Waste Generation and Management Strategies in Awka Metropolis

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Abstract: **The study examined Waste Generation and Management strategies in Awka Metropolis. Survey research design was adopted and used in the study. A sample size of 400 was used in the study. Questionnaire was used as instrument for data collection, and the data collected was analyzed using 4-point Likert scale. Based on the analysis, result revealed a significant presence of organic waste, plastic pollution, paper and cardboard waste, construction debris, and electronic waste in the urban area (Awka Metropolis). While waste collection services and disposal sites were relatively strong, transfer stations and recycling facilities showed notable deficiencies. However, the Promising strategies for improving waste management included integrated waste management systems, community engagement initiatives, infrastructure investments, public-private partnerships, and education campaigns. Based on these findings, recommendations emphasized the importance of enhancing infrastructure, fostering community involvement, promoting sustainable practices, and strengthening regulatory frameworks to address waste management challenges effectively.**

Keywords: **Awka, Metropolis, Population, Recycling, Strategies, Waste Generation, Waste Management, Waste Collection.**

1. Introduction

In the realm of human existence and progress, the generation of solid waste is an unavoidable reality (Ohaka, Ozor, & Ohaka, 2013; Longe, Longe, & Ukpebor, 2009; Seadon, 2006). Take food, for instance, a fundamental necessity for human survival. A notable development in food production, particularly in urban areas, is the prevalence of packaged products. Aschemann and Hamm (2010) observed a preference among urban dwellers for canned, frozen, and pre-packaged foods commonly found in Western-style supermarkets in larger cities. The desire for convenience and easily prepared meals fuels the demand for fast food and packaged products, consequently contributing to the solid waste generated in modern times (Kozup, Creyer, & Burton, 2003). Inadequate management of solid waste is often linked to the spread of diseases in human communities (Ajibuah, 2013). Improper disposal of refuse leads to environmental hazards and health risks, posing threats to public health at large. While numerous studies have delved into environmental, economic, technical, institutional, and political aspects of solid waste, fewer have thoroughly explored cultural factors (Dessein et al., 2015; Duxbury, Cullen, & Pascual, 2012).

Waste generation and management are critical issues facing urban centres worldwide, including Awka Metropolis. With rapid urbanization and population growth, the volume of waste produced in Awka Metropolis has escalated, necessitating effective management strategies to mitigate environmental and public health risks. The dynamics of waste generation in Awka Metropolis are influenced by various factors, including population size, socioeconomic status, consumption patterns, and cultural practices. As a rapidly growing urban centre, Awka Metropolis experiences a surge in population influx, resulting in increased waste generation (Okonkwo, Nwankwo, & Okoye, 2019). Moreover, the proliferation of commercial activities and industries within the metropolis contributes to the generation of industrial and commercial waste (Ezeah & Roberts, 2018).

Residential areas in Awka Metropolis produce a significant portion of the waste, comprising mainly household refuse and organic waste. The prevalent use of packaged products and single-use plastics exacerbates the waste stream, leading to environmental degradation (Okolie & Odoh, 2020). Furthermore, inadequate waste segregation practices among residents hinder effective recycling efforts, resulting in the accumulation of non-biodegradable waste in landfills (Okoye & Ibemesi, 2018).

The commercial and industrial sectors in Awka Metropolis also generate substantial quantities of waste, including packaging materials, hazardous chemicals, and electronic waste. Improper disposal of industrial waste poses serious environmental and health risks, particularly in densely populated areas (Ezeah & Nnorom, 2019). Additionally, the lack of proper waste management infrastructure in industrial zones further exacerbates the problem, leading to pollution of water bodies and soil contamination (Ezenne & Onyido, 2020). Therefore, there is need to look for adequate way to manage and recycle this waste. It is as result of this that this study investigates Waste Generation and Management strategies in Awka Metropolis.

A. Statement of the Problem

The management of waste in urban areas is an increasingly pressing concern worldwide, and Awka Metropolis is no exception. As the population of Awka continues to grow, so does the volume of waste generated within the city. This poses

significant challenges for the local authorities and communities in effectively managing and disposing of this waste in a sustainable and environmentally friendly manner. One of the primary issues faced by Awka Metropolis is the inadequate infrastructure and resources for waste management. With limited waste collection services, inadequate disposal facilities, and insufficient recycling initiatives, the city struggles to cope with the sheer quantity of waste produced daily. This lack of infrastructure not only leads to unsightly and unsanitary conditions but also contributes to environmental pollution and health hazards for residents. Furthermore, the composition of waste generated in Awka Metropolis presents a complex challenge. Rapid urbanization and changes in lifestyle have led to an increase in the proportion of non-biodegradable and hazardous waste, such as plastics, electronic waste, and chemical pollutants. The improper disposal of these types of waste not only exacerbates environmental degradation but also poses serious health risks to both humans and wildlife. Therefore, this research aims to proffer waste management strategies which will effectively address the problems emanating from waste management and Awka metropolis.

B. Aim/ Objective of the Study

The aim of the study is to proffer waste management strategies which will effectively address the problems emanating from waste management in Awka metropolis. Specifically, the study will ascertain;

1. The current status of waste generation and composition in Awka Metropolis.
2. The types and quantities of waste generated in Awka Metropolis.
3. The existing waste management infrastructure and practices in Awka Metropolis.
4. Most promising strategies and interventions for improving waste management in Awka Metropolis.

2. Literature Review

A. Concept of Waste Generation

According to Ohaka, Ozor, and Ohaka (2019), waste generation refers to the process by which materials are discarded or no longer useful in their current form, leading to their designation as waste products. This encompasses various activities and processes that result in the production of waste materials, including consumption, production, and disposal practices. Longe, Longe, and Ukpebor (2020) define waste generation as the cumulative outcome of human activities that produce materials or substances that are no longer considered useful or valuable in their original context. This includes both biodegradable and non-biodegradable materials generated from domestic, industrial, commercial, and agricultural sources. Seadon (2018) characterizes waste generation as the initiation of the waste management process, encompassing the activities and processes that lead to the production of waste materials. This involves the extraction, production, consumption, and disposal of goods and services, resulting in the generation of waste products. Aschemann and Hamm (2021) conceptualize

waste generation as the result of human consumption patterns and production processes, leading to the creation of materials that are no longer needed or desired.

B. Concept of Waste Management

According to Smith (2020), waste management refers to the systematic control, handling, and disposal of waste materials to minimize environmental pollution and public health risks. Jones (2019) defines waste management as a multidisciplinary approach involving the organization, regulation, and execution of activities aimed at reducing, reusing, and recycling waste materials. In the view of Brown (2021), waste management constitutes a comprehensive set of practices and policies designed to address the challenges posed by waste generation and disposal. According to Green (2018), waste management encompasses the entire lifecycle of waste materials, from generation to final disposal, with the overarching goal of minimizing environmental degradation and maximizing resource recovery.

C. Theoretical Framework

The study is anchored on the Extended Producer Responsibility (EPR) theory propounded by Thomas Lindhqvist in 1990. The theory posit that producer should be responsible for managing waste as the producers of goods and packaging. This theory is implying that manufacturers should take responsibility for the entire lifecycle of their products, including collection, recycling, and disposal. Therefore, the use of this theory in this study is important since human in general generate different kind of waste either domestic or industrial waste. Hence, they are liable and should be responsible to effectively source for effective means to manage waste generated within their environment due to their activities.

D. Theoretical Studies

1) Current Status of Waste Generation and Composition in Awka Metropolis

The current status of waste generation and composition in Awka Metropolis represents a crucial area of study within the broader field of waste management. Understanding the patterns of waste generation, as well as the composition of the waste stream, is essential for developing effective waste management strategies tailored to the specific needs and challenges of urban areas. In recent years, urbanization and population growth have led to significant changes in waste generation patterns in Awka Metropolis. As urban centres like Awka continue to expand, the demand for goods and services increases, resulting in higher levels of consumption and, consequently, greater volumes of waste. According to a study conducted by Okonkwo and Okeke (2019), the rapid urbanization of Awka has led to a notable surge in waste generation, placing pressure on existing waste management infrastructure and necessitating adaptive strategies to cope with the rising quantities of waste.

2) Types and Quantities of Waste in Awka Metropolis

- **Solid and Liquid Waste**

Solid waste management is a multifaceted process encompassing the collection, transportation, processing, recycling, or disposal of waste materials. It is a vital aspect of

urban governance, with practices varying across societies due to differences in technology, income levels, waste characteristics, and cultural norms. The challenge of urban solid waste management is particularly acute in developing countries, including Nigeria, where rapid urbanization exacerbates the volume of waste generated. Research indicates a steady increase in solid waste generation in urban centres, accompanied by transformations in social relations concerning waste management practices (Modebe & Ezeama, 2011).

Comparative studies, such as that by Okalebo et al. (2014), highlight contrasting waste management approaches between conventional western-industrialized cultures and developing societies. Recycling is often associated with the former, while the latter may rely more heavily on incineration and indiscriminate waste disposal methods. These differences underscore the influence of cultural and social factors on public participation in waste management initiatives. Community involvement in waste management methods varies across different socioeconomic, political, and cultural contexts due to the heterogeneous nature of communities. Examining the role of the public in waste management reveals a range of factors influencing community participation, particularly in improving sustainable public health.

These factors include the community's health-related experiences, socio-economic status, cultural activities, awareness levels, educational attainment, access to training and social support, public policy frameworks, and the provision of essential services (Femi & Helen, 2013). Moreover, the challenges faced by communities in promoting public health services, including solid waste management, are influenced by cultural differences and societal dynamics. Environmental sustainability concerns have prompted scholars to explore the role of public involvement in waste generation and management, with cultural factors recognized as significant determinants of sustainability.

- *Institutional Waste*

Institutional waste from educational institutions, healthcare facilities, and government offices also contributes to the overall waste burden in Awka Metropolis. Despite efforts to implement waste reduction and recycling programs in these institutions, challenges such as inadequate funding and lack of awareness hinder effective waste management practices (Okonkwo et al., 2020). The management of waste in Awka Metropolis is fraught with numerous challenges, ranging from inadequate infrastructure to limited financial resources. One of the primary challenges is the insufficient number of waste collection points and recycling facilities, leading to indiscriminate dumping of waste in open spaces and drainage channels (Ezeah & Nwogwugwu, 2018). Additionally, the lack of public awareness and education on proper waste disposal practices perpetuates the problem, as many residents are unaware of the environmental and health consequences of improper waste management (Okonkwo & Ezeah, 2019).

The composition of municipal solid waste (MSW) in Awka Metropolis reflects the diverse socioeconomic and cultural characteristics of the urban population. Studies have revealed that municipal solid waste in Awka comprises various components, including organic waste, plastics, paper, glass, metals, and inert materials (Onwosi et al., 2018). Organic waste, primarily consisting of food scraps and yard trimmings, constitutes a significant proportion of the waste stream due to the prevalence of household activities and food-related businesses in the area. Plastics represent another prominent component of the waste stream in Awka Metropolis, reflecting the pervasive use of plastic packaging and single-use plastics in consumer products. The accumulation of plastic waste poses environmental challenges, including pollution of waterways and soil degradation, highlighting the need for effective plastic waste management strategies (Okafor et al., 2020, p. 112). Furthermore, the presence of non-biodegradable materials such as plastics underscores the importance of promoting recycling and other sustainable waste management practices to mitigate environmental impacts and conserve resources.

Paper and cardboard waste constitute a notable fraction of municipal solid waste in Awka, reflecting the prevalence of administrative offices, educational institutions, and commercial establishments in the urban centre. The generation of paper waste underscores the potential for implementing paper recycling initiatives to reduce landfill pressure and promote resource conservation (Okafor et al., 2020). Similarly, glass and metal packaging materials contribute to the waste stream, necessitating appropriate recycling infrastructure to facilitate their recovery and reuse.

In addition to household waste, commercial and institutional sources significantly contribute to waste generation in Awka Metropolis. Markets, restaurants, hotels, and healthcare facilities generate substantial quantities of waste, including food waste, packaging materials, and discarded items. Effective waste management in these sectors requires tailored approaches, such as waste segregation at the source, composting of organic waste, and collaboration with businesses to implement sustainable practices (Onwosi et al., 2018).

The current status of waste generation and composition in Awka Metropolis underscores the importance of holistic waste management strategies that address not only the quantity but also the quality and characteristics of the waste stream. Sustainable waste management initiatives should encompass waste reduction, recycling, composting, and energy recovery, tailored to the specific needs and dynamics of the urban context. Collaboration among government agencies, private sector stakeholders, and the local community is essential for implementing integrated waste management systems that promote environmental sustainability and public health.

3) Existing Waste Management Infrastructure and Practices in Awka Metropolis

Existing waste management infrastructure and practices in Awka Metropolis constitute a critical aspect of urban governance and environmental sustainability. With rapid urbanization and population growth, effective waste management is essential to mitigate environmental pollution, safeguard public health, and promote sustainable development. Research conducted by Onwosi et al. (2018) offers valuable insights into the existing waste management infrastructure in Awka Metropolis. The study highlights the presence of various

components, including waste collection systems, transfer stations, recycling facilities, and disposal sites. Waste collection services are typically provided by municipal authorities or private contractors, employing a combination of manual and mechanized methods to collect waste from households, commercial establishments, and public spaces (Onwosi et al., 2018).

Transfer stations serve as intermediate facilities where collected waste is consolidated before transportation to final disposal sites or recycling facilities. These facilities play a crucial role in optimizing waste transportation logistics and reducing operational costs. However, inadequate transfer station capacity and inefficient waste handling practices can lead to bottlenecks and delays in waste management operations (Onwosi et al., 2018).

Recycling facilities in Awka Metropolis are primarily focused on the recovery of recyclable materials such as plastics, paper, glass, and metals. While efforts to promote recycling have been initiated, the scale and efficiency of recycling operations remain limited due to various challenges, including inadequate infrastructure, low public awareness, and limited market demand for recycled materials (Onwosi et al., 2018).

Disposal sites, including landfills and dumpsites, are the final destination for non-recyclable waste in Awka Metropolis. The management of disposal sites poses significant challenges, including environmental pollution, land degradation, and public health risks. Improper waste disposal practices, such as open dumping and burning, contribute to air and water pollution, contaminating soil and water resources in the surrounding areas (Onwosi et al., 2018).

Despite the presence of waste management infrastructure, several challenges impede the effectiveness of waste management practices in Awka Metropolis. Inadequate funding, limited technical capacity, and institutional weaknesses hamper the implementation of comprehensive waste management programs. Additionally, socio-economic factors, including poverty, informal settlements, and rapid population growth, exacerbate waste management challenges, leading to illegal dumping, littering, and informal waste picking activities (Onwosi et al., 2018).

Community participation and public awareness are crucial elements of effective waste management strategies. However, efforts to engage the public in waste management initiatives face obstacles, including apathy, cultural attitudes, and mistrust of authorities. Enhancing community engagement through education, outreach, and participatory decision-making processes can empower residents to take ownership of waste management issues and contribute to sustainable solutions (Onwosi et al., 2018).

To address the existing challenges and improve waste management practices in Awka Metropolis, a multi-faceted approach is required. This approach should include investments in infrastructure development, capacity building, regulatory enforcement, public education, and community participation. Strengthening institutional coordination and collaboration among government agencies, private sector stakeholders, and civil society organizations is essential for implementing

integrated waste management systems that prioritize environmental sustainability and public health (Onwosi et al., 2018).

4) Promising Strategies and Interventions for Improving Waste Management in Awka Metropolis

One promising strategy for improving waste management in Awka Metropolis is the implementation of integrated solid waste management (ISWM) systems. integrated solid waste management (ISWM) emphasizes a holistic approach that combines various waste management practices, including source reduction, recycling, composting, and energy recovery, to minimize waste generation and maximize resource recovery (Okafor et al., 2020). By integrating multiple waste management techniques, integrated solid waste management (ISWM) systems can optimize resource utilization, reduce environmental impact, and enhance overall efficiency.

Community-based waste management initiatives represent another promising intervention for improving waste management in Awka Metropolis. Engaging local communities in waste management activities, such as waste segregation, composting, and clean-up campaigns, can foster a sense of ownership and responsibility among residents, leading to more sustainable waste practices (Onwosi et al., 2018).

Community participation can also help raise awareness about waste management issues and promote behavioural change, contributing to long-term sustainability goals. Investments in waste infrastructure development and technological innovation are essential for improving waste management in Awka Metropolis. This includes the construction of modern waste treatment facilities, such as material recovery facilities (MRFs), composting plants, and anaerobic digestion facilities, to process and recycle waste more efficiently (Okafor et al., 2020). Technological advancements, such as waste-to-energy systems and smart waste management solutions, can also help optimize waste collection and transportation processes, reduce operational costs, and minimize environmental impact.

Public-private partnerships (PPPs) offer a promising avenue for mobilizing resources and expertise to improve waste management in Awka Metropolis. Collaborations between government agencies, private sector companies, non-profit organizations, and community groups can leverage complementary strengths and resources to implement innovative waste management solutions (Okafor et al., 2020). PPPs can facilitate investments in infrastructure development, technology transfer, capacity building, and public outreach, driving sustainable improvements in waste management practices.

Education and public awareness campaigns play a crucial role in promoting sustainable waste management behaviours and attitudes in Awka Metropolis. By providing information about the environmental, social, and economic benefits of proper waste management practices, educational initiatives can empower residents to take proactive measures to reduce, reuse, and recycle waste (Onwosi et al., 2018, p. 53). Targeted outreach programs, school curriculum integration, and media campaigns can help reach diverse audiences and foster a culture of environmental stewardship and responsibility.

Policy and regulatory interventions are essential for creating an enabling environment for improving waste management in Awka Metropolis. Strong legislative frameworks, enforcement mechanisms, and incentives can encourage compliance with waste management regulations and standards, deter illegal dumping and littering, and promote investments in sustainable waste infrastructure (Okafor et al., 2020, p. 119). Policies such as extended producer responsibility (EPR), waste levies, and landfill bans can also incentivize producers and consumers to adopt more sustainable consumption and production practices.

The improper management of waste in Awka Metropolis poses significant environmental and health risks to its residents. Open dumping of waste pollutes the air, soil, and water, leading to contamination of natural resources and the spread of waterborne diseases (Nwachukwu & Orisakwe, 2019). Moreover, the proliferation of waste dumps serves as breeding grounds for pests and vectors, increasing the incidence of vector-borne diseases such as malaria and dengue fever (Onyido & Ezeah, 2020).

E. Empirical Studies

Awopetu et al. (2013) revealed the public perception of waste minimization strategies in Makurdi, North Central Nigeria. Their study focused on waste reduction, reuse, and recycling, with over 80% of the sampled population expressing support for these strategies as more sustainable approaches to waste management compared to traditional methods. Despite this willingness, the authors identified infrastructure and societal limitations that hindered the actualization of these strategies. Similarly, Olukanni et al. (2018) highlighted constraints such as the cost of establishing material recovery facilities and the need for technical expertise. However, they emphasized that adequate waste characterization was crucial for the successful implementation of waste minimization strategies.

In a separate study, Olanrewaju and Ilemobade (2009) showcased the success of the Ondo State Integrated Waste Recycling and Treatment Project (OSIWRTP) in transforming waste into valuable products using sustainability principles. This approach addressed issues associated with unhygienic and inefficient open dumpsites, contributing to environmental protection and economic development in Ondo State. Conversely, Kofoworola (2007) discussed the informal recycling practices in Lagos State, which, despite their potential benefits, lacked support from government authorities. Only materials like paper, metals, plastics, and glass were recovered due to their high market value.

Similarly, Nzeadibe (2009) highlighted the informal recycling activities in Enugu State, involving scavengers, artisans, and middlemen recovering valuable materials from landfills and illegal dumpsites. Rigasa et al. (2015) recommended integrating marginalized groups like the 'Almajiri' into waste minimization strategies as potential resource recovery agents. Olukanni et al. (2018) underscored the economic benefits of composting biodegradable waste, particularly in South-Western Nigeria, where composting could enhance agricultural production and stimulate economic growth.

Onwurah et al. (2006) further supported the benefits of waste minimization strategies, emphasizing the bioconversion of biodegradable waste into compost and biogas. Their study, conducted in the South-Eastern region of Nigeria, proposed community involvement, industrial collaboration, and Small and Medium-scale Enterprise (SME) engagement to implement integrated environmental technologies effectively. Additionally, Olanrewaju and Ilemobade (2009) identified various recycling activities in Ondo State, including composting, plastic conversion, metal casting, and landfill gas utilization, demonstrating the potential for diverse waste management approaches.

These studies collectively highlight the importance of waste minimization strategies and recycling initiatives in Nigerian cities. Despite challenges such as limited infrastructure, technical expertise, and government support, there is significant potential to transform waste management practices through community engagement, innovative technologies, and sustainable approaches. By addressing these challenges and leveraging local resources and expertise, Nigerian cities can move towards more efficient, environmentally friendly, and economically beneficial waste management systems.

3. Research Methodology

The descriptive survey research design was used for this study. This research design is one in which a group of people or items are studied by collecting and analysing data from only a few people or items considered to be representative of the entire group (Nworgu, 2015). The survey design specify how such data will be collected and analysed.

Study Area: The study is conducted in Awka Nigeria.

Sample Frame: The population of the study consisted of 430,200 of Awka south and North L.G.A of Anambra state.

Sample Size and Sampling Technique: A sample size of 400 was derived from the population of sample using Taro Yamane samples size derivation formular.

In the distribution of the questionnaire, random sampling technique was used to share the questionnaire among respondent without given special preferences to any of the respondent.

Instrument for Data Collection: A structured questionnaire entitled "Waste Generation and Management strategies in Awka Metropolis" was used. The questionnaire was divided into two sections, A & B. Section 'A' seeks personal information about the respondent while Section B reflects on the grading of respondent responses based on the oral interview.

Method of Data Collection: The questionnaire was used to collected data from the respondents and was administered by the researcher with the help of two research assistants. A period of 3days was be used for the data collection.

Method of Data Analysis: Data collected were analysed using 4-point Likert scale rating.

4. Results and Findings

Table 1 presents the current status of waste generation and composition in Awka Metropolis, indicating the mean scores

and remarks for various waste categories. Each value reflects the perceived significance and magnitude of the corresponding waste type in the urban environment.

Table 1
The current status of waste generation and composition in Awka metropolis

Items	Mean	Remark
High Volume of Organic Waste	3.9	Very High
Plastic Pollution	3.7	Very High
Paper and Cardboard Waste	3.8	Very High
Construction and Demolition Debris	3.8	Very High
Electronic Waste (E-waste)	3.7	Very High
Mean of Mean	**3.8**	**Very High**

Starting with "High Volume of Organic Waste", the mean score of 3.9 highlights the considerable presence of organic waste in Awka Metropolis. This waste category includes food scraps, yard trimmings, and agricultural residues, which collectively contribute to environmental pollution and public health concerns. The very high remark underscores the significant role of organic waste in the overall waste composition, necessitating effective management strategies to mitigate its impact.

Similarly, "Plastic Pollution" receives a mean score of 3.7, indicating a substantial presence of plastic waste in the urban landscape. Plastic pollution poses serious environmental threats, including habitat degradation, wildlife entanglement, and microplastic contamination of water bodies. The very high remark emphasizes the urgent need for measures to address plastic pollution through waste reduction, recycling, and proper disposal practices.

The mean score of 3.8 for "Paper and Cardboard Waste" signifies the significant contribution of paper-based materials to the waste stream in Awka Metropolis. Paper and cardboard waste originate from administrative offices, educational institutions, commercial establishments, and households, necessitating efficient recycling and resource recovery initiatives. The very high remark underscores the importance of managing paper and cardboard waste to minimize environmental impact and promote sustainable waste practices.

Similarly, "Construction and Demolition Debris" receives a mean score of 3.8, indicating the substantial volume of waste generated from construction, renovation, and demolition activities. This waste category comprises materials such as concrete, bricks, wood, and metals, which contribute to landfills and environmental degradation if not properly managed. The very high remark highlights the critical role of managing construction and demolition waste to ensure sustainable urban development and infrastructure projects.

Finally, "Electronic Waste (E-waste)" receives a mean score of 3.7, reflecting the significant presence of discarded electronics in Awka Metropolis. E-waste poses environmental and health risks due to hazardous components like lead, mercury, and cadmium, requiring specialized handling and disposal methods. The very high remark underscores the importance of managing e-waste through proper recycling, refurbishment, and disposal practices to prevent environmental contamination and protect public health. The mean of mean score of 3.8 indicates a very high level of waste generation and composition in Awka Metropolis. This comprehensive

assessment underscores the need for integrated waste management approaches that address diverse waste categories and prioritize environmental sustainability and public health.

Table 2 presents an overview of the types and quantities of waste generated in Awka Metropolis, providing mean scores and corresponding remarks for each waste category. Each value reflects the perceived significance and magnitude of the respective waste type in the urban environment. Beginning with "Plastic Waste," the mean score of 4.0 indicates a substantial volume of plastic waste generated in Awka Metropolis. Plastic pollution poses significant environmental and health risks, including habitat destruction, wildlife entanglement, and contamination of water bodies. The very high remark underscores the critical role of addressing plastic waste through waste reduction, recycling, and proper disposal practices to mitigate its adverse impacts on the environment and public health.

Table 2
Types and quantities of waste generated in Awka metropolis

Item	Mean	Remark
Plastics waste	4.0	Very High
Paper and Cardboard waste	4.0	Very High
Construction and Demolition Waste	3.9	Very High
Electronic Waste (E-waste)	3.5	Very High
Mean of Mean	**3.9**	**Very High**

Paper and Cardboard Waste receives a mean score of 4.0, highlighting the significant presence of paper-based materials in the waste stream. Paper and cardboard waste originate from various sources, including administrative offices, educational institutions, commercial establishments, and households. The very high remark emphasizes the importance of managing paper and cardboard waste effectively to minimize environmental degradation and promote sustainable waste practices through recycling and resource recovery initiatives.

Construction and Demolition Waste also receives a high mean score of 3.9, indicating the substantial volume of waste generated from construction, renovation, and demolition activities in Awka Metropolis. This waste category includes materials such as concrete, bricks, wood, and metals, which contribute to landfills and environmental degradation if not properly managed. The very high remark underscores the critical role of managing construction and demolition waste to ensure sustainable urban development and infrastructure projects while minimizing environmental impact.

In contrast, "Electronic Waste (E-waste)" receives a slightly lower mean score of 3.5, indicating a significant but comparatively lower volume of electronic waste in Awka Metropolis. Nonetheless, e-waste poses significant environmental and health risks due to hazardous components like lead, mercury, and cadmium. The very high remark highlights the importance of managing e-waste effectively through specialized handling, recycling, and disposal practices to prevent environmental contamination and protect public health.

Overall, the mean of mean score of 3.9 reflects a very high level of waste generation and composition in Awka Metropolis across various categories. This comprehensive assessment

underscores the urgency of implementing integrated waste management strategies that address diverse waste types while prioritizing environmental sustainability, public health, and resource conservation in the urban environment.

Table 3 provides an analysis of the existing waste management infrastructure and practices in Awka Metropolis, presenting mean scores and corresponding remarks for each item. These values offer insights into the effectiveness and adequacy of waste management systems in the urban area. Waste Collection Services mean score of 3.8 indicates a high level of satisfaction and effectiveness in waste collection efforts within Awka Metropolis. Waste collection services play a crucial role in maintaining cleanliness and hygiene in the city by regularly collecting waste from households, commercial areas, and public spaces. The very high remark highlights the significance of efficient waste collection services in managing waste effectively and preventing environmental pollution.

Table 3
The existing waste management infrastructure and practices in Awka metropolis

Item	Mean	Remark
Waste Collection Services	3.8	Very High
Transfer Stations	1.3	Very Low
Recycling Facilities	1.0	Very Low
Disposal Sites	3.9	Very High
Mean of mean	**2.5**	**Low**

In contrast, "Transfer Stations" and "Recycling Facilities" receive notably low mean scores of 1.3 and 1.0, respectively, indicating significant deficiencies and inadequacies in these aspects of waste management infrastructure. Transfer stations serve as intermediate facilities for consolidating and sorting waste before transportation to final disposal sites or recycling facilities. The very low scores underscore the urgent need for improvements and investments in transfer stations and recycling facilities to enhance waste management practices and promote resource recovery through recycling initiatives.

On the other hand, "Disposal Sites" receive a high mean score of 3.9, reflecting the availability and effectiveness of disposal sites, including landfills and dumpsites, for final waste disposal in Awka Metropolis. Disposal sites play a crucial role in managing non-recyclable waste and minimizing environmental pollution by providing safe and controlled disposal options. The very high remark emphasizes the importance of adequately managing disposal sites to prevent adverse environmental impacts and safeguard public health.

The mean of mean score of 2.5 indicates a relatively low level of effectiveness and adequacy in the existing waste management infrastructure and practices in Awka Metropolis. While waste collection services and disposal sites perform satisfactorily, significant improvements are needed in transfer stations and recycling facilities to enhance waste management efficiency, promote resource recovery, and achieve sustainable waste practices in the urban area. This comprehensive assessment highlights the areas requiring immediate attention and investment to address the challenges and improve waste management systems in Awka Metropolis.

Table 4 outlines the most promising strategies and interventions for improving waste management in Awka Metropolis, providing mean scores and corresponding remarks for each item. Integrated Solid Waste Management (ISWM) Systems, "Community-Based Waste Management Initiatives", and "Investments in Waste Infrastructure and Technology", all receive the highest mean score of 4.0, indicating a unanimous agreement on their effectiveness and importance in enhancing waste management practices. These strategies encompass comprehensive approaches that integrate various waste management techniques, involve community participation, and leverage investments in infrastructure and technology. The very high remarks underscore the critical role of these strategies in promoting sustainable waste management, resource recovery, and environmental protection in Awka Metropolis.

Similarly, "Public-Private Partnerships (PPPs)" receives a high mean score of 3.9, reflecting strong support for collaborative efforts between the public and private sectors in waste management initiatives. "Public-Private Partnerships (PPPs)" facilitate resource mobilization, technology transfer, and capacity building, thereby enhancing the efficiency and effectiveness of waste management programs. The very high remark highlights the importance of fostering partnerships and collaboration to address complex waste management challenges and achieve shared sustainability goals.

In contrast, "Education and Awareness Campaigns" receives a slightly lower mean score of 3.5, indicating a high but slightly less unanimous agreement on its effectiveness in improving waste management practices. Education and awareness campaigns play a crucial role in informing and empowering the public about waste management issues, promoting behavioral change, and fostering a culture of environmental stewardship. The very high remark underscores the significance of educational initiatives in raising awareness, enhancing public participation, and driving positive change in waste management attitudes and practices.

Mean of mean score of 3.2 indicates general agreement on the effectiveness of the identified strategies and interventions for improving waste management in Awka Metropolis. These comprehensive approaches encompassing ISWM systems, community-based initiatives, infrastructure investments, "Public-Private Partnerships (PPPs)" and education campaigns collectively contribute to advancing sustainable waste

Table 4
Most promising strategies and interventions for improving waste management in Awka metropolis

Item	Mean	Remark
Integrated Solid Waste Management (ISWM) Systems	4.0	Very High
Community-Based Waste Management Initiatives	4.0	Very High
Investments in Waste Infrastructure and Technology	4.0	Very High
Public-Private Partnerships (PPPs)	3.9	Very High
Education and Awareness Campaigns	3.5	Very High
Mean of mean	**3.2**	**Agree**

management practices, environmental sustainability, and public health in the urban area. This consensus underscores the importance of adopting integrated, collaborative, and multifaceted approaches to address the complex challenges of waste management in urban environments.

5. Discussion of Finding

The findings provide valuable insights into the current status of waste management in Awka Metropolis and highlight key areas for improvement and intervention. It reveals the prevailing trends in waste generation and composition, indicating a significant presence of organic waste, plastic pollution, paper and cardboard waste, construction and demolition debris, and electronic waste (e-waste). These findings underscore the diverse nature of the waste stream in the urban area and emphasize the need for comprehensive waste management strategies to address various waste categories effectively.

The types and quantities of waste generated in Awka Metropolis are further examined, with high mean scores indicating substantial volumes of plastic waste, paper and cardboard waste, construction and demolition waste, and e-waste. These findings highlight the magnitude of waste generation in the city and underscore the urgency of implementing measures to manage and mitigate the environmental impacts of diverse waste streams.

The existing waste management infrastructure and practices in Awka Metropolis, reveals strengths and weaknesses in waste collection services, transfer stations, recycling facilities, and disposal sites. While waste collection services and disposal sites receive high mean scores, transfer stations and recycling facilities are identified as areas requiring significant improvement and investment. These findings underscore the importance of enhancing waste infrastructure and implementing efficient waste management practices to optimize resource utilization and minimize environmental pollution.

Finally, the most promising strategies and interventions for improving waste management in Awka Metropolis, including integrated solid waste management systems, community-based initiatives, investments in waste infrastructure and technology, public-private partnerships, and education and awareness campaigns. These findings highlight the importance of adopting holistic, collaborative, and proactive approaches to address the complex challenges of waste management effectively.

In conclusion, the findings underscore the importance of adopting integrated, multidisciplinary approaches to waste management in Awka Metropolis. By leveraging the strengths of existing infrastructure, investing in technology and innovation, fostering community engagement, and promoting public awareness, policymakers and stakeholders can work together to develop sustainable solutions that enhance waste management practices, protect the environment, and improve public health and well-being in the urban area.

6. Conclusion and Recommendations

Based on the findings of the study it is recommended that there is a need for improving waste management in Awka Metropolis and the need to enhance infrastructure, including waste collection, recycling, and disposal facilities. Community engagement is vital, with initiatives aimed at raising awareness, encouraging participation, and promoting responsible waste practices among residents. Strengthening public-private partnerships can leverage resources and expertise to implement innovative solutions and improve service delivery. Sustainable consumption and production practices should be promoted to reduce waste generation at the source. Finally, effective regulatory frameworks are crucial for enforcing standards, ensuring compliance, and safeguarding public health and the environment.

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