Original Research Article

Quantification and characterization of solid waste at Lead City University, Ibadan, Nigeria

Abstract

Municipal solid waste quantification and characterization form the cornerstones of an effective solid waste management strategy; yet, in Nigerian universities, the necessary processes of collection, transportation, characterization, and disposal are terribly understudied and rarely executed. Thus, using the ASTM D5231-92 technique, this study quantified and described the trash created at Lead City University and suggested potential integrated solid waste management strategies for a sustainable waste management.

When the research was done, there were 14,636 students enrolled at Lead City University overall, with 11,797 (80.60%) of them residing off campus. The university's average weekly generation of solid waste was estimated to be 15.85146 tons during the one-year study period from August 16 to July 15, 2022/2023 academic session. The largest portion of this waste was generated by university eateries and male and female hostels, at 6 tons and 4 tons, respectively. Dump site and hostel have highest number of biodegradable wastes of 31.14% and 41.16% respectively, followed by paper and cardboard waste of 42.12 1nd 24.14. However, metals and glass waste have least number in all category sampled.An approximate study of the organic MSW produced at LCU, Ibadan revealed that moisture content has the highest percentage of 65.2% in food waste (mixed), volatile matter in plastic (95%), fixed carbon and ash in textiles/rubber/leather (16.2% and 7.0% respectively).

0.72%, 0.69%, 9.96%, 0.81%, 1.36%, 8.24%, 4.16%, 1.23%, 72.74%, and 0.08% were the respective representations of wood, rubber, paper, gravel, metal, plastic, textiles (leader & cloth), glass and ceramics, organic materials, and hospital wastes. On campus, each person generates roughly 0.5 kilogram of solid garbage per day. The dump site and hostel contain the largest percentages of biodegradable garbage (31.14% and 41.16%, respectively), followed by waste made of paper and cardboard (42.12) and cardboard (24.14). But out of every category studied, the least amount of waste is made of glass and metals.

The university's differently dominating areas exhibit varying quantities and compositions of wastes, as demonstrated by T-test, ANOVA, and Chi-Square. This variety in location is primarily responsible for these differences. Solid waste generation reduction, re-usage, recycling, composting, appropriate training, the provision of incentives and other fiscal policies, and other integrated solid waste management techniques were suggested as solutions to the obstacles to successful solid waste management

Keywords:Waste quantification, Waste characterization, Solid waste management, Open Dump Site, Adaptive Sanitary Landfill, Lead City University, Ibadan

1. INTRODUCTION

A waste is any material or item that is thrown away, disposed of, or planned for disposal[1]. The initial phase of any effective waste management policy is waste characterization[2].

Solid wastes include trash and abandoned materials and objects from mining, commercial, industrial, agricultural, and everyday activities. A detailed inventory of these materials may be found[3]. Municipal solid wastes (MSWs) are the term used to describe the majority of wastes that are commonly discarded and regularly disposed of by the general public. MSWs include any materials or items thrown away as leftovers from packaging, newspapers, paint, batteries, lawn clippings, furniture, clothing, bottles, and glasses, food scraps, electric appliances, and so on[4].

The kind of decision-making that results in sufficient solid waste management (SWM) necessitates a good comprehension of the elements and mechanisms that affect wastegeneration[5].

Since the qualities and composition of waste vary depending on their source, special attention should be given to the sources of waste formation. In light of this, waste management initiatives that are founded on an understanding of the makeup of waste and the state of the recyclables market will likely be more effective than ambitious initiatives that are lifted verbatim from another source. It is crucial to understand the features of the trash as well as the local market for recyclables in order to propose waste management solutions that are grounded in the reality of the generating source[6].

Integrated solid waste management (ISWM) is the process of choosing and appropriately implementing appropriate techniques, management guidelines, and technologies to meet particular waste management goals. Waste characterization studies must be completed for this system to succeed[7].

Waste characterization plays a crucial role in correct MSW collection, equipment selection for transportation, energy transformation and recovery, recovery of reusable materials, and proper planning and implementation of the best disposal routes and techniques. Changes in people's purchasing patterns and the quick advancement of technology have led to shifts in the trends of MSW creation and its composition. Each country, region, neighborhood, and even community has a different quantity and makeup of mixed-solid waste (MSW). The disparities may arise from variations in individuals' income brackets, socioeconomic strata, patterns of consumption, or disposal practices[8].

It is required that educational institutions' waste management programs incorporate student participation into the learning process. Furthermore, the internal policy of the Universidad AutónomaMetropolitana (UAM-A) campus in Azcapotzalco is dedicated to environmental care and, in addition, to promoting values for the prudent and responsible use of natural resources[9].

There is a lot of information available regarding the harmful effects of waste management on health. The two main health effects of waste exposure that have been demonstrated to be statistically correlated are congenital abnormalities and cancer. Because there are solid waste dumping sites near dorms on the campus's border, flies, mosquitoes, and rats pose a threat to public health while their organic defenses are still forming. Additionally, these pests contaminate the student body. It is not out of the ordinary that the university administration has not yet determined the Lead City disposal location. However, the amount of solid waste produced within the institution and its environs has increased as a result of growing populations, a booming economy, and better living circumstances within the academic community. If we do not move swiftly to improve solid waste management and sanitation through the development of an adaptable sanitary landfill waste management system in Lead City University, Ibadan, the university's rapidly growing student population and urbanization may further exacerbate the major urban environmental concerns of municipal waste management, sanitation, and associated detrimental health impacts.

1.1 Main Objective

The goal of the study was to create an efficient and sustainable waste management system through constant practices of quantification and characterization of waste for Lead City University in Ibadan.

1.2 Specific Objectives

The specific objectives are to;

1. describe, measure, and classify waste from various waste production sources at Lead City University in Ibadan.

2. examine the opinions of university personnel and students regarding the environmentally friendly and healthier state of the open dump system and adaptable sanitary landfill.

3. provide suggestions for Lead City University in Ibadan for efficient solid waste management.

1.3 Research Question

Is Lead City University, Ibadan's adaptive sanitary landfill a more environmentally friendly and healthful option than the open dump system?

1.4 Hypotheses

H0: Waste's characterization, quantification, and sorting are location-independent.

HA: Waste's characterization, quantification, and sorting are location-dependent.

H0: While adaptive sanitary landfill has been shown to improve university communities' health and environmental conditions, open dump systems do not.

HA: While adaptive sanitary landfill doesn't have any health or environmental effects on campus communities, open dump systems have.

2. MATERIALS AND METHODS

2.1 The Study area

Lead City University, Ibadan is one of the leading private university in Nigeria. As a results of steady increase in student’s population in the university, problem of waste management become enormous. As the time of carrying out this research work, the university population is between one and five million. Lead City University (LCU) is located in the Ibadan, the capital of Oyo State, it has coordinate of 3.8766° E and 7.3268° N.

2.2 Target population

Participants in the study were university staff members and students. There were 480 responders altogether out of the total population. The analysis considered the estimated quantity of waste produced per week in the university.

2.3 A Sample Size

Basic sampling techniques was used to select the sample samples, respondents who were able to provide first-hand knowledge of the topic under investigation were the only ones included in the sample for this study.

Table 1: List of Population of Lead City University, Ibadan, Oyo State.

VARIABLES	POPULATION
Non-teaching staff	398
Academic staff	334
Total number of students	13,647
Number of students living in the both male and female hotel	1,850
Total number of students living outside school	11,797
Other population in school	257
Grand population	**14,636**

Field survey conducted in 2023

2.4 Determination of sample size /sampling techniques

Using the Leslie Kish formula, the 14,636 university population was used to calculate the sample size for this study. Leslie Kish's formula is as follows:

$$n = \frac{z^2 Pq}{d^2}$$

where;

n is the required population sample size.

Z stands for the standard normal deviation, was set at 1.96, representing the 95% confidence level.

P is estimated proportion in the target population, which was set at 0.5

q is population not expected to have good sanitation behavior, which was set at 1-p (1-0.5) = 0.5

d is degree of accuracy desired, which was set at 0.05

$$n = \frac{1.962 \times 0.5 \times 0.5}{0.052}$$

$$\frac{0.9604}{0.0025}$$

$$= 384.16 \quad = 384$$

For easy calculations, 384 respondents were selected.

2.5 Description of the Research Instrument

A semi structured questionnaire was administered to all participants,

Four (4) sections made up the questionnaire.

Section A provides general background information on the participants, while Section B provides operational data on garbage generation, sorting, transfer, and disposal in the university.

Sections C and D provide general details on waste to wealth techniques.

2.6 Data Collection

From the questionnaire survey and the waste compositional analysis, two sets of data were collected. Microsoft Excel for Windows was used for the analysis of the data from the waste composition study, and the Statistical Package for the Social Sciences (SPSS) was used for the analysis of the data from the questionnaire survey. The data that was entered into the computer underwent statistical treatment that was both descriptive (frequency and percentage) and inferential (Chi-square). The collected data were then compiled and displayed in tables and charts.

2.6.1 Procedure for Collecting Qualitative Data

The management of the university and Oyo State Solid Wastes Management (OYSWMA) were visited prior to the questionnaires being distributed to discuss the goals of the qualitative phase of the study and the procedures for distributing the questionnaires. These visits led to suggestions that conversations with pertinent parties would be required.

2.7 Data Analysis

To make coding and data entering into the computer easier, a coding guide was created. Each administered questionnaire copy was examined by the investigator one by one for any necessary actions. SPSS software version 15 was used to code and input data from each copy of the questionnaire. Both descriptive (frequency and percentage) and inferential (Chi-square) statistical analysis were performed on the imputed data. The generated data were then compiled and displayed in tables and charts.

Thematic-content analysis was used to manually group together similar themes in each transcript and identify emerging trends and differences found across the transcripts to analyze qualitative information items from Focus Group Discussions (FGD), interviews with waste management authority, and university management.

2.8 Waste Characterization and Quantification

At each location in the university, investigations and sorting were done at least once every week throughout the duration of the project. A weighing balance was used to measure and record the weight of each composition that had been sorted. The individual weights were added at the conclusion of each sorting to determine the average daily total weight of municipal solid waste (MSW) at that location. The measured weight was divided by the number of days the waste remained at a place before sorting and quantification in those instances when it lingered longer than a day. Differences between biodegradable and non-biodegradable wastes were estimated, along with the percentage makeup of each component.

Table 2:Sources of waste generation on campus

S/N	**Sources of Waste**	**Amount generated per week (g/kg/tons)**
1	University male and female hostels	4 tons
2	University Guest house, halls and event centers	980kg
3	University eateries	6 tons
4	University shop operators/business centers	890g
5	University microfinance bank	230g
6	University hospital	650kg
7	University faculties' buildings and classrooms	450kg
8	University offices	670g
9	University's building under construction	880kg
10	University staff quarters	2tons
11	University sporting unit and allied	560g
	Total	15.85146tons

Source: Research work 2023

All wastes were collected at the site of generation, labeled, and transported to a sorting facility for segregation and weighing. Each source generated records that gave an accurate estimate of the amount of solid waste that was produced, and a list of the different waste types produced across the entire university was also made.

2.9 Identifying the Composition of the Waste

The following steps are involved in determining the waste composition:

Step 1: List the sectors that need to be examined.

Making a list of the interested sectors is crucial if a waste composition analysis is to be carried out across many university departments. However, this stage can be avoided if the waste composition analysis is being conducted within a single home, place of business, or institution.

Step 2: Enlisting and educating participants

To obtain the information necessary, participants in a waste composition analysis may be located inside or outside of the institution. The participants should receive a thorough briefing on how the analysis will be performed and by whom. Due to confidentiality concerns, it may occasionally be challenging to recruit participants in the institution; therefore, an incentive may be helpful to encourage participation.

Step 3: Take waste samples and locate a site for sorting.

Step 4: Prepare the waste for measurement

To be sure that the analysis was performed on a representative sample, it is crucial to collect waste samples from the waste-generating units on their normal garbage collection days. Since most waste-generating machines lack the space to sort through huge amounts of waste, it may be possible to take a sample of the waste to a different location.

The following actions should be taken to prepare the waste samples for measurement:

- Place the waste from each waste-generating unit in a separate area (such as a table or a marked-off area of the floor) where it won't mix with other samples.
- Remove any food from the packaging, then group the packaging into a different pile.
- Classify the garbage according to the study's parameters.
- Sorting the non-decomposable trash into several categories, such as paper, plastic, metals, etc., might be interesting to the study.

Step 5: Weigh and note the information

Separately weigh each type of garbage. Based on the dietary categories chosen for the study, enter the weight data in a prepared spreadsheet.

Step 6: Get rid of the used-up samples.

The samples can be discarded after they have been sorted, weighed, and recorded. It can be required to hire a waste management business for a customized garbage retrieval if the study has a big scope.

Step 7: The data analysis

By multiplying the data by the number of days the unit operates annually, the waste composition analysis results that were collected for a single day from the waste-generating unit can be extrapolated to a whole year.

2.10 Calculation of Waste Quantity

Four ways can be used to measure the calculation: the proportion of material purchased, the percentage of material required by the design, the kg/m2 of gross floor area, and the m3/m2 of gross floor. The waste generation rates are discovered to range from 3.275 to 8.791 kg/m^2, and the survey approach would be done by the composition of volume and mass.

Table 3: Detailed Material Classifications (ASTM D 5231—92, 2003).

Category	**Description**
Mixed Paper	Office paper, computer paper, magazines, glossy paper, waxed paper, and other materials that don't fall under the newspaper or corrugated categories
Newsprint and corrugated	Newspapers, cardboard boxes and cartons, brown (Kraft) paper (corrugated) bags, and corrugated medium
Plastic	Every plastic
Yard waste	Twigs, branches, leaves, grass, and other plant components
Food waste	Except bones, all food waste
Wood	Furniture, pallets, wood items, and lumber
Other organics/combustibles	Leather, rubber, and other primarily burnable materials
Ferrous	Tin, bio-metal, iron, and steel cans
Aluminum	Metal, cans made of metal, and aluminum foil
Glass	Glasses only
Other inorganics and non-combustibles	Stone, sand, dirt, plaster, pottery, non-ferrous metals (copper, brass, etc.), and bones

Field survey conducted in 2023.

Since the sampling technique would have a significant impact on the quality of the waste composition data, this study was strictly adhering to the recommended sampling procedure1: Throughout the procedure, use the Standard-Test-Method for Determining the Composition of

Municipal Solid Waste. This test method is used to determine the average composition of solid waste. It is based on the manual collection and separation of several waste samples into their component parts, data reduction, and reporting of the results. The following terms are used in this study:

Municipal solid waste that has not been processed, or waste that has not been size-reduced or otherwise processed;

Composite item: An object found in waste that is made of various waste components or different materials (such as disposable diapers and pads for women, bi-metal beverage containers, metallic electrical wires covered with plastic insulation, etc.);

Solid waste composition or waste composition: the breakdown of a combination into specific waste components based on weight percent for the purpose of characterizing solid trash;

a 200–300 lb (91–136 kg) piece that is thought to represent the traits of a waste generator is used as the sorting sample;

Waste component: A class of solid waste made up of substances with comparable physical and chemical characteristics that is used to describe the chemical make-up of solid trash (e.g., ferrous, glass, aluminum, etc.).

3.0 Results and Discussion

3.1 Demographic Data Analysis

1. Age

2. Gender

3. Educational background

4. Occupation

5. Location

Table 4: Awareness and Knowledge about waste management techniques

S/N	ITEMS	YES	NO
	B. Awareness and Knowledge:		
6.	Are you aware of the differences between adaptive sanitary landfill and open dump systems?		
7.	Do you understand the environmental and economic implications of each system?		
8.	Have you heard about the benefits of adaptive sanitary landfills in terms of waste management?		
	C. Perceptions and Attitudes:		
9.	What is your opinion about the current waste disposal system in your area?		
10.	Do you think using adaptive sanitary landfills could have positive environmental impacts?		
11.	Are you concerned about the economic feasibility of transitioning to an adaptive sanitary landfill system?		
	D. Usage and Preference:		
12.	What is your opinion about the current waste disposal system in your		

area?

13. Do you think using adaptive sanitary landfills could have positive environmental impacts?

14. Are you concerned about the economic feasibility of transitioning to an adaptive sanitary landfill system?

E. Economic Factors:

15. Have you noticed any changes in waste management costs since the implementation of adaptive sanitary landfills?

16. Do you think the costs associated with adaptive sanitary landfills are justified considering the potential environmental benefits?

F. Environmental Impact:

17. Do you believe the implementation of adaptive sanitary landfills has led to a reduction in environmental pollution compared to open dump systems?

18. Have you observed any changes in air and water quality in your area since the adoption of adaptive sanitary landfills?

G. Community Engagement:

19. Are there any neighborhood projects or educational activities pertaining to landfill systems and garbage management?

20. Have you participated in any programs aimed at promoting sustainable waste management practices?

H. Barriers and Challenges:

21. Are there any obstacles or challenges that prevent the successful implementation of adaptive sanitary landfill systems?

22. What do you think are the main reasons some areas continue to use open dump systems despite potential alternatives?

Age of the respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	15-20	246	64.1	64.1	64.1
	21-25	138	35.9	35.9	100.0
	Total	384	100.0	100.0	

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	185	48.2	48.2	48.2
	Female	199	51.8	51.8	100.0
	Total	384	100.0	100.0	

Educational Background

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Below School Certificate	14	3.6	3.6	3.6

	school certificate	163	42.4	42.4	46.1
	First degree	168	43.8	43.8	89.8
	Above First degree	39	10.2	10.2	100.0
	Total	384	100.0	100.0	

Occupation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Academic	156	40.6	40.6	40.6
	Non Academic	228	59.4	59.4	100.0
	Total	384	100.0	100.0	

Location within Lead City University

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male Hostel	58	15.1	15.1	15.1
	Female Hostel	137	35.7	35.7	50.8
	Senate building	123	32.0	32.0	82.8
	Guest House	32	8.3	8.3	91.1
	College of Medicine	2	.5	.5	91.7
	Eateries	4	1.0	1.0	92.7
	Faculty of Public Health	6	1.6	1.6	94.3

Faculty of Pharmacy	9	2.3	2.3	96.6
CHEW and EHS	6	1.6	1.6	98.2
Sport Complex	6	1.6	1.6	99.7
Staff Quarter	1	.3	.3	100.0
Total	384	100.0	100.0	

Frequency Table

Are you aware of the differences between adaptive sanitary landfill and open dump systems?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	271	70.6	70.6	70.6
	No	113	29.4	29.4	100.0
	Total	384	100.0	100.0	

Do you understand the environmental and economic implications of each system?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	307	79.9	79.9	79.9
	No	77	20.1	20.1	100.0
	Total	384	100.0	100.0	

Have you heard about the benefits of adaptive sanitary landfills in terms of waste management?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	211	54.9	54.9	54.9
	No	173	45.1	45.1	100.0
	Total	384	100.0	100.0	

Do you think using adaptive sanitary landfills could have positive environmental impacts?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	220	57.3	57.3	57.3
	No	164	42.7	42.7	100.0
	Total	384	100.0	100.0	

Are you concerned about the economic feasibility of transitioning to an adaptive sanitary landfill system?

		Frequency	Percent	Valid Percent	Cumulative Percent

Valid	Yes	185	48.2	48.2	48.2
	No	199	51.8	51.8	100.0
	Total	384	100.0	100.0	

What is your opinion about the current waste disposal system in your area?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	320	83.3	83.3	83.3
	No	64	16.7	16.7	100.0
	Total	384	100.0	100.0	

Do you think using adaptive sanitary landfills could have positive environmental impacts?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	375	97.7	97.7	97.7
	No	9	2.3	2.3	100.0
	Total	384	100.0	100.0	

Are you concerned about the economic feasibility of transitioning to an adaptive sanitary landfill system?

		Frequency	Percent	Valid Percent	Cumulative Percent

Valid	Yes	357	93.0	93.0	93.0
	No	27	7.0	7.0	100.0
	Total	384	100.0	100.0	

Have you noticed any changes in waste management costs since the implementation of adaptive sanitary landfills?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	358	93.2	93.2	93.2
	No	26	6.8	6.8	100.0
	Total	384	100.0	100.0	

Do you think the costs associated with adaptive sanitary landfills are justified considering the potential environmental benefits?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	294	76.6	76.6	76.6
	No	90	23.4	23.4	100.0
	Total	384	100.0	100.0	

Implementation of adaptive sanitary landfills

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	341	88.8	88.8	88.8

	No	43	11.2	11.2	100.0
	Total	384	100.0	100.0	

Have you observed any changes in air and water quality in your area since the adoption of adaptive sanitary landfills?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	246	64.1	64.1	64.1
	No	138	35.9	35.9	100.0
	Total	384	100.0	100.0	

Are you aware of any community initiatives or educational programs related to waste management and landfill systems?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	197	51.3	51.3	51.3
	No	187	48.7	48.7	100.0
	Total	384	100.0	100.0	

Have you participated in any programs aimed at promoting sustainable waste management practices?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	160	41.7	41.7	41.7
	No	224	57.4	57.4	100.0
	Total	384	100.0	100.0	

Are there any obstacles or challenges that prevent the successful implementation of adaptive sanitary landfill systems?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	137	35.7	35.7	35.7
	No	247	64.3	64.3	100.0
	Total	384	100.0	100.0	

4.0 Presentation of Data

4.1 Research Questions

4.1.2 Hypotheses Testing

H0: Waste's characterization, quantification, and sorting are location-independent.

HA: Waste's characterization, quantification, and sorting are location-dependent.

H0: While adaptive sanitary landfill has been shown to improve university communities' health and environmental conditions, open dump systems do not.

HA: While adaptive sanitary landfill doesn't have any health or environmental effects on campus communities, open dump systems have.

T-Test

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	T	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
CHARACTERIZATION QUANTIFICATEION & SORTING	86.174	383	.000	2.30208	2.2496	2.3546
LOCATIONS	80.191	383	.000	2.47135	2.4108	2.5319

ANOVA

Characterization, quantification and sorting and Locations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	23.593	2	11.797	55.240	.000
Within Groups	81.365	381	.214		
Total	104.958	383			

Chi-Square Test

Test Statistics

	CHARACTER -IZATION, QUANTIFICA -TION AND SORTING	LOCATIONS
Chi-Square	295.750[a]	161.922[a]
Df	2	2
Asymp. Sig.	.000	.000

The above results were used to test the Hypothesis one set for this research work. The first analytic method used is T-test analytic method. From the T-test table, the t-statistic shows that the characterization, quantifications and sorting factors is 86.174, while the Location is 80.191, the degree of freedom for both is 383. The sig (2-tailed) is 0.000 which is lower than the probability level set at 0.05 (95%), this is auto result to test the significance of the result. The result shows that there is a significant difference in Characterization, quantification and sorting and location in Lead City University, Ibadan. The null hypothesis is hereby rejected.

ANOVA test analysis was used to conduct additional testing, and the results are shown in the anova table above; the f-statistic value is 55.240, the df for comparisons between groups is 23.593, the df for comparisons within groups is 381 and the total df is 383. 0.000, which is less than 0.05, is the Auto sig test result. This demonstrates even more how there are notable differences between the variables taken into account in hypothesis one.

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	T	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Adaptive Sanitary Landfill	18.783	98	.000	6.000	5.37	6.63
Healthier	19.170	98	.000	5.000	4.48	5.52
Environmental friendly	7.231	98	.000	2.57879	1.8711	3.2865

Also, the chi-square analysis shows a significant difference between characterization, quantification and sorting of waste are unaffected by location in Lead City University, Ibadan.

Hypothesis Two

Data in table 5 was used to analyze hypothesis 2 and the result is as shown in the table below.

T-Test

In order to examine the outcome for hypothesis 2, the t-test method was utilized, and the outcome is shown in the t-test table above. According to the table, the t-statistic value for the adaptive sanitary landfill is 18.783, for the healthier status is 19.170, and for the environmental friendly of the waste is 7.231. In each case, the df is 98, and the sig. (2-tailed) is 0.000 in each case. The adaptive sanitary landfill, healthier status, and environmental friendly of the waste varies significantly, as shown by the Sig. (2-tailed) test that is employed to verify the hypothesis. We therefore reject the null hypothesis, according to which the open dump system has observed health and environmental implications on the university communities but adaptive sanitary doesn't.

4.2 Discussion of Findings

4.2.1 Percentage of Population Distribution in LCU

Table 5: Percentage (%) distribution of population in Lead City University, Ibadan

Distribution	**Population**	**Percentage (%)**
Non-teaching staff	398	**2.72**
Academic staff	334	**2.28**
Number of students living in the hotel	1,850	**12.64**
Total number of students living outside school	11,797	**80.60**
Other population in school	257	**1.76**

Total	**14,636**	**100**

Total numbers of students living outside the school premises have higher percentage (80.60%), followed by the number of students living on campus (12.64%). From the table, it was further revealed that the percentage of non-teaching staff (2.72%) is more than academic staff (2.28%). Other population in school ranging from visitors, researchers and transporters have the least percentage (1.76%)

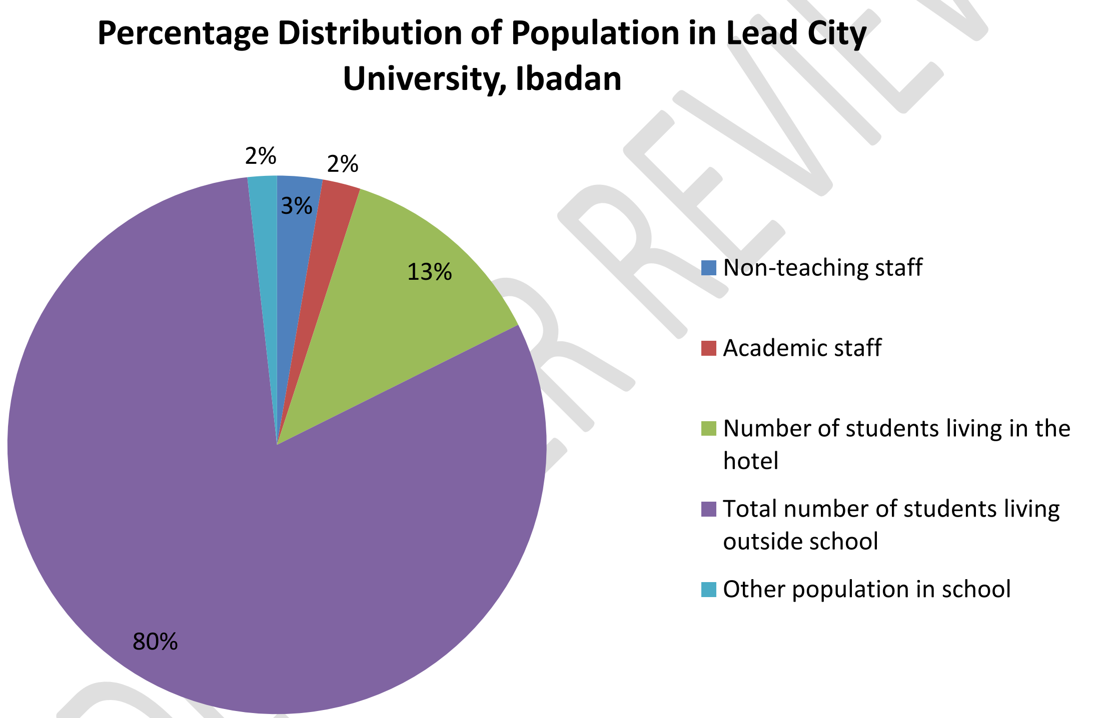

Fig 1: Percentage Distribution of Population in Lead City University, Ibadan

4.3 University Section Analysis

Table 6: University sections analysis

S/N	**SECTIONS**	**FREQUENCIES**	**PERCENTAGE (%)**
1	Male hostel	100	21.0
2	Female hostel	100	21.0

3	University Guest house, hall and event centers	50	10.0
4	University eateries	20	4.5
5	University shop operators/business centers	20	4.5
6	University microfinance bank	10	2.0
7	University hospital	10	2.0
8	University faculties buildings and classroom	40	8.0
9	University offices	40	8.0
10	University buildings under construction	10	2.0
11	University staff quarters	40	8.0
12	University sport unit and allied	20	4.5
13	Other locations within the university	20	4.5
	TOTAL	480	100

Male and female hostels have the highest numbers of respondent of 100 (21% each) while university micro finance bank, hospital and university buildings under construction have the least numbers of respondents of 10 (2% each).

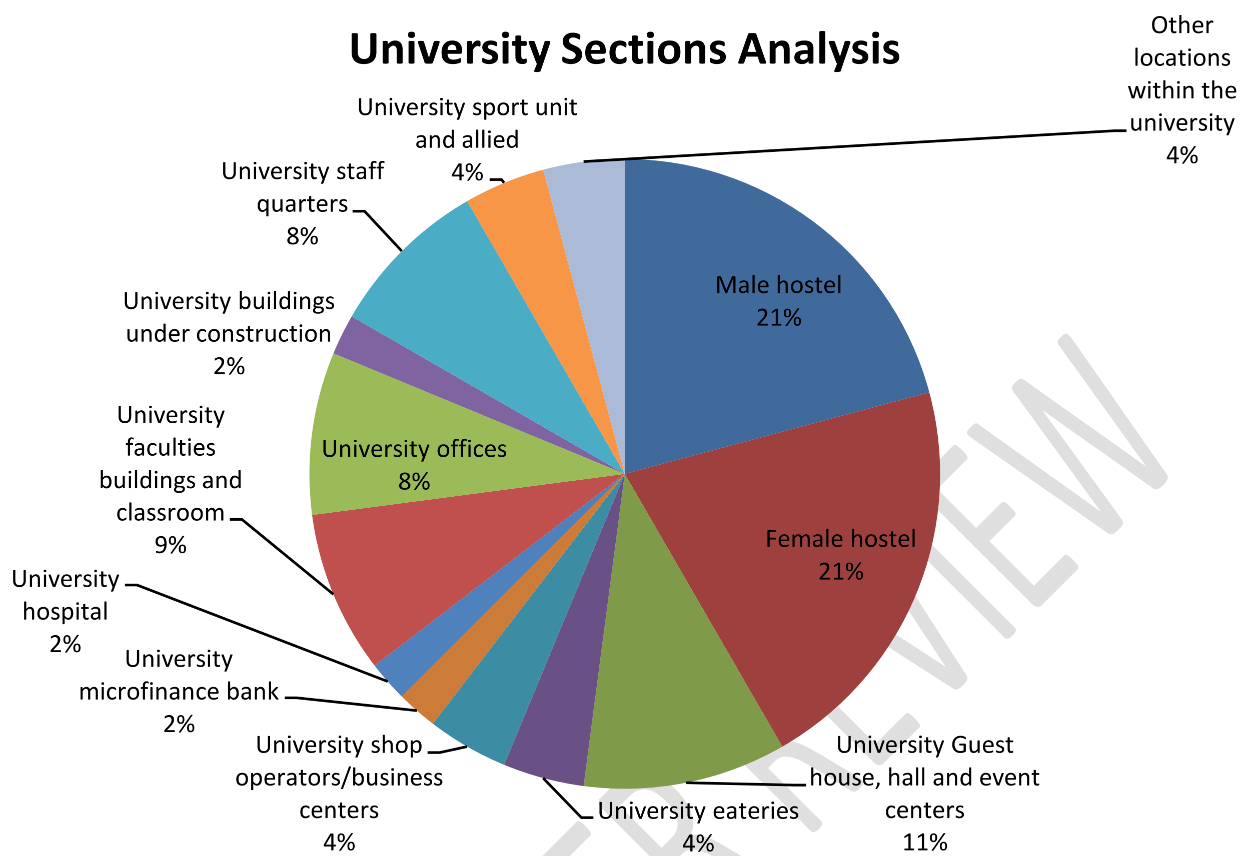

Fig 2: Lead City University, Ibadan Section Analysis

4.4. Distribution of waste characterization in LCU

Table 7: Distribution of waste characterization in LCU, Ibadan by %

Category	Dump Site	Office complex	Lecture Halls	Hostels
Biodegradable	31.14	09.18	04.16	41.16
Paper and cardboard	42.12	74.26	83.10	24.14
Plastics	12.44	13.22	09.44	22.44
Metals	08.18	02.16	02.18	07.13
Glass	06.12	01.18	01.12	05.13

Total	100	100	100	100

Source: Researcher's field work (2023).

Dump site and hostel have highest number of biodegradable wastes of 31.14% and 41.16% respectively, followed by paper and cardboard waste of 42.12 1nd 24.14. However, metals and glass waste have least number in all category sampled.

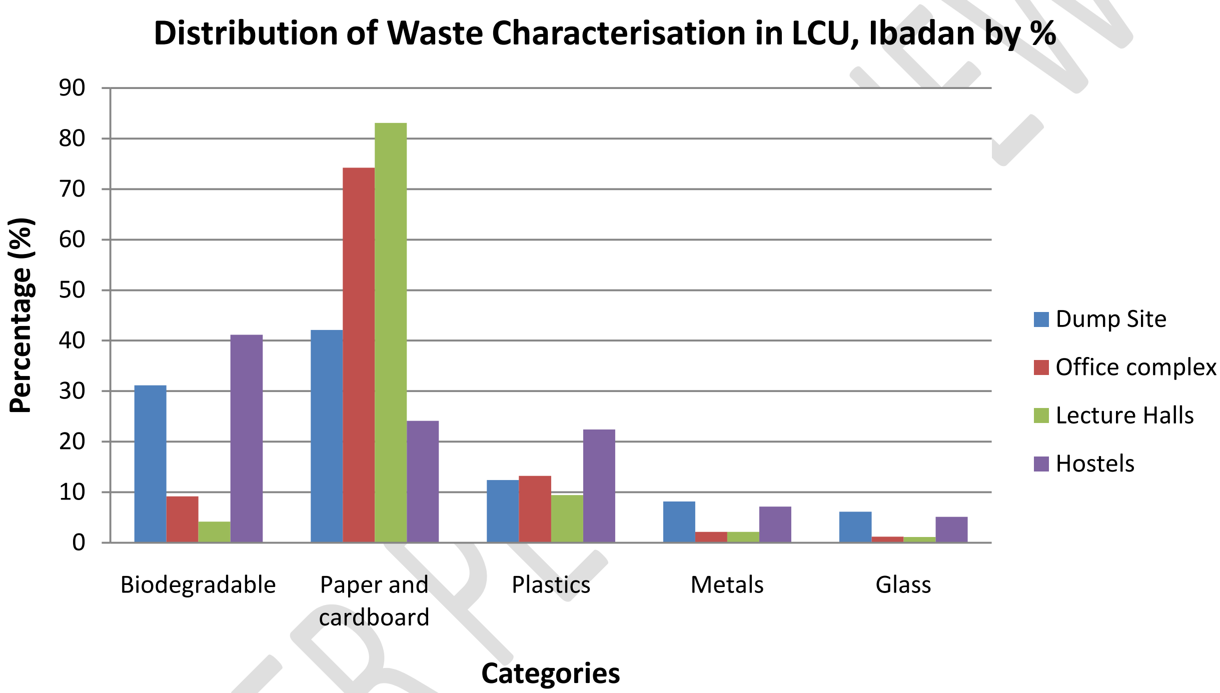

Fig 3: Distribution of Waste Characterization in Lead City University, Ibadan

4.5 Approximate Study of the Organic MSW produced at LCU

Table 8: An approximate study of the organic MSW produced at LCU, Ibadan

Refuse component	Close Analysis (% by weight)				
	Moisture Content	Volatile Matter	Fixed carbon	Ash	Total

Food waste (mixed)	65.2	26	4.0	4.8	100
Wood/ Leaves	19.2	65	15	0.8	100
Paper	6.9	78	9.1	6.0	100
Plastics	0.3	95	2.4	2.3	100
Textiles/rubber/leather	7.8	69	16.2	7.0	100

Fieldwork conducted by researchers in 2023.

Moisture content has the highest percentage of 65.2% in food waste (mixed) and fixed carbon have the least percentage of 4.0%, volatile matter has the highest percentage of 65% in wood/leaves and ash have the least percentage of 0.8% volatile matter have the highest percentage of 95% in plastic and moisture content have the least percentage of 0.3% while volatile matter has the highest percentage of 69% in textiles/rubber/leather and ash have the least percentage of 7.0%.

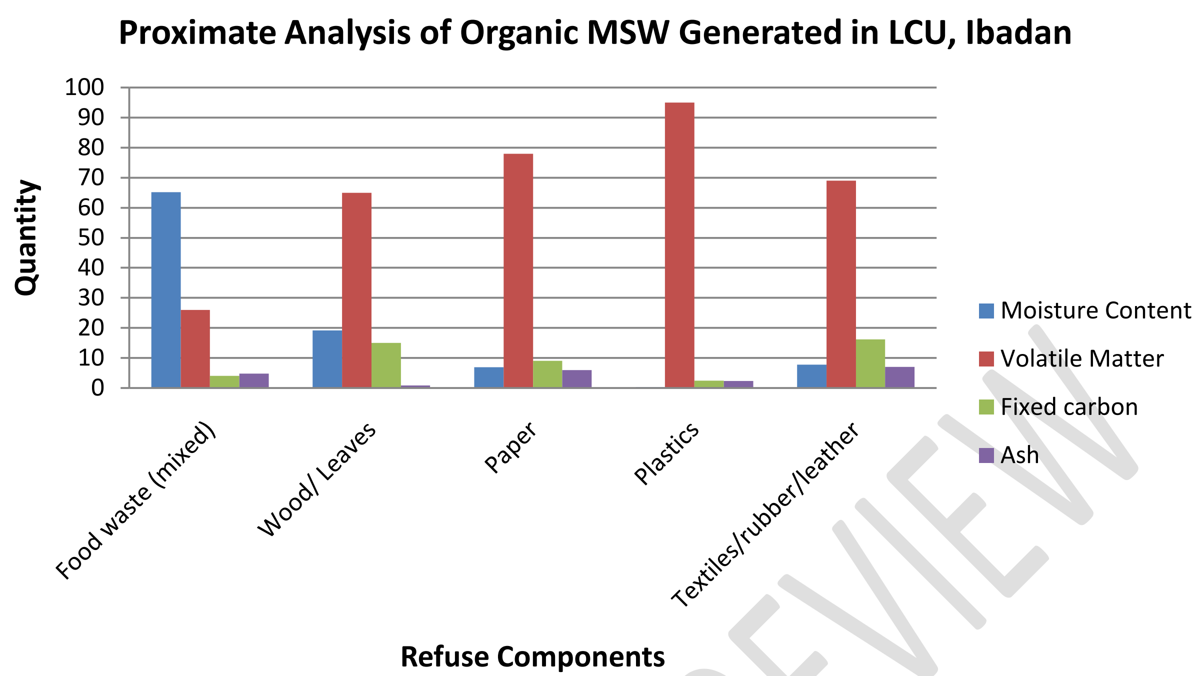

Fig 4: Proximate Analysis of Organic MSW Generated in Lead City University, Ibadan

4.6 Overall Composition of Waste at LCU

Table 9: Overall Composition of waste at LCU

Fractions	**Average (%)**
Wood	0.72
Rubber	0.69
Paper	9.96
Gravel	0.81
Metal	1.36
Plastic	8.24
Textiles(leader & cloth)	4.16

Glass and ceramics	1.23
Organic matter	72.74
Hospital waste	0.08
Total	**100**

Fieldwork conducted by researchers in 2023.

There are three main forms of solid waste at Lead City University in Ibadan:

Domestic garbage is the solid waste produced by households, grocery stores, marketplaces, and business establishments like hotels, shops, and restaurants. This is responsible for the LCU's larger percentage of organic matter (72.74%).

Institutional waste includes the solid garbage produced by hospitals, classrooms, recreation centers, public development initiatives, and other office buildings. This is responsible for other waste fractions with the lowest percentage.

Industrial waste is anything that isn't toxic or hazardous and needs specific care, treatment, or disposal. Ibadan's Lead City University does not apply this.

According to a few variables, waste content varies at Lead City University in Ibadan:

- Season: Waste has a higher organic composition during the rainy season since there is a higher volume of food, fruit, and vegetable waste.
- Richness - Similar to the majority of developing countries, rural areas with poorer populations produce solid waste with a larger percentage of organic matter, between 70 and 80 percent. Contrary to urban regions with wealthy residents, the garbage has a lower percentage of non-biodegradable elements including plastic, metal, and glass, with an average organic content of 72.74%.

- Location: Hostels produce more organic garbage than commercial spaces.

- Cultural Activities: It is noteworthy that not only has the composition of waste changed, but the amount of waste generated also varies in Lead City University, Ibadan, with Women's Day, Christmas, and New Year celebrations and other celebrations resulting in more organic waste generation due to the amount of flowers, trees, etc. bought for the occasion.

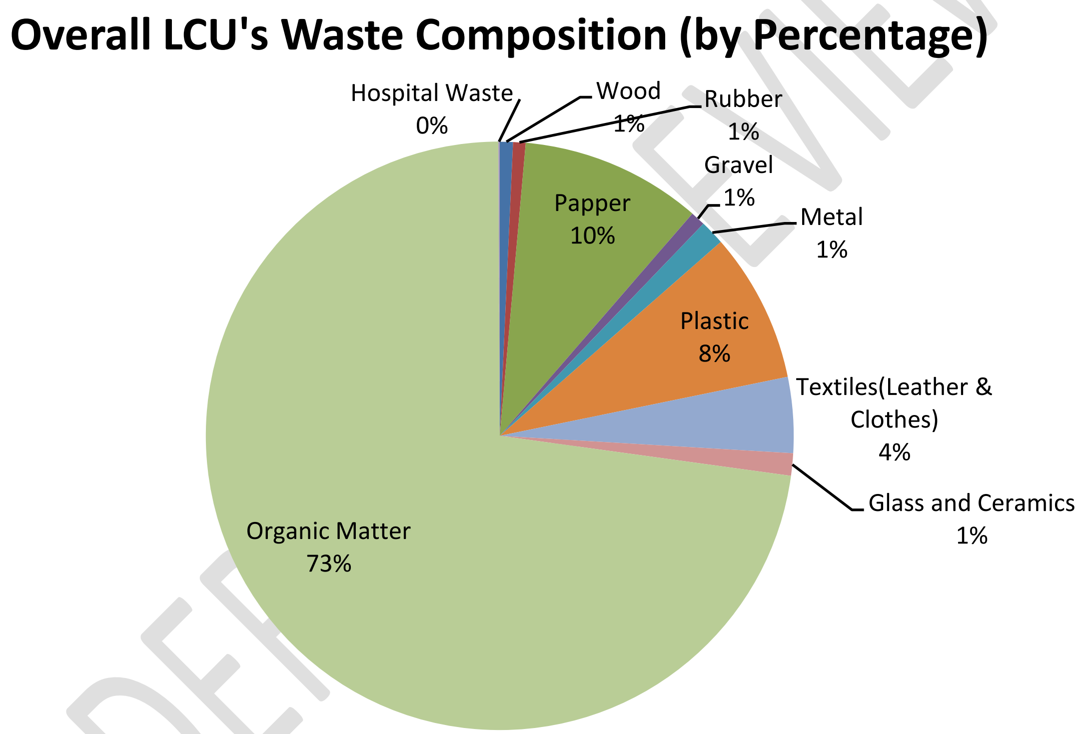

Fig 5: Overall Lead City University Waste Composition

4.7 Estimated Quantity of deposited waste at the LCU dump sites.

Table 10: Estimated Quantity of deposited waste at the LCU dump sites.

Months	Years	
	2021	**2022**

January	1400	1578
February	1330	1460
March	1289	1367
April	1256	1298
May	1178	1246
June	1098	1167
July	2389	2478
August	2505	2617
September	2878	2988
October	3234	3389
November	3689	3856
December	1407	1566
Total (Tons)	**23,653**	**25,010**
Yearly Average	**1.97**	**2.08**

Source: Researcher's field work (2023).

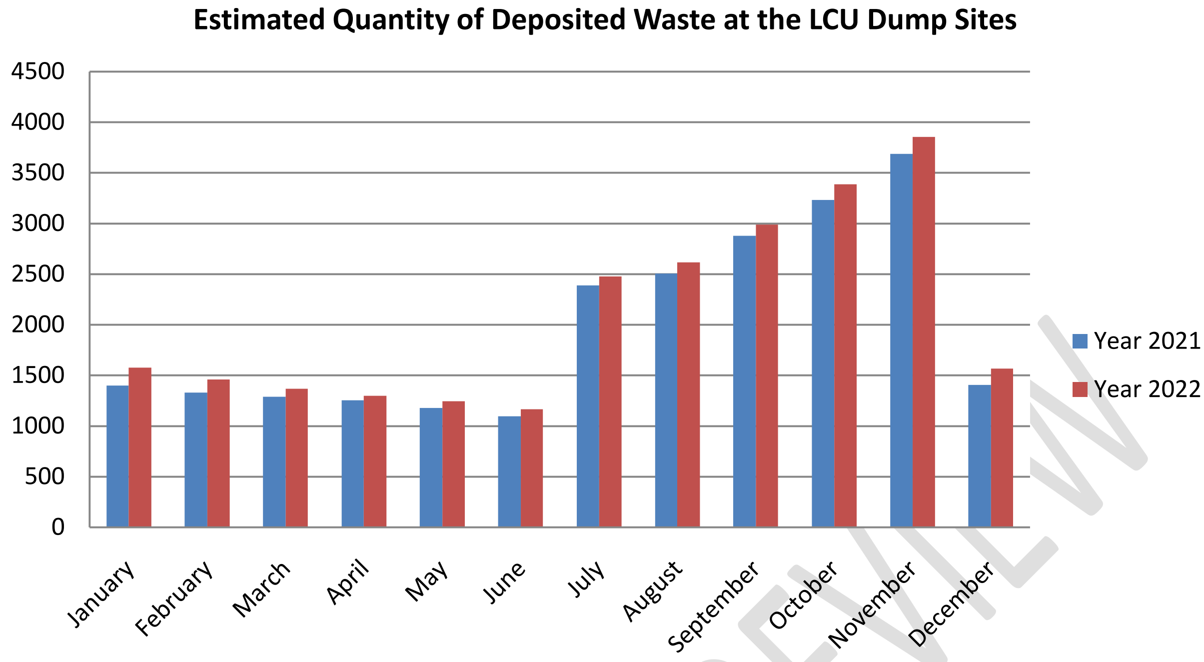

Fig 6: Estimated Quantity of Deposited Waste at the LCU Dump Sites

5.0: Summary of Findings

Findings make it clear that the majority of biodegradable waste produced at the university is produced by the hostels, restaurants, and guest houses, and that when this waste is disposed of in a sanitary landfill, it often results in the production of biogas.

The t-test is the first analytical technique used to assess the hypotheses. the t-statistic shows that the characterization, quantifications and sorting methods is 86.174, while the Location is 80.191, the degree of freedom for both is 383. The sig (2-tailed) is 0.000 which is lower than the probability level set at 0.05 (95%), this is auto result to test the significance of the result. The result shows that there is a significant difference in characterization, quantification and sorting and location in Lead City University, Ibadan. The null hypothesis is hereby rejected.

ANOVA test analysis was used to conduct further testing, and the results show that the f-statistic value is 55.240, the df for comparisons between groups is 23.593, the df for comparisons within groups is 381 and the total df is 383. This demonstrates even more how significantly the variables taken into account in hypothesis one differ from one another and this was collaborated with studies conducted in University of Nigeria, Nsuka, where analysis of variance showed that differently dominated areas of the campus have different quantities and compositions of wastes mainly due to significant variation of organic and polythene components across the differently dominated areas[10].

Additional, the chi-square analysis shows a significant difference between characterization, quantification and sorting of waste are unaffected by location in Lead City University, Ibadan.

The results of hypothesis two were also analysed using the t-test method. The results showed that the t-statistic value for the location of the dump sites is 18.783, for the composition of the wastes is 19.170, and for the quantity for the waste is 7.231. The location, quantity, and composition of the garbage are significantly different, as shown by the Sig. (2-tailed) employed to test the hypothesis.

The proposition that location does not influences the volume and make-up of municipal solid waste (MSW) on the campus of Lead City University is thus refuted. This was in line with a study conducted at the University of Nigeria's Nsukka campus, which suggests that the differences in waste quantities and compositions between the variously populated areas of the university campus are primarily caused by the significant variation in organic and polythene component content across the variously populated areas[11].

With a growth in enrolment, Lead City University in Ibadan produces more waste. The study found that waste output peaked in 2021–2022, when there were 25,010 students, at 5,705.406250 tons/year, up from the preceding session's average (2020/2021) of 5,550.623438 tons/year at 23,653 students. This was further collaborated by the study conducted at University of Nigeria Enugu State[12]

5.0 Conclusion

All the analyses (t-test, ANOVA test and Chi-Square) used in the research work showed that the proposition that location does not influences the volume and make-up of municipal solid waste (MSW) on the campus of Lead City University is thus refuted. This was in line with a study conducted at the University of Nigeria's Nsukka campus, which suggests that the differences in waste quantities and compositions between the variously populated areas of the university campus are primarily caused by the significant variation in organic and polythene component content across the variously populated areas[11].

6.0 Recommendation

The Nigerian government must acknowledge solid waste management as a serious issue and commit sufficient financial and other resources to finding an effective solution. Additionally, university management may research the costs and advantages of outsourcing waste collection and disposal operations to private operators if the available resources at the university are insufficient.

7.0 Contribution to the Knowledge

With the completion of this project work, most of the universities in West Africa Countries and world at large will now understanding how to manage their waste in sustainably manners.

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