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Enhancing Solid Waste Management in University of Abuja Main Campus

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ABSTRACT

Waste management systems are a major obstacle to the goal of sustainable development. The study areas were divided into three categories; Staff/Student Residency Dominated, Academically Dominated, and Commercially Dominated. The university generated 645.72 kg of solid waste per day on average during the two-month study period in the 2022/2023 academic session, which ran from October 19 to December 13. Polythene and organic waste accounted for the largest proportions, constituting 34.64% and 27.00%, respectively. Paper, Plastic, Glass/Bottle, Metal, Wood, Rubber, Textiles/Leather, E-Waste, Medical, Sanitary, Take Away, and other wastes represented 13.11%, 10.95%, 2.85%, 1.08%, 1.48%, 0.62%, 3.13%, 0.50%, 0.40%, 2.12%, 1.15%, and 0.97%, respectively. The campus has a solid waste generation rate per capita of about 0.044 kg per day. Approximately 96.73% of the waste collected has potential for recycling and can be turned into biomass. The analysis of variance demonstrated that differences in quantity and composition across diverse areas are primarily attributable to organic and polyethylene components. The compositions of municipal solid wastes with those of selected countries in the world were compared. The institution has several major obstacles in implementing sustainable methods for Waste Management (SWM). A sustainable waste management approach for integrated solid waste management was recommended.

INTRODUCTION

Solid waste refers to the variety of waste products from human and animal activities that are thrown away as unneeded and undesired (Nwosu and Chukwueloka, 2020). Solid waste originates from industrial, residential, and commercial activities within a specific area, and can be handled in a diverse method (Mudassar *et al*., 2020). Solid waste management plays a crucial role in every society. Irrespective of its origin, composition, or potential hazards, a systematic approach is necessary to ensure adherence to environmental best practices (Mudassar *et al*., 2020; Muhammad *et. al*., 2017). Solid waste management is a crucial aspect of environmental hygiene, it must be considered in environmental planning. Waste can be divided into categories based on material composition, such as organic waste, plastic, glass, paper, and metal (Elena *et al*., 2020). Categorization can also depend on potential hazards, such as radioactive, infectious, flammable, toxic, or non-toxic wastes (Ubuoh *et al.,* 2006). Categorizations may also relate to the waste's origin, industrial, domestic, commercial, institutional, or construction and demolition. Despite its source, composition, or potential hazards, it is crucial to manage solid waste systematically to uphold environmental best practices (Mudassar *et al*., 2020; Oyeniyi, 2011). Solid waste management must be incorporated into environmental planning to maintain environmental hygiene (Mokuolu, 2021).

Solid waste management practices vary depending on whether they originate from residential or industrial sources, urban or rural areas, and developed or developing nations. Local government agencies are in charge of handling non-hazardous waste in urban areas (Elena *et al.,* 2020). The handling of hazardous waste materials is subject to oversight by local, federal, and sometimes international authorities to ensure proper management.

Managing solid waste is one of the issues that many developing countries face especially Nigeria. Negligent handling of solid waste can result in some health, environmental, and socioeconomic issues. The University's solid waste management is plagued by issues such as improper disposal of garbage, ineffective waste collection, and a shortage of disposal facilities.

This study aims to investigate the pattern of solid waste generated at the University of Abuja, main campus. The University provides educational opportunities to all persons without distinction of race, gender, or political convictions (Amarachukwu *et al*., 2020). Educational institutes produce a variety of waste. Paper from books and used notes, food waste from the cafeteria, and cardboard used in projects, all of which could be disposed of responsibly, typically end up in the garbage dump instead (Amarachukwu *et al.,* 2020; Tadele, 2016).

Every university has a legal duty to ensure an efficient school waste management system is in place, that focuses on reducing, reusing, and recycling the rubbish produced, this means using the right bins for storage and disposal, separating as much as possible for recycling (Ugwu *et al.,* 2020). University waste comes in many different forms, which is often the reason many universities struggle to implement an efficient waste management system (Mudassar *et al*., 2020; Ugwu *et al.,* 2020). Being institutions that impart knowledge, educating students about the environmental impacts of dumping or wasting garbage should be one of the primary areas of focus for universities everywhere (Starovoytova, 2018; *Dongyong et al.,* 2020). The general objective is to cut greenhouse gas emissions. In Nigerian towns and cities, solid wastes of different kinds are generated and disposed of indiscriminately causing lots of environmental and health hazards (Ubuoh *et al*., 2006). Information regarding the quantity and composition of solid waste (SW) is not available.

The fact that solid waste in Universities is fast increasing cannot be overemphasized. This is attributed to the increased population in institutions. The significance of this project work is to discover simple yet effective procedures for waste management in the university. Nigeria generates over 32 million tons of solid waste yearly, of which only a small portion is collected, making it imperative to develop regulations that would allow the nation to establish an effective and sustainable solid waste management system (Salamatu and Safianu 2017). The waste management system consists of six functional components, as listed below (Orhorhoro and Oghoghorie 2019):

a. Waste generation: This includes the identification of materials that are no longer useable and are disposed of either systematically by gathering them or by throwing them away.
b. Onsite handling, storage, and processing: This pertains to activities carried out at the site of waste generation to facilitate easier collection. For instance, waste bins are strategically placed at sites that generate significant amounts of waste.
c. Waste collection: An essential step in the waste management process, involves setting up waste collection bins, filling them with waste, and gathering trash at the collection vehicles' dumping locations. While transportation is involved in the collection phase, it typically does not serve as the primary stage of waste transportation.

d. Waste transfer and transport: These activities entail transporting waste from local waste collection points to regional waste disposal sites using large waste transport vehicles.
e. Waste processing and recovery: This pertains to the infrastructure, machinery, and methods used to extract recyclable or reusable materials from the waste stream, aiming to improve the effectiveness of other waste management.
f. Disposal: The final stage of waste management involves systematic disposal of waste in sites like waste-to-energy plants or landfills.

Integrated solid waste management (ISWM) is defined by the Environmental Protection Agency (EPA) of the United States as including landfills, recycling, waste combustion, and waste source reduction. These activities can be carried out interactively or hierarchically. Additionally, it is emphasized by the US Environmental Protection Agency (EPA) (Huseyin, 2016) that environmental education encompasses more than just environmental knowledge. It fosters critical thinking, aids in problem-solving, and cultivates effective decision-making skills. Furthermore, it enhances public awareness and understanding of environmental issues, empowering individuals to offer informed opinions and make responsible decisions (Ogwueleka, 2006).

MATERIALS AND METHODS

Study Area

The location for this research work is the University of Abuja, main campus as shown in Figure 1. The University of Abuja was established in January 1988, the University was allocated a large parcel of land covering over 11,824 hectares along Abuja-Airport Road for the development of its main campus (Amarachukwu *et al*., 2020). It lies between latitude 8°58 north of the equator and longitude 7°10 east of the Greenwich meridian (Ugwu 2020). The University has two campuses: the Main Campus is located along Abuja-Airport Road, a few kilometers from the Nnamdi Azikiwe International Airport, while the Mini Campus is located in Gwagwalada Area Council, about fifty-four kilometers from the city centre (Amarachukwu *et al*., 2020). The majority of the faculties have moved to the Main Campus, however, the University continues to operate from the two sites.

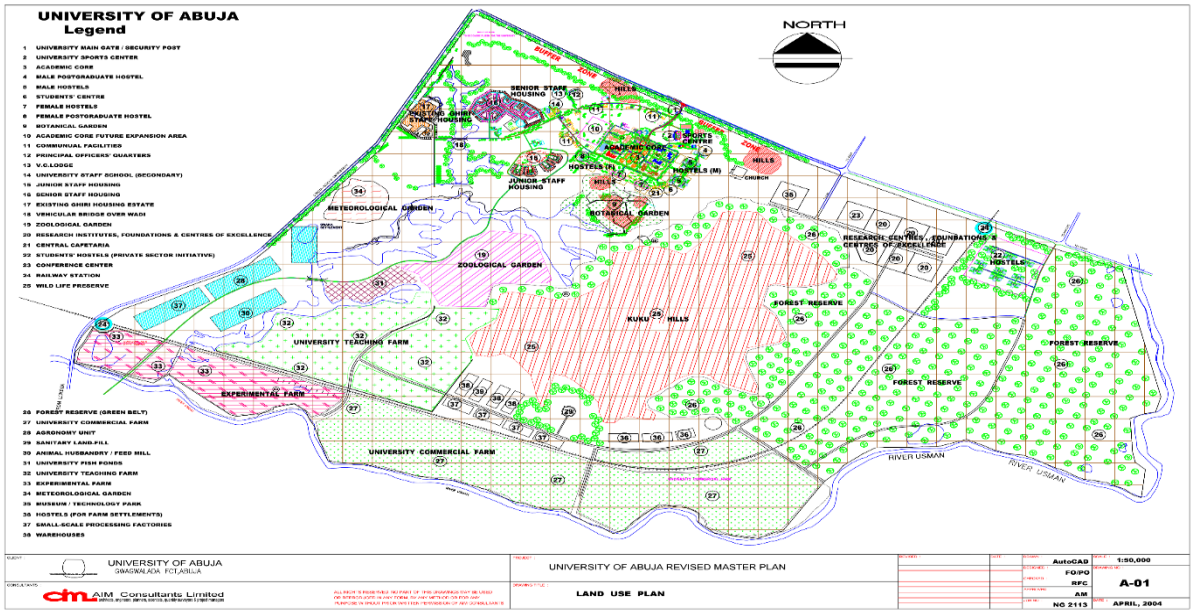

Figure 1: Map of University of Abuja

In addition, the University of Abuja Business School is located in the heart of the city, more precisely, in the university's annexe in Kado, close to the NAF Conference Center. The topography of the study location is slightly sloppy and the soil texture is a mixture of sand and loam with a temperature ranging from between 22 to 29 degrees Celsius.

Data Collection and Analysis

The scientific literature was thoroughly reviewed, with an emphasis on pertinent investigations conducted in the field. To guarantee comprehensive results, a variety of search phrases were used, including SWM, environmental awareness, environmental education, environmental sustainability, and students' attitudes toward garbage. Books, papers, and online resources were the primary sources of secondary data.

Sampling Method

Sampling for municipal solid waste (MSW) characterization was conducted following the ASTM D5231-92 method (Standard Test Method) [ASTM, 2008]. As stated in ASTM D5231-92, the number of sorting samples was determined using equation 1 below, where n is the number of samples to be sorted, S represents the estimated standard deviation, X represents the estimated mean, T represents the desired confidence level, and E is the precision level. The standard recommends a sample weight ranging from 200 to 300 lb (91 to 136 kg). However, the average sample size varied from 20 to 130 kg due to sorting at the dump sites before collection for disposal.

$$n = \left(\frac{TS}{EX}\right)^2 \quad (1)$$

Whereas the component on which the daily campaigns were based depended on the estimated values of the mean and standard deviation. The plastics fraction was chosen as the most typical MSW fraction because of its lightweight, presence in combustible or recyclable fractions, and relative abundance in the MSW that was gathered from the university. Firstly, using the student T value of 1.645 at a 90% confidence level, with an E of 20%, an S value of 0.03, and X at 0.09 corresponding to n = ∞ (Tables 3 and 4 of ASTM D5231-92), the value of n was found to be 8. Equation 1 was then used to calculate additional values using this value, where other parameters remained constant. The student T value for n = 8 is 1.895, at a 90% confidence level resulting in a new value of n = 10. Since 10 is within 10% of 8, a total of 10 samples were collected from the university. The overall amount of solid waste on campus, the characteristics of the waste, and the possibility for recycling could all be assessed by adding together the data gathered from each area. Samples were collected in 2 months from 19th October to 13th December in 2022/2023.

Waste Quantification and Characterization

The ultimate approach used in this study was to measure waste generated per day and characterization through visualization and physical sorting according to ASTM D5231 – 92 as seen in Table 1 and Figure 2.

Materials

The following materials were used: Weighing scales (minimum precision of 0.01g), waste collection bags for collection and weighing, tape, disinfectant, gloves, nose masks, masking tape, record sheets, paper, pens, and tricycle etc.

Table 1: Descriptions of Waste Component Categories

S/N	Waste Categories	Description
1.	Paper	printer paper, mixed paper, newspaper, corrugated cardboard, boxboard and paper towel newspaper, magazines, rough papers, cartons
2.	Plastic	plastic bottles, beverage bottles, plastic packages
3.	Polythene	Nylon, shopping bags
4.	Organic	food waste, fruits, vegetables, plants trees, leaves, and branches
5.	Glass/Bottle	such as bottles, glass containers, broken glasses, incandescent bulbs
6.	Metal (Al., Tin/Can)	such as metal cans, metal containers
7.	Wood	Furniture
8.	Rubber	Broken buckets,
9.	Textiles/Leather	Clothing, cleaning rags, etc
10.	E-Waste	Electronics and electronics packaging
11.	Medical	Syringes, needles, bandages, disposable medical devices, unused/expired drugs, cotton wool, etc.
12.	Sanitary (Pad, Pampers)	Diaper, Tissue, Pampers
13.	Take Away	Disposable pack
14.	Others	Non – recyclable

Figure 2: Waste Characteristic and Quantification

RESULTS AND DISCUSSION

The University Waste Collections System

The university's waste management is handled by a private company, Musfat Cleaning and Hygiene Services. However, the company lacks documented information regarding the quantity, rate, and trend of solid waste generation. Solid waste was disposed of in containers placed openly within the campus (Figure 3). Waste containers were strategically distributed at various locations on campus as seen in Table 2. The waste generated

was collected and disposed of in a large container before the waste collection vehicle came and disposed of it at the new iddo dumpsite.

Figure 3: Open dumping at Female Hostel

Table 2: No of Bin and their location on the campus

Location	No of Containers	Location	No of Containers
Old Female Hostel	9	Market	2
New Female Hostel	12	Chemistry Lab	
Old Boys Hostel	8	Entrepreneurship	1
New boys hostel	7	Faculty of Engineering	4
Post Graduate Hostel	1	Main gate	3
Main Campus Staff Quarter	1		
Printing Press	2	Senate Building	7
Clinic	2	Faculty of Agric	6
College of Health Science	3	Faculty of Science	5
Faculty of Law	3	Faculty of Arts	5
Convocation Ground	4	Institute of Education	7
Faculty of Education	13	Institute for Legislative Studies	2
Faculty of Environmental Science	2	Faculty of Social Science	4
Management Science	1	Veterinary Medical Science	3
E T F	10	C D L	5
Library	3		

Waste Generation Rate and Characterization

The cleaning staff have firsthand information regarding the quantity and types of waste generated on campus. The estimated weight of daily solid waste generated on the University of Abuja Main campus was estimated to be 645.72kg during the study period (2 months) in the 2022/2023 academic session, there were a lot of events that

took place while the study is ongoing (Table 3). The daily generation of solid waste varies across different locations (whether academic/administrative, staff/student residential, or commercial areas). The academic/administrative, staff/student residential, and commercial-dominated areas generated 221.31kg, 347.88kg, and 76.53kg respectively. The rate of waste generated per person was 0.044 kilograms per day. The University of Abuja Main Campus is involved in various operational, teaching, and research activities that result in the generation of substantial amounts of solid waste.

Table 3: Characterization and Grouping of Municipal Solid Wastes

S/N	Waste Categories	Total Waste in Kg	% Waste	Ranking
1.	Paper	84.66	13.11	3rd
2.	Plastic	70.73	10.95	4th
3.	Polythene	223.7	34.64	1st
4.	Organic	174.37	27.00	2nd
5.	Glass/Bottle	18.41	2.85	6th
6.	Metal (Al., Tin/Can)	6.96	1.08	10th
7.	Wood	9.57	1.48	8th
8.	Rubber	4.01	0.62	12th
9.	Textiles/Leather	20.21	3.13	5th
10.	E-Waste	3.23	0.50	13th
11.	Medical	2.57	0.40	14th
12.	Sanitary (Pad, Pampers)	13.66	2.12	7th
13.	Take Away	7.4	1.15	9th
14.	Others	6.24	0.97	11th
Total		**645.72**	**100**	

Barriers Encountered

Implementing sustainable solid waste management (SWM) practices in the university faces numerous significant challenges. These include a lack of proper administration or skilled staff, logistical challenges, and a lack of dedication, enthusiasm, or awareness of sustainability among students. Resource scarcity affects both time and finances. There are not enough resources at the institution to support large-scale, and long-term interventions.

CONCLUSION AND RECOMMENDATIONS

Conclusion

MSW management in universities is a topic growing in interest in the sector. Gaps in solid waste management (SWM) are caused by the absence of an efficient regulatory framework and enforcement mechanisms in the solid waste (SW) industry. During the two-month study period, the University of Abuja main campus produced an average of 645.72kg of solid waste daily, with polythene and organic waste constituting the largest proportions at 34.64% and 27.00%, respectively. The rate of waste generated per person was 0.044 kilograms per day. Analysis of variance revealed variations in waste generation rates and composition across different locations on the campus.

The academic/administrative, staff/student residential, and commercial areas generated 221.31kg, 347.88kg, and 76.53kg of waste, respectively. Approximately 95.38% of the total waste generated was recyclable. Waste characterization was identified as an influencing factor in recycling potential, with a higher proportion of food waste associated with higher recycling potential.

The University is urged to adopt and implement an integrated solid waste management system to minimize the rate at which solid waste is generated, enhance recycling, composting, and disposal mechanisms, and harness energy from solid waste, thereby mitigating public health and environmental impacts while maximizing profitability and generating income. As some solid wastes are released due to a lack of knowledge and carelessness, the institution can minimize its solid waste generation by providing adequate training for handling specific duties or activities, assigning responsibilities, and implementing measures to enhance waste management practices.

Recommendations

It can be started by enforcing a stringent waste reduction approach. In addition, let the university review its daily operations. Evaluate the educational, environmental, and socio-economic benefits of waste reduction. Implementation of this is an effective approach; students will learn environment-based lessons.

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