately, the male hostel has 50 room while the female hostel has 80 rooms with four students in each room and toilet and bath facilities. There are about fifty (50) 80-100 seater capacity classrooms in the Institution and 10 number 300-500 seater capacity lecture theaters. The mini market areas have food canteens, laundry, tuck shops and hair salons where waste forms that include leather produce, human and artificial hair, liquid discharge with other synthetic chemicals and waste products are discharged.

Methods to Determine the Current State of Waste Components and Management Methods in Federal Polytechnic Ede

A one session MSW generated in the polytechnic residential, market/commercial, academic areas and office places were examined. The waste collection facilities on the campus were counted. The solid waste from each of the identified collection points were monitored and measured through the primary and secondary waste collection bins situated in the offices and areas from where they were transported to the dump site. The wastes were measured using weighing balance. This was done for all the locations and the number of bins and the weights were recorded and used to estimate the daily amount of waste generated by the entire polytechnic section by section. This was repeated for a whole week (Monday to Saturday). The average for the week was computed. The sources, types and composition of the wastes were determined through the direct observations and measurements of the wastes generated as shown below in Plate 1.

Plate 1: Examination and measurement of wastes and its constituents.

Parameters like waste generation per capital per day, moisture content, and densities of the wastes were established. The waste generation points include:

a. Administrative Area (Central Administrative Building Block , Student Affairs, Works Department, SIWES unit, Bursary Dept., Audit Unit, Security Office).

b. Academic Area (Accountancy Dept., Office Technology Dept., Science Laboratory Technology Dept., Business Administration Department, Hospitality, Leisure and Tourism Dept., School of Environmental Studies , General Studies Department, Banking and Finance Department, School of Engineering, Staff School.

c. Commercial areas (Restaurants, printing & publishing houses, water production factory).

d. Hostels (Male and Female Hostel).

e. Recreational areas (Senior Staff Club, Sports Pavilion).

f. Health Centre.

Plate 2: Shows the waste bins positioned in some of the areas mentioned above as provided by the Polytechnic with the exception of the commercial area where collection of waste, transportation and disposal is the responsibility of the generators.

Plate 2: Designated waste collection bins and bag.

The CO_2 emissions from the generated wastes in the offices, academic, commercial and residential areas of the polytechnic were measured to determine the percentage of these gases in the polytechnic environment.

The Intergovernmental Panel on Climate Change (IPCC) recommendations was used to estimate the level of GHG emissions based on the current waste generation and management practices of MSW in the institution. The research results were presented inform of tables, figures and plates

3. RESULTS AND DISCUSSION

Waste Transportation, Disposal and Treatments

The disposal of wastes from sources mentioned earlier were done by non-conventional open pit dumping and air burning, The Institution has a designated area where the collected wastes are deposited for an uncontrolled open air burning as shown in Plate 2. The Institution has no formal transportation facility or garbage truck for transporting the collected wastes to the dump site. The mobile dust bins are rolled/dragged to the dumping facility by the staff of the collecting entity of the Institution on daily basis for hostels and weekly basis for other areas except the mini market. The collection at the mini market is unscheduled. Some individuals especially the operators of the mini market take their wastes to the dump site in persons. Many of the mini mart operators dumped and burn collected wastes at an unapproved point in the mini market as shown in Plate 3b.

A 

B 

Plate 3a & b: Waste Disposal Sites.

After careful inspection of the waste collection facilities and final disposal site, the types of waste from the study area are shown in table 1 below.

Table 1: Sources and Types of waste from FPE Premises.

Source	Type of Waste
Administrative area	Nylon, paper, Plastic, wood, leaves, can
Academic area	Paper, plastic, electronic waste, glass, metal, can, nylon
Commercial Area (Mini mart)	Food leftover, bones, vegetal matter, food preparation waste, ash, tins, bottles, paper, plastic, nylon, cloth, leather, leave, electronic waste and sand,
Residential area(Hostels)	Paper, food remnants, food preparation wastes, plastic, textile waste, leather, cans, vegetable matter, glass
Recreational area(Sports pavilion)	Paper, plastic, glass, cans, leather
Recreational area(Staff club)	Food leftover, bones, food preparation waste , ash, tins, bottles, paper, plastic, glass and leaves
Health Center	Sharps, glasses, plastics, cotton wools, bandages and food leftovers
Hospitality, Leisure & Tourism Dept.	Paper, nylon, cloth, plastic, waste food, vegetable matters, food preparation waste, leaves

Measurement of Waste Generation

The waste collection facilities on the campus were counted. The solid waste from each of the identified collection points were monitored and measured through the primary and secondary waste collection bins situated in the offices and areas from where they were transported to the dump site. The wastes were measured using weighing balance. This was done for all the locations and the number of bins and the weights were recorded and used to estimate the daily amount of waste generated by the entire polytechnic section by section. This was repeated for a whole week (Monday to Saturday). The average for the week was computed.

Assessment of Waste Generation per Capital per Day

The record of the total number of staff, students and students residing in each of the halls were obtained from the school authority responsible for staff and student records as well as those responsible for student's accommodation. A random population survey of the mini market operators were equally carried out since there is no existing statistical data on the number of operators of the mini market. In order to determine per capita waste generation the following procedures were followed;

1. Determination of the net weight of solid waste (Ws) stored in each of the waste bins at each locations
2. Determination of the interval (Ts) in days, during which the waste was stored and the population of the polytechnic community (Pp) who contributed to the waste generation.

$$\text{Waste Generation Rate } Wr = \frac{Ws\ (kg)}{Pp \times Ts\ (days)} \quad (kg/capital/day)$$

The results obtained is as presented in Figure 1 and Figure 2 below;

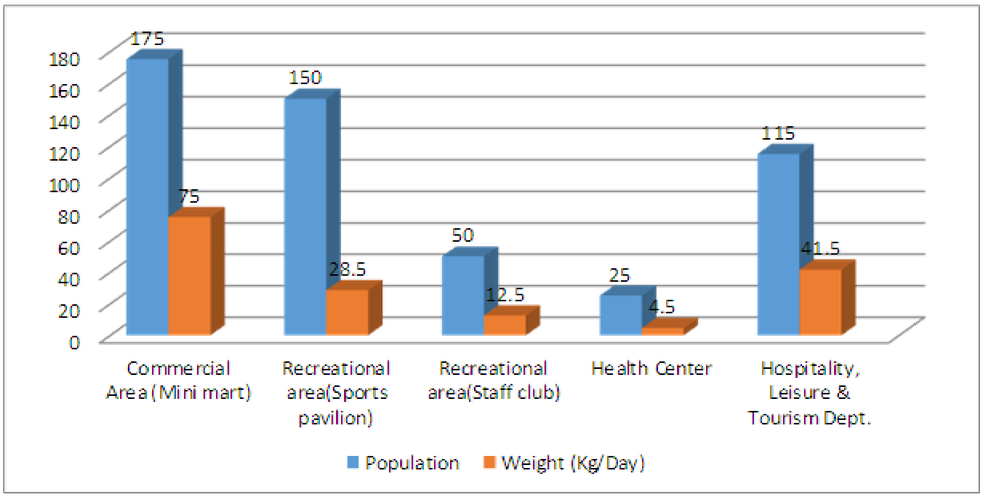

Figure 1: Approximate Average weight of solid waste generated per day in other Areas of FPE.

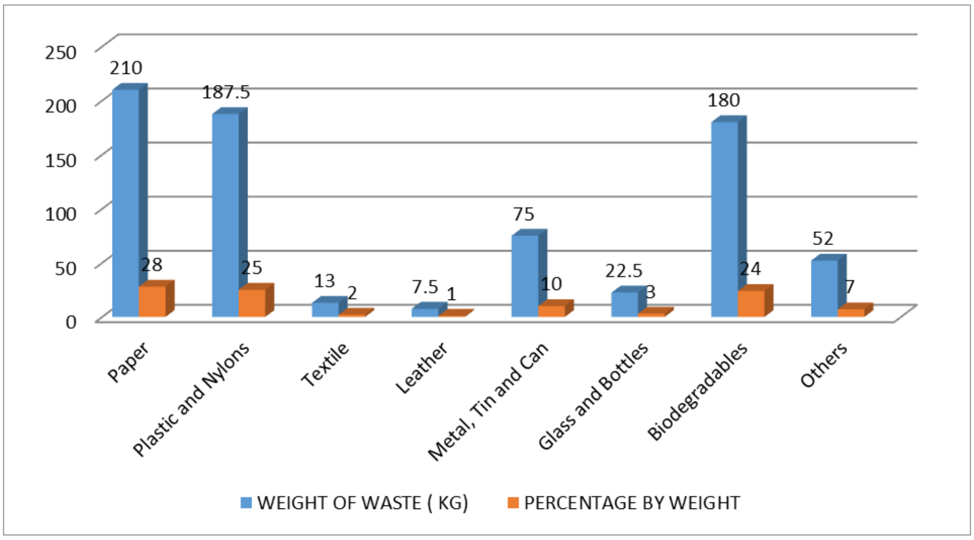

Figure 2: Composition of solid waste generated in FPE in Percentage.

Measurement of the Moisture Content of the Wastes

Moisture content is defined as the ratio of the weight of water (wet weight - dry weight) to the total weight of the wet waste; the dry weight is the weight of sample after drying at 105^{o}C for two hours. Moisture increases the weight of solid wastes and thereby, the cost of collection and transport. In addition, moisture content is a critical determinant in the economic feasibility of waste treatment.

The moisture percentage were calculated, using the formula recommended by Tchobanoglous et al. (1993) below:

$$\text{Moisture content (\%)} = \left(\frac{Ww - Wd}{Ww}\right)100$$

Where W*w* = initial weight of sample as delivered

W*d* = weight of sample after drying at 105^{0}C

Data on the moisture content for the solid waste components are given in Figure 3 below;

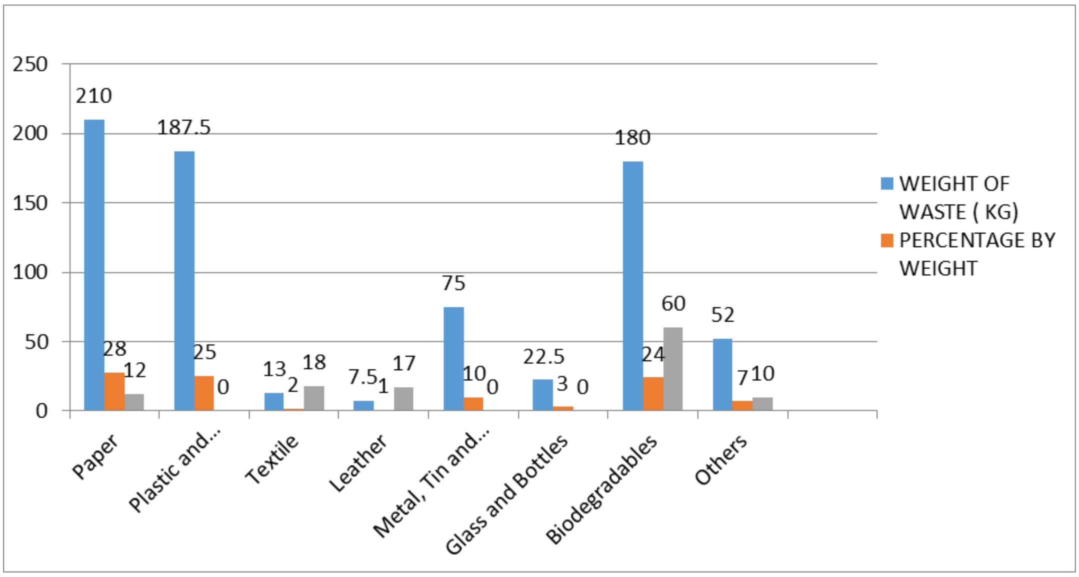

Figure 3: Moisture Content of the Wastes in Percentages.

Densities of the Wastes

The mass per unit volume (kg/m3) of waste is referred to as its density. The densities of solid wastes vary markedly with geographic location, season of the year and the length of time in storage. The volume of the waste were measured using a calibrated container of predetermined length, breadth and height. The wastes were poured into the container and shake gently after weight measurement to reduce the voids. The formula below was adopted in calculating the densities.

Bulk Density (Pb) $=$ Wt - Wb / Vw (kg/m^3)

Where:

*W*b is weight of empty bin using the weighing balance;

*W*T gross weight of container and waste using the weighing balance;

*V*W is the volume of the waste in the container;

Figure 4 below shows the densities for various wastes generated at FPE.

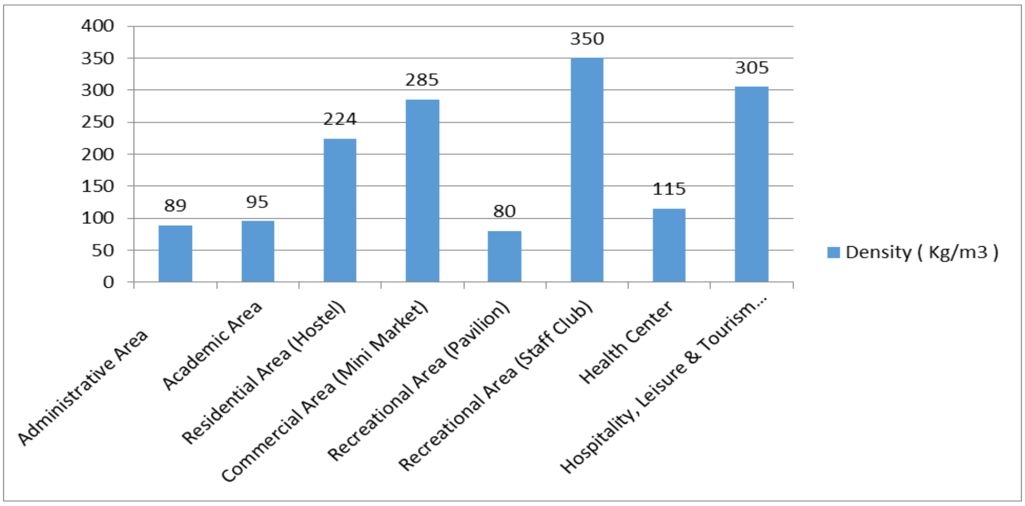

Figure 4: Densities of wastes generated at various sources at FPE.

CO_2 Emission Due to Current Waste Management Practice in FPE

Open burning is currently the treatment operation for collected municipal solid wastes (MSW) in FPE. Theoretically and virtually, all the volatile carbon content in MSW are converted into CO_2 emissions during burning. This study used Tier 2a of IPCC to estimate the amount of CO_2 emissions produced during the open burning after wastes were transported to the dump site and were sampled to reveal the waste physical composition. Table 2 presents the results

Table 2: CO_2 Emission Estimate Based on the Total Amount of Waste Combusted.

Waste Compo-Nent	Weight of Waste (kg/day)	Weight of Waste (Gg/yr) MSW	Dry Content (%)	Dmj	WFj	CFj	FCFj	OFj	$\frac{44}{12}10^3$	CO_2 emissions in kg /t waste generated in the institution
Paper	210	0.767	.78	163.8	1	.48	.05	.58	3667	5002.12
Plastic and Nylons	187.5	0.0684	1	187.5	1	.70	.98	.58	3667	18,712.01
Textile	13	0.0047	.82	10.7	1	.40	.45	.58	3667	15.79
Leather	7.5	0.0027	.83	6.3	1	.67	.20	.58	3667	4.02
Metal, Tin and Can	75	0.0274	0	0	1	NA	NA	.58	3667	0
Glass and Bottles	22.5	0.0082	0	0	1	NA	NA	.58	3667	0
Biodegradables	180	0.0657	.40	72	1	.5	-	.58	3667	2,012.18
Others	52	0.0190	.10	5.2	1	.04	.8	.58	3667	0.67
Total	**747.5**	**0.9631**		**445.5**						**25,746.70**

Where;

WFj = fraction of waste type/material of component j in the MSW (as wet weight burned);

Dmj = dry mass content in the component j of the MSW incinerated, (fraction);

CFj = fraction of carbon in the dry matter (i.e., carbon content) of component j;

FCFj = fraction of fossil carbon in the total carbon of component j;

OFj = oxidation factor;

44/12 = conversion factor from Carbon to CO_2;

103 = conversion factor from ton to kilograms;

j = component of the FPE's MSW open burned; and

∑WFj = 1.

4. CONCLUSION

The major shortcomings in respect of source, current storage and management practices are poor storage facilities in the commercial area and non-segregation of different waste constituents in all areas. Non-segregation of wastes at source complicates recovery of, for example, organic waste of which are good part is suitably used as feed material in biogas and compost production. Waste disposal is another waste management functional element that has major shortcomings in FPE. Only fraction of bottled water plastics of the total waste is not disposed of in a centralized disposal site and open burnt due to informal source sorting by those that needs the items for a reuse. The dumping and burning is as well uncontrolled. The current practices is responsible for emission of about 25,746.70 CO_2 emissions in kg /t waste equivalent into the environment on daily basis which need to be mitigated.

Segregation of waste at the source through use of different waste containers was found to be practicable at community level. This has not been found to be effective in developing nations due to lack of institutional commitment, lack of education and incentive for compliance. On the whole, improvement of institutional solid waste management seems to be hinged mainly on segregation of waste followed by resource recovery and recycling. In the light of these challenges there is the need to evolve an innovative SWM practices which would bridge the identified gab through the use of Material Recovery Facility that will engender conscious efforts at wastes separation for re use, and recycling.

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