Strategies For Effective Solid Waste Management System in Bells University of Technology Ota.

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Abstract- ***Campus sustainability activities include techniques for effective solid waste management. Several activities involving students, staff members, and other parties that affect how much energy, water, and other resources are consumed are currently centered on the university campus. Studies revealed that typical wastes include: organic; plastics; polyethene; paper/cardboard; metal/cans; sanitary ware; wood; leather/textile; glass/bottles; polystyrene; food; and medical. As a result, this article explored the methods employed for solid waste management systems. Among the strategies are the following: preventing the creation of avoidable waste, reducing waste production through recovery, reusing recovered garbage, recycling recyclable materials, composting organic waste for the generation of energy/electricity, and finally disposal in sanitary landfills. Descriptive research was used in this study, using a well-structured questionnaire and field observation as data sources. The study population are members of the university community, university staff and students with a sample size of 300 respondents. The majority of the food waste and hostel waste produced at Bells University Campus was organic, whereas the majority of the inorganic waste was paper waste from administrative and educational activities. Hence the study recommended the use of colour-coded bins, incineration and composting for easy wastes recycling.***

Indexed Terms- ***Sustainability, Waste, Solid waste, Solid Waste Management System, Institution***

I. INTRODUCTION

Solid waste is all leftover, discarded, and abandoned stuff from human and animal activities such as production and consumption. There are various sorts of solid waste; they are typically divided into urban, industrial, and hazardous garbage. University production of municipal solid waste is significant. Numerous actions carried out by students, teachers, support personnel, and other parties have an environmental impact, either directly or indirectly. Numerous studies have emphasized the importance of solid waste management in creating institutional sustainability. There is a large number of possibilities for decreasing the quantity of municipal solid waste produced on the Bells University campus by implementing sustainable solid waste management. At Bells University, the primary focus of environmental sustainability is solid waste management systems, The recycling rate for waste generated on campuses ranges from 55 to 90 %.

According to (Budihardjo, 2021). female university students typically have more consumptive lifestyles than male students. Tissue, paper, plastic, and other feminine products are typically used by women more frequently, which results in more trash being produced. According to (Vicente-Molina, 2018)gender research is done since it's thought to have an impact on environmental knowledge and behavior. For sustainable solid waste management to be implemented successfully at higher education institutions, environmental awareness and knowledge are essential. These factors include involving individuals in the program and teaching them to be environmentally responsible. (Debrah, J. K., Vidal, D. G., & Dinis, M. A. P., 2021).

Education level is thought to have a significant impact on this matter since people with higher levels of education are likely to be more environmentally conscious, which could lead to a favorable attitude toward solid waste reduction. In order to suggest better

solid waste management strategies for Bells University, this paper discusses and evaluates waste reduction and recovery techniques.

II. LITERATURE REVIEW

- Solid Waste Management.

This involves gathering, handling, and disposal of solid waste that has been disposed because it is no longer needed or serves its intended purpose. Improper municipal solid waste disposal can result in unclean circumstances, which can then cause environmental pollution and outbreaks of vector-borne diseases, rodent-borne diseases, and insect-borne diseases.

Figure 1: Major Types of Waste

Source: Google, 2022

2.1. The Importance of Effective Waste Disposal

Depending on the scope or circumstances surrounding waste generation, effective waste management can take many different forms; for example, it may only require that staff and students place their waste in a trash can and refrain from littering. (Nattapon I, 2019)

2.2 Benefits of Effective Waste Disposal

Key benefits of effective waste disposal include:

i. Environment protection against contamination or pollution that in the long term will reduce the rate of diseases and improve the living conditions of the residents of the institutional environment.
ii. Financial gain - recyclables are sold to generate income (IGR).
iii. Safety – irresponsible disposal of waste can harm people.

2.3 Classification of Solid Waste

On several criteria, such as origin, form, and property, solid waste can be categorized or grouped. Clinical waste is typically produced by hospitals. Domestic waste is typically created by families. Agricultural waste is typically produced from industrial animal waste. Agricultural land is typically created from construction and industrial sites. Lastly, nuclear waste is typically produced by petrochemical companies. In terms of form, it can be categorized as solid, liquid, or gas. Additionally, it can be categorized as inert, poisonous, combustible, biodegradable, or carcinogenic wastes based on its qualities. (Ugwu, 2021)

2.4 Strategies for Waste Utilization and Reduction

The long-established hierarchy of waste management includes prevention, minimization, recycling and reuse, biological treatment, incineration, and landfill in that order of preference (Robinson, 2017).

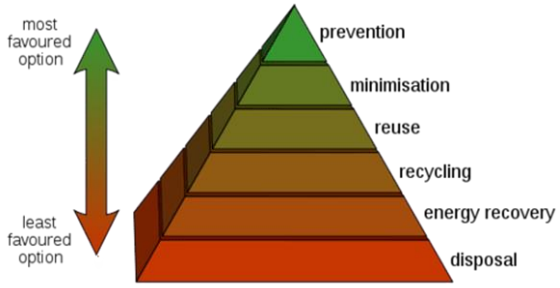

Figure 2: Hierarchy of Waste Management

Source: (Drstuey, 2008)

I. Waste Prevention

Avoiding the need to produce garbage in the first place is the greatest option for waste management. Therefore, one of the primary objectives of all waste management methods is to prevent waste. There are a number of technologies that can be applied throughout the phases of a product's lifecycle—production, usage, and post-use—to reduce waste and, consequently, to lessen or prevent pollution. Examples of such projects include the employment of cutting-edge leak monitoring systems to save materials, inventive chemical neutralization techniques to reduce reactivity, or water conservation technology to lessen the need for freshwater input.

II. Waste Minimization

Many times, it is impossible to entirely remove residues from a range of activities. To stop or limit the formation of manure, however, a number of strategies can be adopted. The phrase "waste minimization," which is often used to refer to "source reduction,"

refers to a collection of design and production methods that seek to provide products or services with the least amount of waste while simultaneously lowering their toxicity. These initiatives frequently come up as a result of identifying particular trends or goods that might be a factor in waste stream issues and taking steps to remedy such problems. By recycling materials, moving to less dangerous substitutes, or altering design and production processes, waste in the industrial sector can be decreased. Waste minimization or source reduction has a number of advantages, such as lower consumption of natural resources and reduced waste toxicity.

III. Recycling and Re-use

Recycling is the act of removing materials like glass, paper, plastic, wood, and metals that can be used to make new products from the waste stream. As resource recycling rises, less raw material is required for similar applications. Recycling enables the recovery and use of waste products as valuable commodities, reducing the need to extract natural resources to get raw materials. The reduction of energy use and greenhouse gas emissions during the extraction of raw materials and the subsequent production of finished goods, as well as the reduction of incineration or landfilling of garbage, are all benefits of recycling waste. Additionally, recycling has the potential to boost GDP and establish job markets, among other economic advantages. Paper, plastic, glass, aluminum, steel and plastic are often recyclable materials. Every day, there are countless instances of recycling and reuse projects that are successful. Recycled materials are occasionally utilized as inputs and then further processed to create finished goods. Examples of this include processing used aluminum cans to create new aluminum products or recycling waste paper to create new paper.

IV. Incineration

In addition to creating usable solid end products, waste degrading by-products can be used as a beneficial energy source (such as compost). As was already indicated, the anaerobic digestion of waste can result in the production of biogas, which can be stored and utilized as fuel. As an alternative, the trash can be immediately burned to provide energy. Waste is burned at incredibly high temperatures to create power. Ash is a by-product of combustion that needs to be accurately defined before being disposed of or, in some cases, usefully reused. Additionally, hazardous waste such as oils, solvents, pesticides, chlorinated hydrocarbons, and medical waste are frequently effectively mitigated through incineration.

III. METHODOLOGY

Descriptive research was used in this study, using a well-structured questionnaire and field observation as a data source. Data was derived through questionnaire filled by students, staffs who reside in the school. Observation was also carried out in the study area (Bells University of Technology, Ota, Ogun State). A total of 300 questionnaires were used for the purpose of data collection. All were dully filled and thus used for the data analysis.

3.1 Location: Bells University of Technology, Ota, Ogun State. The school is located in a hot and humid tropical area with unique characteristics of distinct wet and dry seasons, respectively.

Plate 1: Layout of Bells University of Technology

Source: Author's Fieldwork, 2022

IV. FINDINGS

Table 1: Wastes Generated on the Bells University Campus, their Characteristics and Source

Type	Characteristics	Recyclability	Items Considered	Source/Origin	Management Strategy(s)
Paper/cardboard	When dry, flammable, and when perpetually wet, degradable	Recyclable	Papers and allied packages-carbon papers, tissue papers, cardboards.	Domestic and industrial waste and may result from Staff quarters and hostels, classrooms, photocopying centers, offices.	Source separation Reusable Recyclable Energy Generation
Garbage	Organic and biodegradable; and combustible when dried.	leftover	left over from food,	lecturer quarters and hostels, bakery, restaurants.	Creation of compost Energy for the production of Animal feed
Plastics, polythene and packaging foils	Not biodegradable, and their residue barely decomposes when burned	Recyclable	Can buckets, bags, waterproof bags, syringes, beakers, burrettes, broken plastic chairs, cables, and ball pens are examples of items manufactured of plastic.	from food court, school clinic and laboratories.	Recyclable
Metals/Junks	Neither combustible nor biodegradable	Recyclable	Auto-mobile junks, metal cans, plates, aluminum, scrap electronic equipment.	Majorly industrial waste may result from staff quarters, hostels, guest house, food courts, and machines from workshops.	Recyclable Reusable Source separation
Ashes	Biodegradable but non-combustible	Non-recyclable	Burned paper, leaves, and wood	Space allocated for burning close the staff gate	Treatment and enrichment of the soil
Rags	Non-Biodegradable but combustible	Recyclable	Threads, cotton, wool, and nylon from abandoned clothing	Domestic waste that could come from staff housing, hostels, and tailor shops	Recyclable Reusable

E-Waste	made up of various non-biodegradable components. While some components, like those made of rubber, plastic, etc., are flammable, others, like those made of metal, are not.	Recyclable	cables for electricity, ink for printers, and phone accessories	Domestic and industrial waste from electrical devices in print shops, hostels, staff housing, and workshops	Reusable Recyclable
Leather	not biodegradable but flammable	Recyclable	Leather shoes and bags	Mostly from the staff quarters, the cobbler shop and the hostels	Reusable Recyclable
Sanitary waste	Non-biodegradable	Non-recyclable,	diapers, pads, and cotton wool	primarily from the restrooms in the classrooms, hotels, and staff quarters	Hygienic disposal

Source: Authors' Fieldwork, 2022

4.1 Solid Waste Disposal in Bells University

In public buildings, high-rise buildings, for example, the regulation states that it is necessary to provide a garbage pit (hollow shaft coming from top to bottom), where the waste is collected in a collection bin and then taken for disposal (Jingguo X, 2022). The school has designated janitors in all buildings who will take them to the dump, where they sort cans, plastic bags and packages.

Plate 2: Waste Collection Method at Bells University Hostel

Source: Authors' Fieldwork, 2022

Plate 3: Cleaning of Hostel at Bells University

Source: Authors' Fieldwork, 2022

On getting to the dump site, a waste contractor makes sure the waste is sorted out in plastic, bottle and nylon, the rest that cannot be recycled is being burned. Waste that can be recycled.

Plate 4: Transportation of sorted Waste
Source: Authors' Fieldwork, 2022

Plate 5: Waste Collection Point, Bells University
Source: Authors' Fieldwork, 2022

4.2 Data Analysis and Results

4.2.1 Personal Information of Respondents

Table 2: Frequency Distribution of Gender of Respondents

Gender	Frequency	Percentage (%)
Male	216	72
Female	84	28
Total	300	100

Source: Authors' Fieldwork, 2022

Table 2 shows that out of 300 respondents of this study,216 (72%) were male, while 84(28%) respondents were female. This implies that there were more male respondents in this study than their female counterparts.

Table 3: Frequency Distribution of Age of Respondents

Age	Frequency	Percentage (%)
15 years -20 years	248	82.6%
21-40	49	16.3%
41-50	1	0.3%
51 and above years	2	0.8%
Total	300	100%

Source: Author's Fieldwork, 2022

Table 3 shows age frequency distribution, most of the respondents 248(82.6%), were between the age group of 15 years and 20 years, followed by 49(16.3%) respondents were between the ages of 21-40years, while the least numbers of respondents 1(0.3%) were between the ages of 41 and 50 years. This implies that respondents with 15 years -20 years participated more in this study.

Table 4: Frequency Distribution of Educational Qualification of Respondents

Educational Qualification	Frequency	Percentage (%)
HND/BSC	254	84.6%
MSC/PGD	44	14.7%
PHD	2	0.7%
Total	300	100%

Source: Author's Fieldwork, 2022

Table 4 shows the result on the educational qualification of the respondents, the result shows that 44 (14.7%) of the respondents were MSC/PGD holders. 254 (84.6%) respondents were HND/BSC

holders. While only 2 (0.7%) were holders of Ph.D. This implied that respondents with BSC qualifications participated more in this research work.

Table 5: Frequency Distribution of Marital Status of Respondents

Marital Status	Frequency	Percentage (%)
Single	289	96.4%
Married	11	3.6%
Total	300	100%

Source: Author's Fieldwork, 2022

Table 5 revealed that out of 300 respondents that participated in this study, 11 (3.6%) were married, while 289 (96.4%) were single. This shows that there were more single respondents in this study than their married counterparts.

Table 6: Where did you hear about the Solid Waste Management?

Medium	Frequency	Percentage
Over the radio	38	12.7%
Over the t.v	20	6.7%
In public meetings	15	5%
In school	221	73.7%
On posters	6	1.9%
Total	300	100%

Source: Author's Fieldwork, 2022

Table 6 above shows the result of the question where the respondents heard about solid waste management.

Table 7: In What type of Container do you collect Waste in the University?

medium	Frequency	Percentage
Carton	9	15.2%
Waste bucket	47	79.7%
Old bucket	2	3.4%
Plastic bag	1	1,7%
Total	59	100%

Source: Author's Fieldwork, 2022

Table 7 above reports the result of the question, what type container the respondents use to collect waste

Table 8: How often should a Waste Container Should be Emptied?

Statement	Frequency	Percentage
Once a day	245	80.4%
Once in two days	57	19%
Once in three days	1	0.3%
Once a week	1	0.3%
Total	300	100%

Source: Author's Fieldwork, 2022

Table 8 above reports the result of the question, how often the waste container should be emptied.

Table 9: Do you know about the Environmental Impact of Solid Waste?

Statement	Frequency	Percentage
Yes	294	98%
No	6	2%
Total	59	100%

Source: Author's Fieldwork, 2022

Table 9 shows the result of the question do you know about the environmental impact of solid waste? 294 (98%) respondents answered that they know the impact, while only 6(2%) responded that they do not know the environmental impact of solid waste.

Table 10: Do you Notice the Presence of the Following in and Around Public Waste bin at Bells University?

Statement	Dark flowing water	Rats	Odour	Mosquitoes and cockroaches
yes	13(10.2%)	300 (100%)	300(100%)	300(100%)

no	287(89.8%)			

Source: Author's Fieldwork, 2022

Table 10 above reports the results to question if the respondents have noticed the presence of the following in and around public waste bin at Bells University? 300(100%) noticed the presence of rats, odour, mosquitoes and cockroaches while 13(10.2%) said they noticed the presence of dark flowing water and 287(89.8%) said they didn't.

Table 11: Have you heard about Sustainable Development?

Medium	Frequency	Percentage
Yes	300	100%
No	-	-

Source: Author's Fieldwork, 2022

Table 11 above reports the results of the question, have you heard about sustainable developments? 300 (100%) respondents answered that they have heard about sustainable development.

Medium	Frequency	Percentage
Yes	300	100%
No	-	-

Source: Author's Fieldwork, 2022

Table 12 above reports the results of the question, do you think Solid waste management has an impact on sustainable developments? 300 (100%) respondents answered that Solid waste management has an impact on sustainable development.

Table 13; do you agree that Solid Waste Management should be developed at Bells University for Sustainable Development?

Medium	Frequency	Percentage
Yes	300	100%
No	-	-

Source: Author's Fieldwork, 2022

Table 13 above reports the results of the question, do you agree that solid waste management should be developed at Bells University for sustainable development? 300 (100%) respondents answered that Solid waste management should be developed at Bells University for sustainable development.

V. DISCUSSION

As previously indicated, the majority of the organic waste produced at Bells University Campus came from the food and dorms, whereas the majority of the inorganic garbage was paper waste from the campus's administrative and educational activities. The emission of greenhouse gases from organic waste might draw pests inside the house and attract them. Therefore, if these wastes are not properly disposed of or used to create animal feed, composting products, or alternative energy for colleges, they could cause environmental and health hazards. Paper, polyethene, and plastic made up the majority of the inorganic waste produced on campus. Plastic bottles for water and soft drinks, for example, are frequently made of polyethene plastic. The production of waste also included high-density plastics from abandoned home objects including buckets, plastic chairs, and appliances. Plastic is the largest contributor to university waste after organic waste.

CONCLUSION

One of the major environmental problems is solid waste. Inadequate waste management alters ecosystems and contributes to air, water, and soil contamination, which poses a serious risk to human health. The high costs of the municipal budget were made more difficult by the rising generation of solid garbage. The rate, volume, and quality of municipal solid waste output have been dramatically accelerated by population growth, fast urbanization, a rising economy, and an increase in standard of life. The amount of recyclable material, particularly the organic contents, is controlled by the biodegradation of municipal solid waste over time. The properties of solid wastes are significantly impacted by poor bin

collection procedures and collection, transfer, and/or transport systems.

5.3 Recommendations for Solid Waste Disposal at Bells University

- Recycling

Recycling encompasses both material recycling, which involves recovering raw materials from waste, and direct reusing of used goods (such as used auto parts and discarded clothing) (e.g., the production of new glass from scrap, smelting scrap iron and producing recycled building materials from construction waste). The practice of recycling waste to create goods that are inferior to the raw materials is known as "downcycling."

i. Use of color-coded bins: Bins are containers for the temporary storage of waste and can be plastic or metal. It is also a trash can that holds garbage until it is collected. There are 4 types of waste bins, namely;

- Blue: it is used for glass wastes.
- Green: it is used for Organic wastes.
- Red: it is used for household metal waste.
- Yellow: For paper waste.

Incineration

Combustible residential waste and wood waste that cannot be recycled are thermally processed in waste incineration plants or wood waste furnaces. In industrial plants like cement factories, waste with a high calorific value and low level of pollution can be used in place of fossil fuels. Waste polluted with organic pollutants is subjected to specialist thermal treatment (e.g in hazardous waste incineration plants). Incinerators must have a flue gas treatment system.

Composting

It entails the microbial breakdown of organic waste, allowing the trash to accumulate in a pit for a very long time. Compost that is high in nutrients can be used to nourish plants. The procedure takes a long time and uses a lot of land, though. Soil fertility is significantly increased via biological reclamation.

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