

Waste Management Practices and Circular Economic Potential in Nigerian Public Universities: A Comparative Analysis of Behavioural and Institutional Drivers

¹Cordelia Ochuole Omoyi, ²Daodu Adeniyi Emmanuel, ³David Ogar Ushie, ⁴Gideon Adonokpem Ogban-Ekpe

Department of Mechanical Engineering, University of Calabar, Calabar, Cross River State, Nigeria

<https://orcid.org/0000-0002-4453-20711>, <https://orcid.org/0009-0006-1915-284X2>,
<https://orcid.org/0009-0001-2850-21203>; <https://orcid.org/0009-0001-2850-21204>

Corresponding Author: cordeliaochuole@unical.edu.ng

Receive November, 2025, accepted and published January, 2026

Abstract

This study provides a comparative assessment of waste management practices, institutional performance, and circular economic potential in selected Nigerian public universities. Using a mixed-method cross-sectional design, data were collected between January and February 2026 through structured questionnaires (n = 400), key informant interviews, and field observations across four universities in southern Nigeria. The results reveal that approximately 10,000 kg of waste is generated daily, with organic waste (46.9%), plastics (31.3%), and paper (12.5%) constituting the dominant fractions. This composition indicates that more than 90% of the waste stream is potentially recoverable, demonstrating strong prospects for resource recovery and circular economy implementation within university settings. Despite this significant recovery potential, operational performance remains low, as reflected by a Waste Efficiency Index (WEI = 0.25), indicating that only a small proportion of waste is currently recovered or utilised. Behavioural analysis shows that attitude ($\beta = 0.42$) is the strongest predictor of proper waste disposal behaviour, followed by perceived behavioural control ($\beta = 0.36$) and subjective norms ($\beta = 0.22$), highlighting the critical role of individual motivation and access to enabling infrastructure. Institutional evaluation further reveals weak performance across the universities, with Institutional Performance Index (IPI) values ranging from 0.38 to 0.50, suggesting inadequate policy implementation, insufficient infrastructure, and limited enforcement capacity. Overall, the study identifies a clear disconnect between high waste recovery potential and actual system performance, driven by the interaction of behavioural, infrastructural, and institutional constraints. The findings underscore the urgent need for integrated waste management strategies that combine source segregation, investment in recycling and composting infrastructure, strengthened institutional governance, and sustained behavioural change initiatives. By addressing these interconnected factors, Nigerian public universities can transition from disposal-based systems to circular, resource-efficient, and sustainable waste management models.

Keywords: Waste generation and management practices; waste disposal, Circular economy; waste recovery, recycling and reuse and waste disposal behaviour

Introduction

Solid waste management has become a major environmental concern across the world, especially in developing countries (Kaza et al., 2018). As populations grow and consumption

increases, the volume of waste generated continues to rise, placing significant pressure on existing waste management systems. Universities are not left out of this trend. As centres of learning with large populations of students and staff, they generate significant amounts of waste daily, including food waste, plastics, paper, and other materials. In Nigeria, many public universities struggle with effective waste management due to rapid population growth, inadequate infrastructure, and weak institutional frameworks (Mbama et al., 2023). Waste is often poorly handled, with little or no sorting, inadequate disposal systems, and weak institutional support.

This situation poses serious risks to public health, environmental quality, and campus aesthetics. Poor waste management practices can lead to environmental pollution, unpleasant surroundings, and increased exposure to disease-causing organisms within university communities. Despite increasing waste generation within Nigerian public universities, existing waste management systems remain largely ineffective. These systems are characterised by inadequate segregation at source, insufficient infrastructure, weak policy enforcement, and low stakeholder awareness (Okeke & Olagunju, 2023).

These deficiencies result in inefficient waste collection, limited recycling activities, and environmentally unsound disposal practices, with significant implications for public health, campus environmental quality, and institutional sustainability. Empirical studies in Nigeria have predominantly examined waste generation patterns or disposal practices in isolation, with limited integration of behavioural determinants, institutional capacity, and circular economy opportunities within a unified analytical framework. Moreover, there is a scarcity of comparative, multi-university evidence that captures variations in institutional performance and user behaviour across similar socio-environmental contexts. Consequently, the absence of integrated and comparative evidence constrains the design of effective, evidence-based interventions for sustainable campus waste management.

This study addresses this gap by examining waste management practices, behavioural drivers, and institutional effectiveness across four Nigerian public universities, while also evaluating opportunities for circular economy adoption. This study is significant in several respects. First, it provides empirical evidence on waste generation patterns, behavioural dynamics, and institutional performance across multiple Nigerian public universities, thereby contributing to the limited comparative literature on waste management practices and circular economy potential in Nigerian higher institutions.

Second, the study offers practical insights for university management and policymakers by identifying key gaps in infrastructure, policy enforcement, and stakeholder behaviour that affect waste management efficiency. Third, the findings highlight the potential for circular economy implementation, demonstrating how waste streams can be transformed into valuable resources through recycling, composting, and recovery systems. Finally, the study contributes to broader efforts toward environmental sustainability and public health improvement by proposing strategies that can enhance waste management practices and support sustainable campus development in Nigerian higher institutions.

Waste management is the systematic process of collection, transportation, treatment, recycling, and final disposal of waste materials in a manner that minimises environmental and health impacts (UNEP, 2024). Effective waste management is essential for maintaining environmental quality, reducing pollution, and promoting sustainable development, particularly in rapidly urbanising regions (UNEP, 2021). Sustainable waste management emphasises the principles of waste reduction, reuse, and recycling (3Rs), which aim to minimise waste generation at source and enhance resource efficiency (Wilson et al., 2021). This approach shifts the focus from mere disposal to resource conservation and environmental protection. In institutional settings such as universities, sustainable waste management is particularly important due to high consumption patterns and diverse waste streams generated from academic, residential, and commercial activities.

The concept of the circular economy extends traditional waste management practices by promoting a closed-loop system in which waste materials are reintegrated into production cycles as valuable resources. This model contrasts with the conventional linear economy (take–make–dispose) by emphasising resource recovery, recycling, and regeneration (World Bank, 2018). In the context of higher education institutions, the circular economy offers opportunities for transforming organic waste into compost, recycling plastics and paper, and reducing overall environmental footprints. Waste composition in developing countries is largely organic and recyclable (Ya’u, 2025), while recycling intention is influenced by perceived behavioural control (Igbinomwanhia et al., 2016). Circular economy strategies are increasingly promoted in higher education institutions (Geissdoerfer, 2017). Orhorhoro et al. (2025) demonstrated the potential of recycling and reprocessing materials such as acrylonitrile butadiene styrene (ABS) through additive manufacturing, underscoring how material recovery and reuse can support sustainable waste management and circular economy initiatives within Nigerian public universities.

Furthermore, effective waste management is influenced not only by technical systems but also by behavioural and institutional factors, including awareness, attitudes, policy frameworks, and infrastructure availability. Studies by Dosumu (2025) have shown that inadequate infrastructure, weak policy enforcement, and low stakeholder participation are major barriers to effective waste management in developing countries. The integration of automation and control principles in waste management systems can enhance efficiency, monitoring, and resource recovery processes in Nigerian public universities, thereby supporting the transition toward a circular economy (Daniyan, 2023). Omoyi and Adeleke (2021) further highlight that active management participation and structured decision-making frameworks are critical for improving operational efficiency in Nigerian industries, a principle that can be applied to strengthen institutional waste management systems and advance circular economy practices in public universities. Therefore, the integration of sustainable waste management principles with circular economy strategies provides a comprehensive framework for improving waste handling systems

in universities, enhancing environmental sustainability, and promoting efficient resource utilisation.

Theoretical framework

This study is anchored on three key theoretical perspectives: the Theory of Planned Behaviour, Institutional Theory, and Circular Economy Theory, which collectively provide a comprehensive framework for understanding waste management practices from behavioural, organisational, and sustainability dimensions. The Theory of Planned Behaviour (TPB) posits that individual behaviour is influenced by three major factors: attitude toward the behaviour, subjective norms, and perceived behavioural control (Ajzen, 1991). The theory has been widely applied in environmental studies to explain pro-environmental behaviours such as waste sorting and recycling (Aikowe & Mazancová, 2021). In the context of this study, TPB explains how students' and staff's attitudes, social influences, and perceived ability to properly dispose of waste shape their waste management behaviour within universities.

Institutional Theory emphasises the role of formal structures, policies, and organisational practices in shaping behaviour within institutions (Alhassan & Boateng, 2023). The theory suggests that institutional effectiveness depends on the strength of regulations, enforcement mechanisms, infrastructure, and organisational coordination. In this study, Institutional Theory provides a basis for understanding how weak policy enforcement, inadequate infrastructure, and poor institutional coordination contribute to ineffective waste management systems in Nigerian universities.

Circular Economy Theory advocates a shift from the traditional linear model of resource use (take–make–dispose) to a regenerative system in which waste is minimised and materials are continuously reused. The theory highlights the importance of recycling, composting, and resource recovery in achieving environmental sustainability. Within the context of this study, it provides a framework for identifying opportunities to transform waste streams into valuable resources across the selected universities.

The integration of these three theoretical perspectives enables a holistic understanding of waste management practices by linking individual behaviour (Theory of Planned Behaviour), institutional structures (Institutional Theory), and sustainability strategies (Circular Economy Theory). This combined framework is particularly relevant for analysing the complex interactions that influence waste management systems in higher education institutions.

Research objectives

The main objective of this study is to critically evaluate waste management practices, behavioural determinants, institutional performance, and circular economy potential across selected Nigerian public universities

- a. Examine the types and composition of waste generated across the selected universities.
- b. Assess the effectiveness of existing waste management practices within the institutions.
- c. Analyse behavioural and institutional factors influencing waste management outcomes.
- d. Evaluate opportunities for implementing circular economy strategies, including recycling, composting, and resource recovery

Research Questions

To achieve the above objectives, the study addresses the following research questions:

- a. What are the predominant types and composition of waste generated across the selected universities?
- b. How effective are the existing waste management practices?
- c. What behavioural and institutional factors influence waste management outcomes?
- d. What opportunities exist for the adoption of circular economy strategies within the universities?

Research design and Methodology

This study adopted a mixed-method, cross-sectional research design to comprehensively assess waste management practices, behavioural determinants, and institutional performance in selected Nigerian public universities. The design combined quantitative and qualitative

approaches within a single period, enabling triangulation of data and improving the reliability and validity of findings. The quantitative aspect utilised structured surveys to examine behavioural factors influencing waste disposal practices, while the qualitative component involved interviews and field observations to provide deeper insights into institutional conditions and operational practices.

The research was conducted in four public universities in southern Nigeria: the University of Uyo, University of Benin, University of Calabar, and University of Cross River State located in a humid tropical environment with high rainfall that affects waste decomposition, particularly organic waste. The target population included students, academic staff, non-academic staff, and waste management personnel, as these groups are the main producers of waste and key participants in waste management activities. The combined population across the institutions was estimated at approximately 20,000 individuals (Different University staff and students register within the study period, 2025-2026).

Sample size was determined using Taro Yamane's formula for finite populations. The estimated population ($N \approx 20,000$) was obtained from institutional records, including student enrolment and staff statistics across the four universities:

$$n = \frac{N}{(1+N(e^2))} \quad 1$$

where:

n = required sample size

N = total population size

e = level of precision (0.05)

Based on available institutional records, the combined estimated population of the four universities (students, staff and waste personnel) was approximately $N = 20,000$. From equation 1,

$$n = \frac{N}{(1+N(e^2))} = \frac{N20,000}{(1+20,000(0.05^2))} \approx 399.7$$

With $N \approx 20,000$ and $e = 0.05$, $n \approx 399.7$; this is rounded up to 400 to improve statistical precision and representation. A stratified sampling technique was employed to ensure proportional representation of the different population groups (students, academic staff, non-academic staff, and waste personnel). Within each stratum, purposive sampling was used to select respondents with relevant exposure to waste management practices. Approximately 100 respondents were selected from each university.

Data were collected using three primary instruments: a structured questionnaire, semi-structured interviews, and an observation checklist. The structured questionnaire captured respondents' demographic characteristics, waste generation patterns, waste management practices, and behavioural constructs derived from the Theory of Planned Behaviour, including attitude (ATT), perceived behavioural control (PBC), subjective norms (SN), and waste disposal behaviour (WDB). Semi-structured interviews were conducted with key informants (3–5 per university) to obtain detailed insights into institutional policies, operational challenges, and management practices, while the observation checklist was used to evaluate physical waste management infrastructure, such as the availability of waste bins, segregation practices, and disposal systems across campus locations. All questionnaire items were measured using a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5).

Measurement of Variables

Behavioural constructs were operationalised as composite indices derived from multiple questionnaire items:

$$ATT = \frac{1}{k} \sum_{i=1}^k ATT_i \quad 2$$

$$PBC = \frac{1}{k} \sum_{i=1}^k PBC_i \quad 3$$

$$SN = \frac{1}{k} \sum_{i=1}^k SN_i \quad 4$$

$$WDB = \frac{1}{k} \sum_{i=1}^k WDB_i \quad 5$$

where K, represents the number of items used to measure each construct.

WDB = WasteDisposalBehaviour

(β_0) = intercept

$(\beta_1, \beta_2, \beta_3)$ = regression coefficients

(ATT) = Attitude

(PBC) = Perceived Behavioural Control

(SN) = Subjective Norms

(ε) = error term

Content and face validity of the research instruments were established through expert review by specialists in environmental management and test construction. A pilot study was conducted outside the selected universities to refine the instruments.

Reliability was assessed using Cronbach's alpha.

$$\alpha = \frac{k}{k-1} \left(1 - \frac{\sum \sigma_i^2}{\sigma_T^2} \right) \quad 6$$

(α) = Cronbach's alpha

(k) = number of items

(σ_i^2) = variance of each item

(σ_T^2) = variance of total score bar

The obtained value ($\alpha \approx 0.78$) indicates acceptable internal consistency.

Data collection was conducted over an eight-week period (January–February 2026) using a standardised protocol across all study sites. Ethical approval and institutional permissions were obtained prior to data collection, and informed consent was secured from all participants. A total of 400 questionnaires were administered and successfully retrieved. Interviews lasted between 20 and 35 minutes, while observations were conducted across key campus locations, including lecture halls, hostels, cafeterias, and waste disposal points during both morning and afternoon periods

Waste Quantification and Composition Analysis

Total waste generated was computed as:

$$W = O + P + Pa + Ot$$

where:

O = organic waste,

P = plastics,

Pa = paper,

Ot = other waste types

The percentage composition of each waste category was determined using:

$$\text{Waste Component (\%)} = \frac{W_i}{W} \times 100 \quad 8$$

3.10 Waste Efficiency Index (WEI)

The efficiency of waste recovery was measured using:

$$\text{WEI} = \frac{R_u}{W} \quad 9$$

where:

R_u = quantity of waste effectively recovered or utilised,

W = total waste generated.

Institutional Performance Index (IPI)

Institutional performance was evaluated using a composite index based on policy, infrastructure, and enforcement indicators:

$$\text{IPI} = \frac{P_{norm} + I_{norm} + E_{norm}}{3} \quad 10$$

where each component is normalised as:

$$X_{norm} = \frac{X - X_{min}}{X_{max} - X_{min}} \quad 11$$

Model Specification and Data Analysis

Quantitative data were analysed using SPSS (Version 25). Descriptive statistics (frequencies and percentages) were used to summarise waste composition and management practices.

To examine the influence of behavioural factors on waste disposal behaviour, a multiple linear regression model was estimated:

$$\text{WDB} = \beta_0 + \beta_1\text{ATT} + \beta_2\text{PBC} + \beta_3\text{SN} + \varepsilon \quad 12$$

The estimated model is expressed as:

$$\text{WDB} = \beta_0 + 0.42\text{ATT} + 0.36\text{PBC} + 0.22\text{SN}$$

Model Evaluation and Diagnostic Tests

The explanatory power of the model was assessed using the coefficient of determination:

$$R^2 = \frac{SS_{regression}}{SS_{total}} = 0.61$$

This indicates that 61% of the variation in waste disposal behaviour is explained by the independent variables. Model significance was evaluated using the F-statistic:

$$F = \frac{MS_{regression}}{MS_{residual}} = 52.34, p < 0.05 \quad 13$$

Diagnostic tests were conducted to ensure model validity, including:

Normality test (residual distribution)

Multicollinearity test (Variance Inflation Factor, $VIF < 5$)

Homoscedasticity test (constant error variance)

Qualitative data obtained from interviews and observations were analysed using thematic analysis, involving coding, categorisation, and theme development. The qualitative findings were used to complement and explain the quantitative results through triangulation.

Results and Discussion

Volumes of waste generated

The analysis reveals that a substantial volume of waste is generated across the four selected universities, with an estimated 10,000 kg of waste produced daily. Table 1 presents the distribution of waste generation by type and institution.

From result on Table 1 the University of Calabar (Univ C) records the highest daily waste generation (2813 kg), while the University of Benin (Univ B) records the lowest (2083 kg).

Organic waste constitutes the largest fraction across all institutions, reflecting the dominance of biodegradable materials such as food waste.

Table 1: Volume of waste Generation Across Universities

University	Organic (kg/day)	Plastics (kg/day)	Paper (kg/day)	Others (kg/day)	Total (kg/day)	Recoverable (%)	WEI
Univ A	1125	750	300	221	2396	91%	0.26
Univ B	938	625	260	260	2083	89%	0.22
Univ C	1354	833	365	261	2813	91%	0.28
Univ D	1271	917	325	195	2708	92%	0.24
Total	4688	3125	1250	937	10,000	≈ 91%	0.25

Although approximately 90–92% of the waste stream is potentially recoverable, the Waste Efficiency Index (WEI = 0.25) indicates that only a small proportion of this potential is currently realised. This highlights a significant gap between waste generation and effective recovery.

Waste Composition Analysis

The composition of waste across the universities is presented in Table 2.

Table 2: Waste Composition

Waste type	Quantity (kg/day)	Percentage (%)
Organic	4688	46.9
Plastic	3125	31.3
Papers	1250	12.5
Others	937	9.4
Total	10,000	100

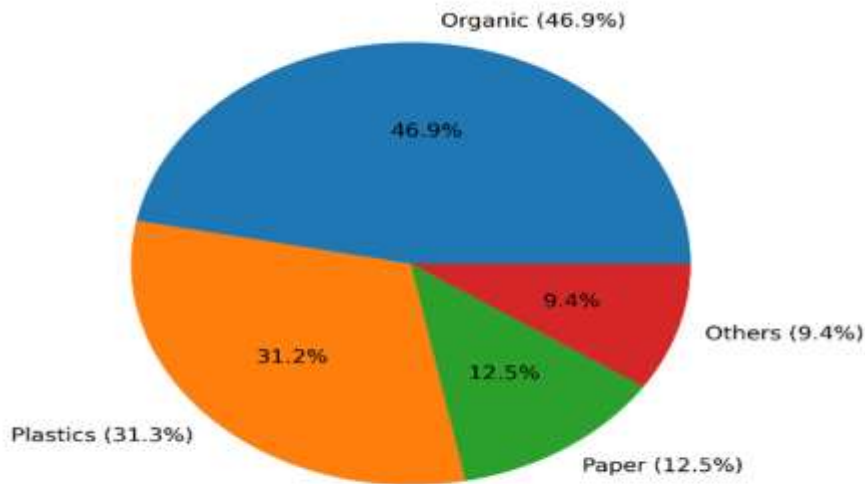


Figure 1: Waste composition across the selected universities

The results show that organic waste (46.9%) is the dominant component, followed by plastics (31.3%) and paper (12.5%), while other waste types account for 9.4%. This composition indicates that a large proportion of the waste stream is biodegradable or recyclable.

The high share of organic waste suggests strong potential for composting initiatives, while the substantial proportion of plastics highlights the need for structured recycling systems. The composition confirms that resource recovery strategies are both feasible and necessary within the studied institutions.

Waste Management Practices

The assessment of waste management practices reveals generally inefficient systems across the four universities. Findings from surveys, interviews, and observations indicate that waste is predominantly collected in mixed forms, with minimal segregation at source. Respondents reported inadequate availability and poor placement of waste bins, leading to improper disposal practices such as littering and indiscriminate dumping. Observational evidence further shows that existing bins are rarely differentiated for waste sorting, thereby limiting recycling opportunities. Waste collection practices are largely centralised, with waste transported to dumping sites without prior sorting or treatment. This contributes to low recycling rates and

inefficient utilisation of recoverable materials. Institutional support for waste management was found to be weak. Policies are either absent or poorly enforced, and environmental awareness programmes are limited. These factors collectively constrain the effectiveness of waste management systems and hinder the transition toward sustainable practices.

Behavioural Factors Influencing Waste Disposal

The results of the multiple regression analysis examining behavioural determinants of waste disposal behaviour are presented in Table 3.

Table 3 Behavioural Factors Influencing Waste Disposal

Variable	Beta	t-value	sig.	Interpretation
Attitude	0.42	8.80	0.000	Strong Positive effects
Perceived Behavioural Control (PBC)	0.36	6.17	0.000	Moderate effects
Subjective Norms (SN)	0.22	4.20	0.000	Weak effects

$R^2 = 0.61, F = 52.34, p < 0.05.$

The regression results indicate that behavioural factors significantly influence waste disposal behaviour. The model explains 61% of the variation in waste disposal behaviour, indicating strong explanatory power. Among the predictors, attitude ($\beta = 0.42$) has the strongest influence, suggesting that individuals with positive environmental attitudes are more likely to engage in proper waste disposal practices. Perceived behavioural control ($\beta = 0.36$) also shows a significant effect, indicating that access to facilities and perceived ease of disposal are critical determinants. Subjective norms ($\beta = 0.22$) have a weaker but statistically significant influence, suggesting that social pressure plays a secondary role compared to personal attitudes and perceived control.

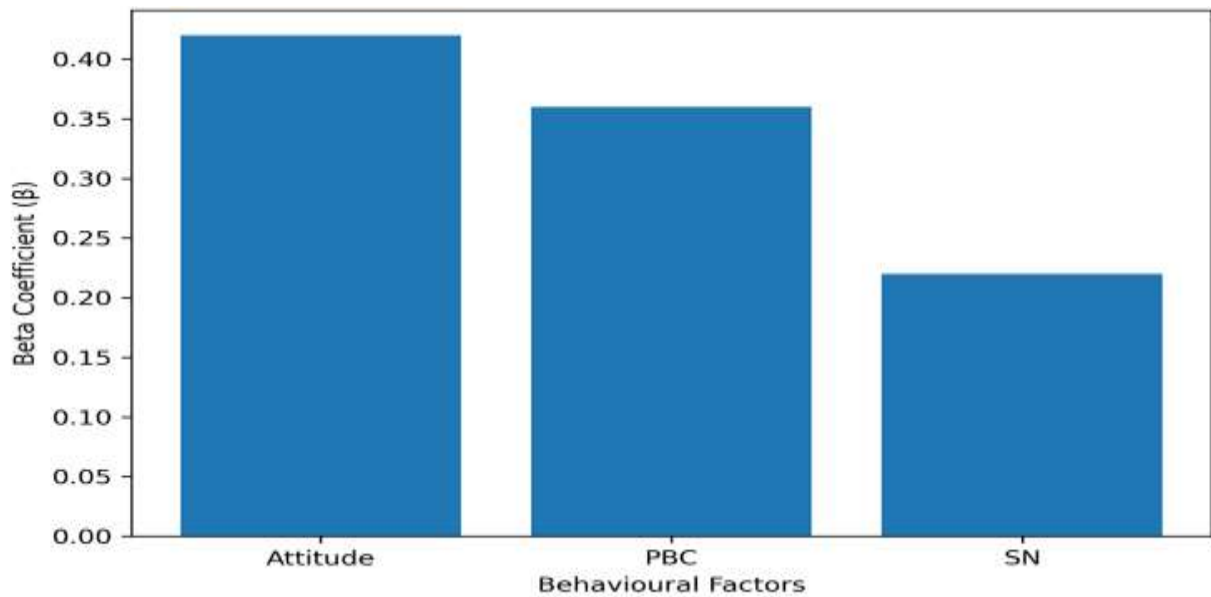


Figure 2 Influence of behavioural factors on waste disposal behaviour.

Institutional Performance Analysis

The Institutional Performance Index (IPI) was used to evaluate waste management effectiveness across the universities.

Table 4: Institutional Performance Index (IPI)

Universities	Code IPI Scores
University of Uyo	Univ. A 0.45
University of Benin	Univ. B 0.38
University of Calabar	Univ. C 0.50
University of Cross River State	Univ. D 0.42

The results indicate generally low institutional performance across the universities, with IPI values ranging from 0.38 to 0.50. University of Calabar shows the highest performance (0.50), while University of Benin records the lowest (0.38). All values fall below 0.60, indicating weak institutional capacity in terms of policy implementation, infrastructure provision, and enforcement mechanisms.

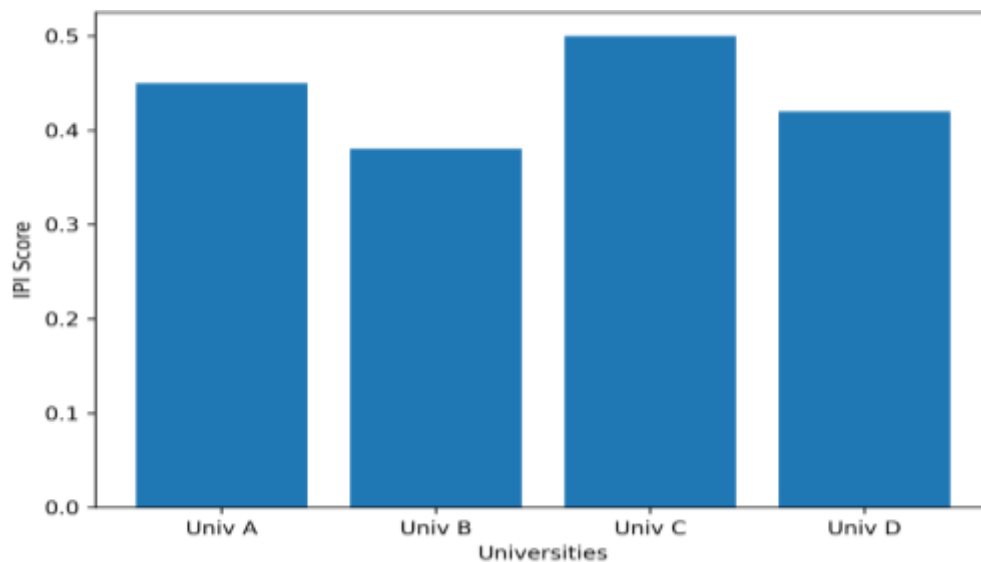


Figure 3 Institutional Performance Index (IPI) across universities.

Circular Economy Potential

The analysis identifies significant opportunities for implementing circular economy strategies within the universities.

Table 5: Circular Economy Opportunities

Opportunity	Potential
Composting	High
Plastic Recycling	High
Paper Recycling	Moderate

The high proportion of organic waste supports the feasibility of composting initiatives, while the substantial share of plastics indicates strong potential for recycling systems. Paper recycling also presents moderate opportunities. These findings demonstrate that circular economy practices can significantly reduce waste volumes and enhance resource recovery if properly implemented

Discussion of Findings

The findings indicate that approximately 10,000 kg of waste is generated daily across the studied universities, with organic waste (46.9%), plastics (31.3%), and paper (12.5%)

constituting the dominant components. This composition suggests that more than 90% of the waste stream is potentially recoverable, highlighting substantial opportunities for resource recovery within a circular economy framework. These results are consistent with Onungwe et al. (2023), who reported that organic and recyclable materials account for a significant proportion of waste generated in university environments. The similarity in findings suggests that the waste profile observed in this study reflects a common pattern in higher education institutions.

It also supports the assertion by Akinwale and Salami (2021) that universities generate waste streams with strong potential for recovery and reuse. The prominence of organic waste in the present study has important practical implications. Since nearly half of the waste stream is biodegradable, the findings reinforce the position of Alshuwaikhat and Abubakar (2008) and Ferronato and Torretta (2019) that waste should be viewed not only as an environmental burden but also as a valuable resource within a circular economy system. In this context, composting emerges as a feasible strategy for reducing waste volume while recovering value from campus-generated organic materials.

Despite this high recovery potential, the Waste Efficiency Index (WEI = 0.25) indicates that only a small proportion of waste is currently recovered or utilised, revealing a significant gap between potential and actual performance. This finding demonstrates inefficiencies in existing waste management systems and aligns with Aiguobarueghian et al. (2024) and Ahsan et al. (2014), who observed that waste segregation and recycling infrastructure remain inadequate in many Nigerian tertiary institutions. It also supports Omokaro et al. (2026), who found that ineffective waste management in universities is often associated with insufficient facilities, weak policy enforcement, and limited operational coordination. The present study extends these earlier findings by demonstrating that these challenges persist across multiple universities rather than being limited to a single institution.

Field observations further confirmed that waste bins are often insufficient, poorly located, and rarely differentiated for sorting. This observation mirrors the concerns raised by

Alshuwaikhat and Abubakar (2008), who noted that campus sustainability initiatives are frequently undermined by weak environmental management systems and inadequate operational structures. Thus, the results clearly show that poor waste infrastructure directly constrains recycling and recovery efforts.

The regression analysis further revealed that behavioural factors play a significant role in shaping waste disposal practices. Attitude ($\beta = 0.42$) emerged as the strongest predictor, followed by perceived behavioural control ($\beta = 0.36$) and subjective norms ($\beta = 0.22$). These findings highlight the importance of individual motivation and access to enabling infrastructure in promoting sustainable waste practices. The pattern is consistent with the Theory of Planned Behaviour, as applied by Onungwe et al. (2023), which posits that behaviour is influenced by individual attitudes, social expectations, and perceived ability to act. The results also support the meta-analytic studies of Armitage and Conner (2001) and Mokuolu and Timothy (2021), which demonstrated that pro-environmental behaviour is strongly influenced by attitudinal and control-related factors. In practical terms, the findings suggest that individuals are more likely to dispose of waste properly when they believe their actions are important and when they have access to appropriate facilities. This is consistent with Precious et al. (2025), who emphasised that awareness and behavioural orientation are key determinants of responsible waste disposal practices. Notably, the present study shows that attitude is a stronger driver than subjective norms in the university context, indicating that personal conviction and internal motivation may be more influential than social pressure in shaping daily waste management behaviour.

Institutional analysis revealed generally weak performance across the universities, with Institutional Performance Index (IPI) values ranging from 0.38 to 0.50. These results indicate inadequate policy implementation, insufficient infrastructure, and weak enforcement mechanisms, all of which limit effective waste management. Even the highest-performing university did not demonstrate strong institutional capacity. This finding is consistent with Institutional Theory as presented by Scott (2021), which emphasises the importance of

organisational rules, structures, and coordination in shaping institutional performance. The relatively low IPI scores observed in this study suggest that the institutional environment is not yet sufficiently developed to support efficient waste management systems.

This observation also agrees with Mbama et al. (2023), who identified weak policy enforcement and poor institutional support as major barriers to effective waste management in Nigerian universities. Overall, the study demonstrates that waste management challenges in Nigerian public universities are not solely technical but systemic, involving the interaction of behavioural, infrastructural, and institutional factors. Nevertheless, the high proportion of recoverable waste identified in this study provides a strong foundation for transitioning toward circular and sustainable waste management systems.

Conclusion

This study provides a comprehensive assessment of waste generation patterns, behavioural drivers, institutional performance, and circular economy potential across selected Nigerian public universities. The findings reveal that although a substantial volume of waste is generated daily, the composition of this waste—dominated by organic, plastic, and paper materials—offers significant opportunities for recovery and reuse within a circular economy framework. However, a clear mismatch exists between this high recovery potential and current operational performance, as reflected in the low Waste Efficiency Index and weak institutional capacity.

The study further establishes that waste management challenges in Nigerian public universities are multidimensional, arising from the combined effects of inadequate infrastructure, weak policy enforcement, limited institutional commitment, and behavioural constraints. Importantly, the results demonstrate that improving waste management requires an integrated systems approach that simultaneously strengthens infrastructure, enhances institutional governance, and promotes positive behavioural change. By addressing these interconnected factors, universities can transition from inefficient disposal-based systems to sustainable,

resource-efficient waste management models that support environmental sustainability and circular economy development.

Recommendations

- a) **Implement Waste Segregation at Source or sorting at source:** Universities should introduce clearly labelled and strategically placed waste bins for different categories of waste, including organic materials, plastics, paper, and residual waste. Source segregation will improve recycling efficiency and increase material recovery rates.
- b) **Invest in Recycling and Composting Infrastructure:** Given the high proportion of organic and recyclable waste, universities should establish small-scale composting facilities and recycling systems to convert waste into valuable resources, thereby reducing landfill dependency and supporting circular economy practices.
- c) **Strengthen Institutional Policies and Enforcement Mechanisms:** Universities should develop comprehensive waste management policies supported by adequate funding, trained personnel, and effective monitoring systems. Clear institutional responsibilities and performance indicators should be established to ensure accountability and compliance.
- d) **Promote Behavioural Change and Environmental Awareness:** Regular environmental education campaigns, sustainability programmes, and incentive-based initiatives should be implemented to improve attitudes and encourage responsible waste disposal behaviour among students and staff.
- e) **Establish Monitoring and Evaluation Systems:** Universities should adopt performance measurement tools such as the Waste Efficiency Index (WEI) and Institutional Performance Index (IPI) to track progress, identify operational gaps, and support evidence-based decision-making for continuous improvement.

References

- Ahsan, A., M. Alamgir, M.M. El-Sergany, S. Shams, M.K. Rowshon, N, N. Nik Daud, 2014. Assessment of Municipal Solid Waste Management Systems in a Developing Country. Retrieved from <http://dx.doi.org/10.1155/2014/561935> on 5th May 2015.
- Aiguobarueghian, I., Uwaga, M. A., Ogunbiyi, E. O., & Okina, S. (2024). Waste management and circular economy: A review of sustainable practices and economic benefits. *World Journal of Advanced Research and Reviews*, 22(2), 1708–1719
- Aikowe, L. D., & Mazancová, J. (2021). Plastic Waste Sorting Intentions among University Students. *Sustainability*, 13(14), 7526. <https://doi.org/10.3390/su13147526>
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Akinwale, Y. O., & Salami, A. T. (2021). Institutional challenges of waste management in Nigerian universities. *Sustainable Environment Research*, 31(1), 1–10. <https://doi.org/10.1186/s42834-021-00085-7>
- Alhassan, H., & Boateng, K. (2023). Solid waste composition and recovery potential in African universities. *Waste Management*, 155, 120–130.
- Alshuwaikhat, H. M., & Abubakar, I. (2008). An integrated approach to achieving campus sustainability: Assessment of the current campus environmental management practices. *Journal of Cleaner Production*, 16(16), 1777–1785. <https://doi.org/10.1016/j.jclepro.2007.12.002>
- Armitage, C. J., & Conner, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology*, 40(4), 471–499. <https://doi.org/10.1348/014466601164939>
- Daniyan, I. A. (Ed.). (2023). *Principles of automation and control*. Bentham Science Publishers. <https://doi.org/10.2174/97898150809261230101>
- Dosumu, I., Kpalo, S. Y., Sadiq, A. U., & Obiukwu, S. C. (2025). The challenges and barriers faced in implementing circular economy practices in waste management in Karu LGA of Nasarawa State, Nigeria. *International Journal of Research and Innovation in Social Science*. 12(3), 234-256
- Ezeah, C., Fazakerley, J. A., & Byrne, T. (2019). Tourism waste management in the European Union: Lessons for developing countries. *Waste Management*, 87, 628–637. <https://doi.org/10.1016/j.wasman.2019.02.030>
- Ezeudu, O. B., & Ezeudu, T. S. (2019). Implementation of circular economy principles in industrial solid waste management: Case studies from a developing economy (Nigeria). *Recycling*, 4(4), 42-63

- Ezeudu, T. S., & Ezeudu, O. B. (2023). Addressing urban solid waste challenges through circular economy model in a developing economy (Nigeria). *Global Scientific Journal*, 11(2), 118-132; <http://www.globalscientificjournal.com>
- Ferronato, N., & Torretta, V. (2019). Waste mismanagement in developing countries: A review of global issues. *International Journal of Environmental Research and Public Health*, 16(6), 1060. <https://doi.org/10.3390/ijerph16061060>
- Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The circular economy – A new sustainability paradigm? *Journal of Cleaner Production*, 143, 757–768. <https://doi.org/10.1016/j.jclepro.2016.12.048>
- Igbinomwanhia, D. I., Obanor, A. I., Olisa, Y. P., & Akhator, P. E. (2016). Evaluation of waste-to-energy potential of domestic solid wastes in Benin metropolis, Nigeria. *Journal of Applied Science and Environmental Management*, 20(4), 1089–1092. <http://dx.doi.org/10.4314/jasem.v20i4.23>
- Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). *What a waste 2.0: A global snapshot of solid waste management to 2050*. World Bank. <https://doi.org/10.1596/978-1-4648-1329-0>
- Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, 127, 221–232. <https://doi.org/10.1016/j.resconrec.2017.09.005>
- Mbama, C. A., Otegbulu, A., Beverland, I. J., & Beattie, T. K. (2023). Solid waste recycling within higher education in developing countries: A case study of the University of Lagos. *Journal of Material Cycles and Waste Management*, 25(2), 886–898. <https://doi.org/10.1007/s10163-022-01569-5>
- Mokuolu, O. A., & Timothy, R. S. (2021). Circular economy and waste management actions during the COVID-19 pandemic in Nigeria. *Journal of Human Environment and Health Promotion*, 7(1), 1–5.
- Okeke, C. C., & Olagunju, T. E. (2023). Governance and policy gaps in waste management in Nigeria. *Environmental Policy and Governance*, 33(2), 145–158. <https://doi.org/10.1002/eet.2015>
- Omokaro, G. O., Michael, I., Efeni, O. S., Adeyanju, O. I., & Obomejoro, J. (2026). Waste management in Nigeria: Systemic failures, circular economy pathways and sustainable solutions. *Environmental Development*, 57, 101363. <https://doi.org/10.1016/j.envdev.2025.101363>
- Omoyi, C. O., & Adeleke, T. B. (2021). Analysis of management participation and economic influence for a re-contextualization of Osha portable concept in the industrial sector in Nigeria using analytic hierarchy process. *NIPES Journal of Science and Technology Research*, 3(4), 86–96.

- Onungwe, I., Hunt, D. V. L., & Jefferson, I. (2023). Transition and implementation of circular economy in municipal solid waste management system in Nigeria: A systematic review of the literature. *Sustainability*, 15(16), 12602. <https://doi.org/10.3390/su151612602>
- Orhororo, E. K., Omoyi, C. O., & Agbonko, E. B. (2025). Evaluation of the tensile properties of additive manufactured acrylonitrile butadiene styrene plastic. *European Journal of Sustainable Development Research*, 9(3), 188-199; em0294. <https://doi.org/10.29333/ejosdr/16336>
- Precious, O. I., Izu, O. Z., Ojevwe, A. T., & Chudi, A. F. (2025). Smart cities and circular economy: Advancing waste management through urban innovation in Nigeria. *Journal of Economy, Tourism and Service*, 4(2), 85–115.
- Scott, W. R. (2021). *Institutions and organizations: Ideas, interests, and identities* (5th ed.). SAGE Publications.
- UNEP. (2024). *Global waste management outlook 2024: Towards a circular economy*. United Nations Environment Programme.
- United Nations Environment Programme (UNEP). (2021). *From pollution to solution: A global assessment of marine litter and plastic pollution*. UNEP.
- Wilson, D. C., Velis, C., & Cheeseman, C. (2021). Role of informal sector recycling in waste management systems. *Waste Management & Research*, 39(2), 123–134. <https://doi.org/10.1177/0734242X211029534>
- World Bank. (2018). *What a waste 2.0: A global snapshot of solid waste management to 2050*. World Bank.
- Ya'u, M. (2025). Sustainable waste management in North-Eastern Nigeria: An integrated approach. *African Journal of Environmental Sciences and Renewable Energy*, 20(1), 106–119. <https://doi.org/10.62154/ajesre.2025.020.01016>