British Journal of Education. 13(9),53-63, 2025
Online ISSN: 2054-636X (Online)
Print ISSN: 2054-6351(Print)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development-UK

# Perception and Barriers to Effective Implement of Circular Economy in Waste Management in Isoko South in Delta State

**Lois Erowo Obed-Ojukwu**
Department of Health Promotion, Environmental and Safety Education, Faculty of Education, University of Port Harcourt

**Ifeoma Vivian Ugwueke**
Department of Public Health David Umahi Federal University of Health Sciences, Uburu, Ebonyi State

doi: https://doi.org/10.37745/bje.2013/vol13n95363 Published August 04, 2025

**Citation**: Obed-Ojukwu, L. E., & Ugwueke I.V. (2025) Perception and Barriers to Effective Implement of Circular Economy in Waste Management in Isoko South in Delta State. *British Journal of Education, 13(9),53-63*

**Abstract:** *The circular economy (CE) offers a sustainable alternative to the traditional linear model of waste management by promoting recycling, reuse, and resource efficiency. This study examined the perception and barriers to the effective implementation of CE in waste management in Isoko South Local Government Area, Delta State, Nigeria. A descriptive cross-sectional design was employed, involving a sample of 3,223 participants selected from twelve rural communities using stratified and simple random sampling techniques. Data were collected using a validated self-structured instrument titled Perception and Barriers to Effective Implementation of Circular Economy in Waste Management Questionnaire (PBEICEWMQ) with a reliability index of 0.89. The instrument contained 24 items, including demographic variables and 20 CE-related items measured on a 4-point Likert scale. Data were analysed using SPSS version 27 employing percentage, mean and standard deviations as statistical tools. Demographic data revealed that 52.3% of respondents were female, while 47.7% were male. In terms of age, 61.8% were between 26–50 years, 22.4% were aged 15–25, and 15.8% were above 50 years. It was found that the participants had a positive perception towards the implementation of circular economy in waste management with aggregate mean score of 3.03±0.863. it was also found that despite the participants' positive perceptions, a plethora of barriers towards effective implementation of CE in WM which included Low public awareness about circular economy (Mean = 3.40 ± 0.74); Lack of government policies and support (Mean = 3.15 ± 1.02); Cultural attitudes toward waste (Mean = 2.60 ± 0.97); and Lack of collaboration among stakeholders (Mean = 2.60 ± 0.74) among others. The study concluded that although public perception toward CE in waste management was positive, implementation was hindered by systemic barriers. It recommended enhanced public education and awareness, along with government investment in infrastructure and collaborative stakeholder engagement to support circular economy adoption and Sustainable Development Goals (SDGs), particularly SDG 12(Responsible Consumption and Production and SDG 13(Climate Action)*

**Keywords:** circular economy, waste management, perceived barriers, perceptions, effective implementation

British Journal of Education. 13(9),53-63, 2025
Online ISSN: 2054-636X (Online)
Print ISSN: 2054-6351(Print)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development-UK

## INTRODUCTION

The ever-growing problem of waste generation and its mismanagement poses severe environmental, social, and economic threats globally, demanding innovative and sustainable responses. One such response gaining momentum is the *Circular Economy (CE)*, which is a creating products and systems that are restorative and regenerative by design. regenerative system aimed at minimizing waste, maximizing resource use, and designing out pollution from the production cycle (Ekins et al., 2020). Unlike the traditional linear model of "take, make, dispose," CE emphasizes reduce, reuse, recycling, and sustainable product design. In waste management, CE is particularly relevant as it shifts the focus from disposal to resource recovery, transforming waste into a valuable input for new production cycles. Moraga et al. (2019) argue that CE indicators—such as material reuse and recycling rates—demonstrate its potential to reduce environmental impact, conserve natural resources, and foster innovation. Therefore, implementing CE principles in waste management offers a viable strategy for achieving sustainability, particularly in developing regions experiencing rapid urbanization and growing waste volumes.

Globally, circular economy has the potential to transform the way we produce, consume, and live, fostering a more sustainable future for all. Countries and organizations worldwide are adopting circular economy principles, driving innovation and sustainability in various sectors, including manufacturing industries are designing sustainable products and supply chains and agriculture industries are promoting regenerative agriculture practices. Community-level adoption of CE practices in waste management has been both promising and challenging. In Nigeria, the discourse is gaining traction but remains fragmented, often constrained by structural, political, and cultural factors (Onungwe, Hunt & Jefferson, 2023). Community-level implementation is critical as it reflects grassroots engagement and sustainability of CE initiatives. However, debates persist regarding the adaptability and appropriateness of CE models developed in high-income contexts to low- and middle-income communities (Corvellec, Stowell & Johansson, 2022). Empirical studies such as those by Ezeudu et al. (2021) and Debrah et al. (2022) show that Nigerian waste systems still largely operate linearly, with open dumping and landfilling as common practices. Though pilot projects and awareness campaigns on encouraging the reuse and recycling of materials to minimize waste. exist, implementation remains sluggish due to lack of infrastructure, policy alignment, and local engagement. Nevertheless, there are signs of progress, such as promoting the use of renewable energy and resources. the market-based initiatives in Southeast Nigeria (Ezeudu et al., 2021), suggesting that context-specific models can emerge with proper stakeholder involvement.

Understanding community perception is fundamental to implementing CE in waste management, particularly in decentralized settings. Perception, broadly defined as the process by which individuals interpret and make sense of environmental stimuli, shapes community attitudes, decisions, and engagement with sustainability innovations (Chukwuone, Amaechina & Ifelunini, 2022). Public perception towards CE influences not only behavioral adoption but also support for

policies, willingness to separate waste, and participation in recycling programs. Akintayo et al. (2023) highlight that cultural norms, awareness levels, and trust in governance deeply affect how communities engage with waste management strategies in Nigeria. Misconceptions, low-risk perception, and skepticism about the benefits of recycling or reusing waste materials often undermine policy effectiveness. Therefore, gauging the perception of people in Isoko South is essential to identifying the readiness, resistance, or receptiveness of the population to CE interventions.

Another critical dimension of this study is the identification of perceived barriers to CE implementation in local waste systems. *Perceived barriers* refer to subjective beliefs or observations about obstacles that hinder the adoption or effectiveness of a given innovation or strategy. These barriers may be technical, economic, institutional, or sociocultural in nature. In Nigeria, issues such as weak enforcement of environmental laws, lack of infrastructure, low technical capacity, poor funding, and public apathy have been identified as major hindrances (Ezeudu et al., 2021; Nwosu & Chukwueloka, 2020). Specifically, factors like informal waste systems, low awareness, and policy incoherence make CE adoption highly context-dependent (Al-Otaibi et al., 2022). Ojo, Oladinrin & Obi (2021) also emphasized that even in sectors with high environmental footprints, environmental management remains tokenistic due to institutional inertia and limited stakeholder engagement. Understanding these perceived barriers within Isoko South will help provide localized insights into why CE initiatives may stall or succeed.

Despite growing interest in CE and its application in waste management, significant gaps remain in understanding its contextual dynamics within local Nigerian communities. Previous studies have either focused on urban centers like Lagos (Chukwuone et al., 2022) or specific markets in Anambra (Ezeudu et al., 2021), with few empirical investigations into smaller local government areas like Isoko South in Delta State. This gap limits the generalizability and localization of findings and undermines effective policy design. Moreover, the limited integration of community perceptions and lived experiences into CE discourse creates disconnections between top-down policies and ground realities. Building on the foundational works of Ekins et al. (2020) and Onungwe et al. (2023), this study aims to fill that gap by exploring the perception and perceived barriers to effective CE implementation in waste management in Isoko South. Thus, the central thesis is that while CE holds transformative potential for sustainable waste management, its success hinges on aligning local perceptions and addressing context-specific barriers.

**Statement of the problem**

The world is facing an unprecedented waste management crisis, with the linear economy model of "take, make, dispose" contributing to environmental degradation, climate change, and unsustainable resource depletion. The circular economy (CE) has emerged as a promising solution, aiming to reduce waste, promote resource efficiency, and foster sustainable economic growth. However, despite its potential, the implementation of CE in waste management remains hindered by various barriers and misconceptions. Based on this, the focus of the current study is to

investigate the Perception and Barriers to Effective Implement of Circular Economy in Waste Management System in Isoko South in Delta State

**Aim and objectives**

The ultimate focus of the current study is to investigate the Perception and Barriers to Effective Implement of Circular Economy in Waste Management System in Isoko South in Delta State. More precisely, the study explored the following objectives:

1. To examine the perception of people resident in Isoko South in Delta State towards the Implement of Circular Economy in Waste Management System in Nigeria.
2. To ascertain the perceived barriers to effective implementation of Circular Economy in Waste Management System in Isoko South in Delta State. Nigeria

**Research questions**

In line with the specific objective, the study answered the following two research questions

1. How do people resident in Isoko South in Delta State perceive the Implement of Circular Economy in Waste Management System in Nigeria?
2. What are the perceived barriers to effective implementation of Circular Economy in Waste Management System among people resident in Isoko South in Delta State. Nigeria?

## METHODOLOGY

This study adopted a descriptive cross-sectional survey design to investigate the perception and barriers to the effective implementation of circular economy (CE) in the waste management system in Isoko South Local Government Area of Delta State, Nigeria. The study was conducted across twelve selected rural communities in the area, targeting both male and female residents aged 15 years and above. The choice of design allowed for a snapshot assessment of community views and challenges regarding CE at a specific time.

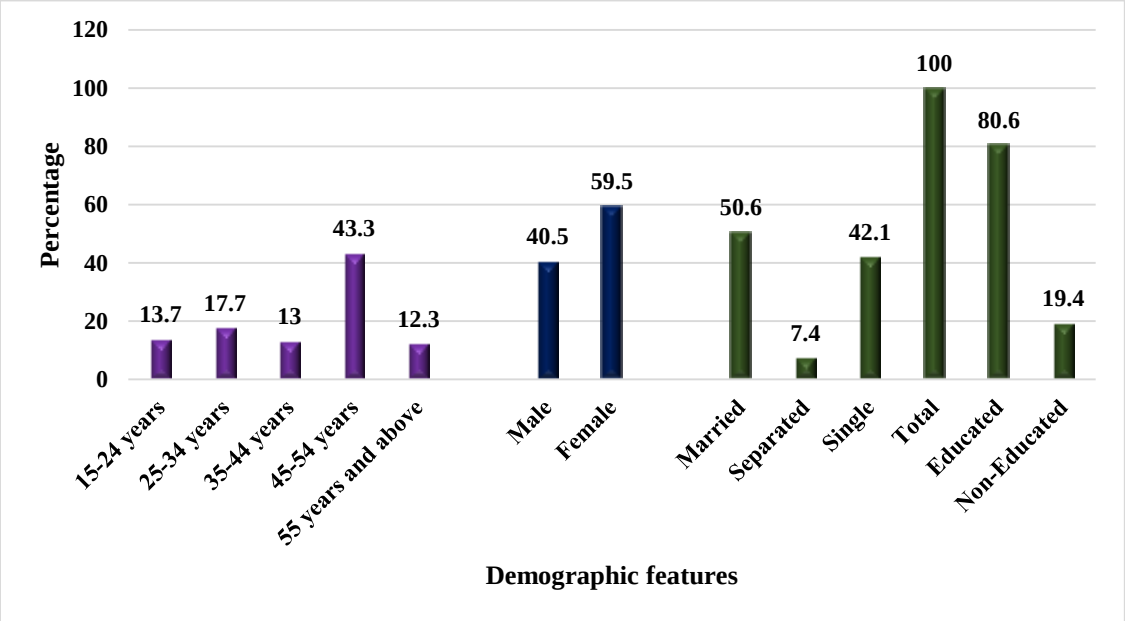
The study population was drawn from the projected 2022 population of Isoko South, estimated at 322,300 individuals. A scaling factor of 0.01 was applied to determine the final sample size, yielding a total of 3,223 respondents. The sample was proportionally distributed across the selected communities and data collection was carried out over a five-month period, from August 2023 to January 2024. Stratified and simple random sampling techniques were employed to ensure adequate representation of the population across age groups, gender, and community location. Data collection was facilitated through a validated self-structured questionnaire titled Perception and Barriers to Effective Implementation of Circular Economy in Waste Management Questionnaire (PBEICEWMQ). The instrument consisted of 20 items divided into two sections: Section A contained four demographic questions, while Section B featured twenty items—ten assessing perception and ten examining perceived barriers—measured on a 4-point Likert scale (Strongly Agree, Agree, Disagree, Strongly Disagree). The instrument demonstrated high internal consistency with a Cronbach's Alpha reliability index of 0.89.

British Journal of Education. 13(9),53-63, 2025
Online ISSN: 2054-636X (Online)
Print ISSN: 2054-6351(Print)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development-UK

Data were analyzed using SPSS version 27. Descriptive statistics such as frequencies, percentages, mean and standard deviations were the statistical tools used in analyzing the study demographics and research questions. The demographic characteristics of the participants were presented in a cluster bar chart using the percentage on the Y-axis and demographic features on the X-axis. The results of the questions analysis were presented in tables (1 and 2) observing American Psychological Association Styles (APA 1 format)

## RESULTS

**Figure 1: Percentage analysis of the participant's demography**




The demographic chart reveals that the largest age group among respondents is 45–54 years (43.3%), followed by 25–34 years (17.7%). Females make up the majority at 59.5%, while males account for 40.5%. In terms of marital status, 50.6% are married, 42.1% are single, and 7.4% are separated. The educational distribution shows that 80.6% of respondents are educated, while 19.4% are not. This suggests that the majority of respondents are middle-aged, educated, and female. The high level of education and marital status may influence positive attitudes toward community issues such as circular economy and waste management.

**Table 1:**
**Mean analysis of participants' perceptions of the Implement of Circular Economy in Waste Management System in Isoko South in Delta State.**

| S/N | Perceptions | SA | A | D | SD | Mean | St.Dev |
|---|---|---|---|---|---|---|---|
| 1 | I understand what the circular economy means in the context of waste management. | 1610 | 968 | 484 | 161 | 3.25 | 0.805 |
| 2 | I believe circular economy practices can help reduce waste problems in Isoko South. | 966 | 1127 | 644 | 486 | 2.80 | 1.117 |
| 3 | I recognize that recycling and reuse are key parts of effective waste management. | 2417 | 483 | 323 | 0 | 3.65 | 0.735 |
| 4 | I see the potential of circular economy to create employment opportunities in my community. | 1190 | 873 | 999 | 161 | 2.96 | 0.663 |
| 5 | I think applying circular economy strategies will improve environmental health in Isoko South. | 644 | 1290 | 806 | 483 | 2.65 | 1.108 |
| 6 | I believe people in my community are aware of the importance of recycling and reuse. | 1257 | 516 | 999 | 451 | 2.80 | 0.8856 |
| 7 | I think a circular economy model is better than traditional waste disposal methods. | 1610 | 161 | 968 | 484 | 2.90 | 0.805 |
| 8 | I see public education and awareness as essential for circular economy adoption. | 1104 | 766 | 249 | 1104 | 3.29 | 1.117 |
| 9 | I understand that circular economy encourages responsible use and reuse of resources. | 2417 | 0 | 323 | 483 | 3.35 | 0.735 |
| 10 | I think solid waste issues in Isoko South can be addressed better through a circular economy approach. | 1127 | 161 | 1774 | 161 | 2.70 | 0.663 |
| | **Aggregate** | **1434** | **635** | **757** | **297** | **3.03** | **0.863** |

The mean analysis in Table 1 reveals that participants in Isoko South generally have a positive perception of implementing circular economy principles in solid waste management. The highest mean score (3.65) is associated with recognizing recycling and reuse as key practices, indicating strong agreement. Statements regarding understanding the concept and its potential benefits, such as employment and environmental improvement, also received relatively high means (above 2.9). However, lower scores were recorded for community awareness and preference over traditional methods. The aggregate mean of 3.03 and standard deviation of 0.863 suggest a consistent positive perception of the implementation of circular economy in waste management among participants.

**Table 2:**
**Mean analysis of Barriers to Effective Implement of Circular Economy in Waste Management System in Isoko South in Delta State.**

| S/N | Barriers | SA | A | D | SD | Mean | St.Dev |
|---|---|---|---|---|---|---|---|
| 11 | Lack of government policies and support hinders the implementation of circular economy. | 1290 | 1288 | 484 | 161 | 3.15 | 1.024 |
| 12 | Inadequate infrastructure makes it difficult to recycle or reuse waste. | 1935 | 161 | 644 | 483 | 3.10 | 1.179 |
| 13 | There is limited access to funding for circular economy initiatives. | 1289 | 805 | 968 | 161 | 3.00 | 0.949 |
| 14 | Public awareness about circular economy is low in Isoko South. | 1772 | 967 | 484 | 0 | 3.40 | 0.735 |
| 15 | Cultural attitudes towards waste hinder circular economy practices. | 645 | 1128 | 966 | 484 | 2.60 | 0.97 |
| 16 | There is insufficient technical knowledge and manpower to manage a circular system. | 1386 | 870 | 645 | 322 | 3.03 | 0.9714 |
| 17 | The private sector is not fully involved in waste recycling efforts. | 1290 | 1288 | 161 | 484 | 3.05 | 1.024 |
| 18 | Informal waste collectors are not integrated into formal recycling systems. | 1935 | 161 | 644 | 483 | 3.10 | 1.179 |
| 19 | Poor enforcement of environmental laws affects circular economy adoption. | 1289 | 805 | 968 | 161 | 3.00 | 0.949 |
| 20 | There is a lack of collaboration between government, private sector, and community in waste management. | 645 | 1128 | 966 | 484 | 2.60 | 0.735 |
| | **Aggregate** | **1348** | **860** | **693** | **322** | **3.00** | **0.972** |

Table 2 presents the mean analysis of barriers to implementing the circular economy in waste management in Isoko South. The results show that respondents generally agree that several factors hinder progress. The highest mean (3.40) was recorded for low public awareness, followed by lack of policies, infrastructure, and integration of informal waste collectors (means above 3.0), highlighting these as significant obstacles. Barriers like cultural attitudes and lack of collaboration received lower means (2.60), suggesting more varied opinions. The aggregate mean of 3.00 and standard deviation of 0.972 reflect a moderate level of agreement and variability among participants regarding the identified barriers.

## DISCUSSION OF FINDINGS

The results showed that participants in Isoko South generally held a positive perception of implementing circular economy principles in solid waste management. Participants strongly acknowledged reduce, reuse, recycling and recover as important components, suggesting a good

level of awareness of fundamental of circular economy concepts. This finding was in agreement with the work of Ekins et al. (2020), who asserted that recycling and reuse formed the core of circular economy practices and were crucial for reducing environmental degradation. Similarly, Moraga et al. (2019) highlighted that understanding and engaging in such practices served as valid indicators of circular economy progress. Participants also demonstrated good understanding of circular economy, as well as its potential benefits, such as improving environmental health and creating employment opportunities for both young and old in the society. These perceptions aligned with the findings of Ajieh et al. (2024), who reported similar attitudes in a related study in Isoko South. However, not all studies supported this optimistic outlook. For example, Debrah, Teye, and Dinis (2022) observed limited or no understanding of circular economy concepts in some Sub-Saharan African communities, pointing out that awareness was often superficial and largely policy-driven. Likewise, Chukwuone et al. (2022) noted that in some urban Nigerian communities, public misconceptions and poor perception of waste-related risks weakened local engagement with circular economy practices, despite available infrastructure.

Findings also revealed several perceived barriers to the effective implementation of circular economy in waste management. Low public awareness, inadequate infrastructure, lack of policy support, and the exclusion of informal waste actors emerged as significant challenges. These findings were consistent with Chikeka et al (2024) who highlighted sseveral determinants influence refuse disposal practices, including knowledge, accessibility of disposal facilities, and government policies. Comparisons with studies in Agege and Enugu by Iyasele and Dangana (2023) and Ekperi et al. (2019) highlight the significance of these factors in shaping waste management behaviors. Effective interventions should address these determinants comprehensively to promote sustainable waste management practices and mitigate environmental and public health risks. Others are Onungwe, Hunt, and Jefferson (2023), and Ezeudu et al. (2021), who identified similar issues across various regions in Nigeria also. Debrah et al. (2022) further emphasized that poor technical capacity and limited funding mechanisms constrained progress in many Sub-Saharan African contexts. Barriers such as weak collaboration among stakeholders and cultural resistance also reflected deep-seated socio-cultural and institutional challenges, as highlighted by Akintayo et al. (2023) in their review of Nigeria's waste management approaches. However, Corvellec, Stowell, and Johansson (2022) offered a more critical stance by suggesting that some of the issues were not only practical but also conceptual. They argued that the circular economy model itself had limitations and that its assumptions, often based on high-income contexts, might not seamlessly fit local realities. Thus, while respondents in Isoko South rightly identified local barriers, some scholars believed the broader limitations of the model also needed to be considered.

The practical implications of these findings were considerable. The positive perception observed among participants suggested a strong foundation for future circular economy policies and programs. With appropriate education and community engagement, this awareness could translate into sustainable behavior change. Nonetheless, the identified barriers required urgent attention to avoid stagnation and loss of public interest. Integrating informal waste workers, as recommended

by Onuegbu (2024), could enhance system efficiency and bridge the gap between formal and informal waste management practices. Furthermore, addressing technical limitations and encouraging stronger partnerships among government agencies, the private sector, and community stakeholders, as advised by Al-Otaibi et al. (2022), could support the structural development of circular economy systems. Overall, the study offered valuable insights from a local perspective, contributing to the broader understanding of how circular economy initiatives could be effectively implemented within Nigerian communities and this could be implemented globally as well.

## CONCLUSION

This study explored the perception and barriers to the effective implementation of circular economy in waste management within Isoko South, Delta State. Findings revealed that residents generally had a positive outlook toward circular economy practices, particularly regarding recycling, environmental sustainability, and job creation potential. However, despite this positive perception, implementation was hindered by several key barriers, including low public awareness, inadequate infrastructure, limited government support, and weak collaboration between stakeholders. These barriers reflect systemic and contextual challenges that must be addressed to transition from linear to circular waste systems effectively. The study underscored the importance of community engagement, education, and policy alignment in fostering sustainable waste practices. It also highlighted the need for inclusive models that integrate informal waste actors and reflect the socio-cultural realities of the region. Overall, the study contributed localized insights to the broader discourse on circular economy in Nigeria and emphasized the urgency of responsive, context-specific interventions which will sustain the positive perception of the resident of Isoko South, government and NGOs should intensify localized awareness campaigns and practical education on circular economy benefits.

### Recommendations

Following the study discovery, the following were recommended:

1. To sustain positive perception, government and NGOs should intensify localized awareness campaigns and practical education on circular economy benefits.
2. To address barriers, policymakers must invest in recycling infrastructure and build inclusive partnerships with communities and private sector actors.

## REFERENCES

Ajieh, M. U., Ogbomida, E. T., Uhunamure, N. D., Agbale, R. N., Ajieh, G. I., Ekperi, R., ... & Okafor, I. F. (2024). Analytical assessment of knowledge, attitude and practices (KAP) of waste management practices to optimize energy and food nexus: A case study of Oleh, Isoko South LGA, Delta State, Nigeria.

Akintayo, T., Hämäläinen, J., Pasanen, P., & John, I. (2023). A rapid review of sociocultural dimensions in Nigeria's solid waste management approach. *International Journal of Environmental Research and Public Health*, *20*(13), 6245-6253.

Al-Otaibi, A., Bowan, P. A., Abdel Daiem, M. M., Said, N., Ebohon, J. O., Alabdullatief, A., & Watts, G. (2022). Identifying the barriers to sustainable management of construction and demolition waste in developed and developing countries. *Sustainability*, *14*(13), 75-86.

Chikeka., C.O., Ndie E.C., & Ugwu F.C (2024) Determinants of Knowledge, Attitude and Practices of Refuse Disposal Method among Residents of Port Harcourt Metropolis. *Journal of Health, Applied Sciences and Management, 7*(2), 5-18

Chukwuone, N. A., Amaechina, E. C., & Ifelunini, I. A. (2022). Determinants of household's waste disposal practices and willingness to participate in reducing the flow of plastics into the ocean: Evidence from coastal city of Lagos Nigeria. *Plos one*, *17*(4), e0267739.

Corvellec, H., Stowell, A. F., & Johansson, N. (2022). Critiques of the circular economy. *Journal of industrial ecology*, *26*(2), 421-432.

Debrah, J. K., Teye, G. K., & Dinis, M. A. P. (2022). Barriers and challenges to waste management hindering the circular economy in Sub-Saharan Africa. *Urban Science*, *6*(3), 57-64.

Ekins, P., Domenech Aparisi, T., Drummond, P., Bleischwitz, R., Hughes, N., & Lotti, L. (2020). The circular economy: What, why, how and where.

Ezeudu, O. B., Agunwamba, J. C., Ugochukwu, U. C., & Ezeudu, T. S. (2021). Temporal assessment of municipal solid waste management in Nigeria: prospects for circular economy adoption. *Reviews on environmental health*, *36*(3), 327-344.

Ezeudu, O. B., Agunwamba, J. C., Ugochukwu, U. C., & Ezeudu, T. S. (2021). Temporal assessment of municipal solid waste management in Nigeria: prospects for circular economy adoption. *Reviews on environmental health*, *36*(3), 327-344.

Ezeudu, O. B., Ezeudu, T. S., Ugochukwu, U. C., Agunwamba, J. C., & Oraelosi, T. C. (2021). Enablers and barriers to implementation of circular economy in solid waste valorization: The case of urban markets in Anambra, Southeast Nigeria. *Environmental and Sustainability Indicators*, *12*, 10-50.

Moraga, G., Huysveld, S., Mathieux, F., Blengini, G. A., Alaerts, L., Van Acker, K., & Dewulf, J. (2019). Circular economy indicators: What do they measure? *Resources, Conservation and Recycling*, *146*, 452-461.

Nwosu, A. O., & Chukwueloka, H. E. (2020). A review of solid waste management strategies in Nigeria. *Journal of Environment and Earth science*, *10*(6), 132-143.

Nzeadibe, T. C., & Ejike-Alieji, A. U. (2020). Solid waste management during Covid-19 pandemic: policy gaps and prospects for inclusive waste governance in Nigeria. *Local Environment*, *25*(7), 527-535.

Ojo, L. D., Oladinrin, O. T., & Obi, L. (2021). Critical barriers to environmental management system implementation in the Nigerian construction industry. *Environmental Management*, *68*(2), 147-159.

Onuegbu, F. E. (2024). Assessment of Solid Waste Disposal Practices and Management Strategies in Eke Okigwe Market, Imo State, Nigeria. *Mediterranean Journal os Social Sciences*, *15*, 1-14.

Onungwe, I., Hunt, D. V., & 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.

Parveen, N., Naik, S. C. S., Vanapalli, K. R., & Sharma, H. B. (2024). Bioplastic packaging in circular economy: A systems-based policy approach for multi-sectoral challenges. *Science of the Total Environment*, *945*, e173893.