ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

Assessment of Sustainable Solid Waste Reduction Strategies: A Case Study of Households and Institutions in Maiduguri Metropolis, Nigeria

Umar Jiddum Jidda[1]; Abba Jato Ibrahim[2]; Ishaq Iliyas Ishaq[3]; Aliyu Hassan Muhammad[4]; Ibrahim Umar Asheikh[5]; Ali Muhammad Kole[6]; Abdulsalam Mala Yakubu[7]; Saala Yakubu Saala[8]

Publication Date: 2025/12/15

How to Cite: Umar Jiddum Jidda; Abba Jato Ibrahim; Ishaq Iliyas Ishaq; Aliyu Hassan Muhammad; Ibrahim Umar Asheikh; Ali Muhammad Kole; Abdulsalam Mala Yakubu; Saala Yakubu Saala (2025) Assessment of Sustainable Solid Waste Reduction Strategies: A Case Study of Households and Institutions in Maiduguri Metropolis, Nigeria. *International Journal of Innovative Science and Research Technology*, 10(12), 622-645. https://doi.org/10.38124/ijisrt/25dec052

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

ABSTRACT

Rapid population growth and urbanization have intensified the challenge of municipal solid waste management in Maiduguri Metropolis. Inefficient disposal practices have created environmental hazards, threatened public health, and strained institutional resources. This study assessed sustainable solid waste reduction strategies among households and selected institutions in Maiduguri with the aim of identifying practical measures to minimize waste generation and improve management efficiency. A descriptive survey design was employed. Data were collected through structured questionnaires and interviews administered to randomly selected households and institutional stakeholders across the metropolis. The study examined patterns of waste generation, existing disposal methods, public awareness, and the adoption of waste-reduction techniques such as source segregation, composting, reuse, and recycling. Descriptive statistics and simple inferential analyses were used to summarize responses and to explore relationships between socio-economic factors and waste-management practices. The findings revealed that household and institutional wastes were dominated by organic and plastic materials, while formal recycling and composting were limited. Although awareness of sustainable practices was moderate, implementation was hindered by inadequate infrastructure, inconsistent policy enforcement, and insufficient public sensitization.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

TABLE OF CONTENTS

CONTENTS

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

CHAPTER ONE
INTRODUCTION

According to the World Bank (2023), the management of municipal solid waste is one of the most pressing environmental challenges globally, with the world generating over 2.24 billion tonnes of waste each year. In many developing countries, particularly across Sub-Saharan Africa, inadequate collection systems, weak institutional capacity, and poor public awareness continue to exacerbate environmental and public health problems (Ferronato & Torretta, 2019).

In Nigeria, improper disposal of solid waste through open dumping, burning, and irregular collection continues to threaten environmental sustainability and the quality of urban life (Adegoke & Adeyemi, 2021). Maiduguri Metropolis, the capital of Borno State, faces similar challenges due to rapid population growth, insufficient waste management infrastructure, and weak policy enforcement.

To address these issues, sustainable solid waste reduction strategies such as recycling, reuse, composting, and public sensitization have been identified as effective measures (World Bank, 2022). However, limited infrastructure, low community participation, and poor government support have hindered their success in Maiduguri.

This study aims to assess the level of awareness, attitudes, and practices of households and institutions toward sustainable solid waste reduction strategies in Maiduguri metropolis. The findings are expected to provide insight for policymakers, environmental agencies, and local authorities to improve waste management and promote a cleaner, healthier environment.

➢ *Background to the Study*

Rapid urbanization and population growth have created unprecedented challenges for solid waste management (SWM) in Nigerian cities. Over the past two decades, Nigeria's population has grown from 122 million in 2000 to more than 220 million in 2024 (World Bank, 2024), with the urban share rising above 52%. This rapid growth, coupled with changing consumption patterns, has significantly increased the volume and complexity of solid waste generated daily across urban centers. Recent research estimates that Nigerian cities collectively produce over 32 million tons of solid waste annually, but less than 30% is properly collected and disposed of (Ukala, 2020; Abubakar et al., 2022).

In Maiduguri Metropolis, the situation has become more complex due to the combined effects of rapid population influx, urban displacement, and infrastructural strain caused by prolonged insecurity in the Northeast. According to Ibrahim (2023), the city's population has grown beyond the designed waste-handling capacity of the Borno State Environmental Protection Agency (BOSEPA). Most neighborhoods lack consistent waste collection services, leading to indiscriminate dumping along roadsides, water channels, and open plots. The consequence is widespread environmental degradation, health hazards, and flooding during the rainy season (Nzediegwu & Chang, 2020).

Solid waste in Maiduguri primarily consists of organic materials (45–60%), plastics (15–20%), paper (10%), and other mixed recyclables (Shitu, 2023). Similar waste composition patterns are reported in other Nigerian cities such as Lagos, Kano, and Port Harcourt, where rapid urbanization has also overwhelmed municipal waste infrastructure (Ferronato & Torretta, 2023; Etim, 2024). However, while larger cities benefit from relatively stronger private-sector participation, smaller urban centers like Maiduguri remain dependent on underfunded municipal systems (Onungwe et al., 2023).

The global movement toward sustainable solid waste reduction emphasizes the 3Rs (Reduce, Reuse, Recycle) within the broader circular economy framework. In Nigeria, the 2020 National Policy on Solid Waste Management and the 2021 Circular Economy Roadmap aim to reduce landfill dependency and promote resource recovery. Yet, implementation remains inconsistent due to financial, institutional, and behavioral barriers (Eneh, 2025; Zhang, 2024). The experience of Maiduguri demonstrates how urban governance gaps hinder the realization of these policy goals at the subnational level.

Thus, understanding and improving solid waste reduction strategies in Maiduguri requires assessing both household behaviors and institutional management practices, alongside the structural constraints—policy, financial, and technical—that shape outcomes. This study therefore aims to provide evidence-based insights into sustainable waste management strategies suitable for the unique socio-economic and infrastructural context of Maiduguri Metropolis.

➢ *Statement of the Problem*

Solid waste management in Maiduguri Metropolis presents a persistent environmental and governance challenge. Despite the existence of BOSEPA, the city lacks efficient waste collection, disposal, and recycling infrastructure. The agency reportedly collects less than 40% of the total daily waste generated, with the remainder ending up in open dumps or drains (Ibrahim, 2023). This inefficiency contributes to flooding, disease outbreaks, air pollution, and visual blight. The uncontrolled burning of waste also exacerbates greenhouse gas emissions, undermining Nigeria's climate mitigation commitments (Abubakar et al., 2022).

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

While previous studies have examined solid waste in Lagos, Abuja, and Kano, empirical research focusing on Maiduguri's household and institutional waste management practices is limited, particularly in the context of sustainable reduction strategies (Shitu, 2023). Moreover, there is insufficient integration of community-level practices with institutional frameworks. Unlike Lagos, where private contractors operate under public-private partnerships (PPP), Maiduguri relies heavily on manual, unsystematic waste collection and informal dumping. This research addresses these gaps by assessing current practices and proposing practical, sustainable waste reduction strategies tailored to Maiduguri's context.

➢ *Objectives of the Study General Objective*

To assess sustainable solid waste reduction strategies applicable to households and institutions in Maiduguri Metropolis.

- *Specific Objectives*

✓ To analyze the quantity, composition, and management patterns of solid waste generated by households and institutions in Maiduguri.
✓ To examine current waste handling practices and public attitudes toward waste reduction.
✓ To identify institutional, financial, and policy barriers affecting sustainable waste management.
✓ To propose feasible, locally appropriate strategies for sustainable solid waste reduction and resource recovery.

➢ *Research Questions*

- What is the current level of waste generation and composition in Maiduguri households and institutions?
- How do residents and institutional actors manage and dispose of solid waste?
- What are the main barriers preventing effective waste reduction in Maiduguri?
- Which strategies could enhance waste reduction, recycling, and environmental sustainability in the metropolis?

➢ *Significance of the Study*

This study provides a timely contribution to urban environmental management literature in Nigeria by focusing on a city often neglected in national policy research. The results will be valuable for policymakers, municipal agencies, and donor organizations seeking to design sustainable, community-based waste management models for secondary cities. It will also help align Maiduguri's waste management practices with Nigeria's National Policy on Solid Waste Management (2020) and Sustainable Development Goal (SDG) 11 on sustainable cities and communities. Furthermore, by comparing findings with cities like Lagos and Kano, the study provides insights into how localized solutions can complement national frameworks (Etim, 2024; Zhang, 2024).

➢ *Scope and Delimitation*

The research covers selected wards within Maiduguri Metropolis, focusing on households and institutions such as schools, hospitals, and markets. It examines the generation, segregation, disposal, and reduction practices of solid waste. The study does not cover industrial or construction waste due to data limitations. The time frame for field data collection spans six months (January–June 2025), allowing for seasonal variation analysis.

Comparative references to Lagos, Abuja, and Kano are used only for contextual analysis.

➢ *Definition of Key Terms*

- Solid Waste: Unwanted or discarded materials from households, institutions, and commercial activities that require collection and disposal.
- Waste Reduction: Strategies aimed at minimizing waste generation through changes in design, production, consumption, and reuse.
- Recycling: The process of converting waste materials into new usable products.
- Composting: Biological decomposition of organic waste to produce nutrient-rich soil conditioner.
- Public-Private Partnership (PPP): Cooperative arrangements between government and private sector entities to deliver waste management services.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

CHAPTER TWO
LITERATURE REVIEW

- *Conceptual Framework and Definitions*

Solid waste management (SWM) refers to the collection, transportation, processing, recycling, and final disposal of waste materials generated by human activity in ways that are environmentally sound, economically viable, and socially acceptable (Abubakar et al., 2022). Sustainable waste management emphasizes not only safe disposal but also waste minimization, reuse, recycling, energy recovery, and community participation (Ferronato & Torretta, 2023).

Waste can be categorized as municipal solid waste (MSW), industrial waste, hazardous waste, or agricultural waste, depending on its origin. The present study focuses on municipal solid waste, which includes residential, institutional, and commercial waste in Maiduguri Metropolis.

The conceptual framework guiding this study is based on the 3Rs Model (Reduce, Reuse, Recycle) within a Circular Economy perspective. The 3Rs hierarchy is complemented by environmental governance and behavioral change theories, which emphasize that effective waste reduction requires institutional policy frameworks, private-sector involvement, and public participation (Zhang, 2024).

Figure 2.1 (Conceptual Model) would later summarize the interrelationships between *household behavior*, *institutional support*, and *policy enforcement* as key determinants of sustainable solid waste reduction.

- *Global Overview of Solid Waste Management*

Globally, the management of municipal solid waste has evolved from mere disposal to integrated waste management (IWM), which prioritizes resource efficiency and environmental protection. According to the World Bank (2023), the world generates over 2.24 billion tonnes of solid waste annually, and this figure is projected to increase by 70% by 2050 if no significant reforms occur.

High-income countries recycle and recover up to 50–60% of their municipal waste, while most developing countries—including Nigeria—recycle less than 10% (Ferronato & Torretta, 2023). The main challenge in the Global South remains inefficient collection, weak institutional structures, limited funding, and low public awareness.

In many African countries, including Ghana, Kenya, and Tanzania, community-based waste collection systems and micro-enterprise partnerships have shown potential in bridging municipal capacity gaps (Abila & Kantola, 2022). Similarly, Ethiopia's Addis Ababa and Rwanda's Kigali have adopted zero-waste city initiatives, integrating community cooperatives and recycling entrepreneurs into formal waste systems.

The global discourse increasingly focuses on circular economy principles, where waste is treated as a valuable resource. Recent studies emphasize technological innovations such as waste-to- energy (WTE) plants, plastic-to-fuel conversion, and composting of organic materials as practical routes toward sustainable waste management (Etim, 2024).

However, global evidence shows that technological interventions alone are insufficient. Success depends on good governance, citizen participation, and consistent policy enforcement. The implication for Nigeria—and specifically Maiduguri—is that replicating best practices requires adapting them to local socio-economic and infrastructural contexts rather than copying foreign model's wholesale.

- *Solid Waste Management in Nigeria*

Solid waste management in Nigeria reflects a mix of modern and traditional approaches, with wide disparities between states. The Federal Ministry of Environment (FME) provides policy guidance, while local governments and agencies like BOSEPA (Borno State Environmental Protection Agency) handle operations. Yet, inadequate funding, poor data systems, and weak enforcement hinder effective service delivery (Onungwe et al., 2023).

The average waste generation rate in Nigerian cities is estimated between 0.44–0.66 kg/person/day, depending on income level and consumption pattern (Ukala, 2020). Lagos, Abuja, and Port Harcourt have relatively structured waste collection systems managed by public-private partnerships (PPPs), such as LAWMA (Lagos Waste Management Authority). In contrast, northern cities like Maiduguri, Kano, and Sokoto rely mostly on manual, unorganized collection, with open dumping as the dominant disposal method (Ibrahim, 2023).

Research by Abubakar et al. (2022) indicates that most Nigerian municipalities spend over 60% of their waste management budgets on collection alone, leaving limited resources for treatment or recycling infrastructure. Consequently, dumpsites—rather than engineered sanitary landfills— remain the primary disposal facilities. Open burning is still common, releasing greenhouse gases and toxic emissions (Nzediegwu & Chang, 2020).

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

Another major challenge is institutional overlap. Waste management functions are fragmented between federal, state, and local authorities, leading to duplication of roles and poor coordination (Onungwe et al., 2023). For example, while the National Environmental Standards and Regulations Enforcement Agency (NESREA) set environmental standards, enforcement at the municipal level remains inconsistent.

Public participation in Nigeria's waste management remains low. A 2023 study by Shitu found that only 25% of Maiduguri households regularly dispose of waste through authorized collection services, while over 60% engage in informal dumping or open burning. Factors influencing behavior include income level, education, and accessibility of collection points. Similar patterns are observed in Kano and Enugu, underscoring the need for public awareness campaigns and incentives for sustainable waste practices (Ferronato & Torretta, 2023).

- *Waste Composition, Generation, and Characterization in Maiduguri*

Maiduguri's waste profile reflects the consumption patterns of a medium-sized, rapidly urbanizing city with both traditional and modern influences. Household waste consists largely of organic matter (45–60%), followed by plastics (15–20%), paper (10–12%), metal/glass (8%), and textiles (5%) (Shitu, 2023). Institutional waste from hospitals and schools includes paper, food residues, and minor quantities of hazardous materials.

Waste generation is strongly correlated with socio-economic class. High-income areas produce more packaging waste (plastics, paper), while low-income communities produce more organic matter due to reliance on fresh produce markets (Ibrahim, 2023). Seasonal variation also influences waste generation, with peaks during festive seasons and market days.

Collection efficiency in Maiduguri is estimated below 40%, compared to 60–70% in Lagos and Abuja (Etim, 2024). The limited number of functional trucks, poor road networks in peri-urban zones, and lack of transfer stations constrain BOSEPA's operations. Informal waste collectors ("yan bola") play a crucial but unregulated role in scavenging recyclables such as plastics, metals, and bottles for resale.

Despite the challenges, Maiduguri exhibits opportunities for improvement. Studies have shown that community-based waste schemes and school-based environmental clubs can significantly enhance segregation and recycling (Eneh, 2025). However, these initiatives require technical support, continuous public education, and integration with the city's formal waste management framework.

- *Institutional and Policy Framework for Waste Reduction in Nigeria*

Effective solid waste reduction depends on sound institutional and policy structures. In Nigeria, the Federal Ministry of Environment (FME) serves as the apex body responsible for environmental policy development, while implementation is decentralized to state and local governments. The National Environmental Standards and Regulations Enforcement Agency (NESREA), established in 2007, ensures compliance with environmental laws, including solid waste management guidelines (Onungwe et al., 2023).

The National Policy on Solid Waste Management (NPSWM), revised in 2020, emphasizes the waste hierarchy—prevention, reduction, reuse, recycling, recovery, and disposal. It seeks to reduce waste generation at source, strengthen recycling markets, and integrate informal waste collectors into formal systems (Etim, 2024). Complementing this, the National Circular Economy Roadmap (2021) promotes the reuse of materials and encourages investment in waste- to-energy technologies.

At the subnational level, states like Lagos, Ogun, and Abuja (FCT) have established semi- autonomous waste management agencies with private-sector partnerships. The Lagos Waste Management Authority (LAWMA), for example, operates a multi-tier system involving franchises, waste-to-energy projects, and recycling hubs (Ferronato & Torretta, 2023). In contrast, Maiduguri's BOSEPA still relies primarily on government subventions, manual collection, and limited community partnerships (Ibrahim, 2023).

Weak institutional capacity and poor enforcement remain recurring issues across northern cities. According to Shitu (2023), Maiduguri's waste management suffers from overlapping responsibilities between the local councils and BOSEPA, lack of modern equipment, and low morale among sanitation workers. Inadequate budgetary allocations and irregular payment of waste contractors further exacerbate inefficiency.

Nevertheless, opportunities exist through public-private partnerships (PPPs) and community- based initiatives. For instance, the "Keep Kano Clean" project (2022) demonstrated that local government collaboration with private recyclers and community associations significantly improved collection rates and public participation. Maiduguri can adapt similar models, supported by local incentives and donor funding.

- *Sustainable Waste Reduction Approaches*

Sustainable waste reduction involves systematic interventions aimed at minimizing waste generation, promoting resource recovery, and preventing environmental degradation. According to Ferronato and Torretta (2023), such approaches must integrate

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

technical, behavioral, and governance dimensions.

- *The 3Rs Principle (Reduce, Reuse, Recycle)*

The 3Rs principle forms the cornerstone of modern solid waste reduction strategies. "Reduction" focuses on minimizing waste at the point of generation through changes in consumer behavior, packaging design, and product life cycles. "Reuse" promotes extending product utility, while "Recycling" involves reprocessing materials into new products (Etim, 2024).

In Maiduguri, household-level reduction can be achieved through public awareness and incentives for waste separation. Reuse practices, such as using old containers and shopping bags, are already common among low-income households but need scaling up. Recycling is largely informal— driven by scavengers collecting plastics, metals, and bottles for resale. Formalizing this sector through training and cooperatives can significantly enhance resource recovery (Eneh, 2025).

- *Composting of Organic Waste*

Given the high organic content (45–60%) in Maiduguri's waste stream, composting presents a practical, low-cost reduction strategy. Studies by Dickson et al. (2023) and Abubakar et al. (2022) show that decentralized composting at community and institutional levels reduces landfill load and provides compost for urban agriculture. The climatic conditions of Maiduguri—warm and semi- arid—are favorable for rapid biodegradation.

- *Waste-to-Energy (WTE) Conversion*

Emerging waste-to-energy technologies convert municipal waste into electricity or heat. While capital-intensive, WTE offers long-term environmental benefits by reducing open dumping and methane emissions. Lagos and Abuja have pilot projects, but such technologies are currently unfeasible for Maiduguri due to infrastructural constraints (Ferronato & Torretta, 2023). Instead, small-scale biogas digesters for organic waste could serve institutional kitchens and markets (Zhang, 2024).

- *Extended Producer Responsibility (EPR)*

The EPR approach shifts the financial and physical responsibility for waste management from municipalities to manufacturers and distributors. Nigeria adopted an EPR policy for electronics, plastics, and packaging materials in 2021. However, enforcement remains weak outside major cities (Onungwe et al., 2023). Strengthening EPR in Borno State could help reduce plastic pollution by engaging beverage companies and packaging industries.

- *Public-Private Partnerships and Community Participation*

Sustainable waste reduction cannot rely solely on government institutions. Studies across Nigeria reveal that public-private partnerships (PPPs) improve efficiency, accountability, and innovation (Etim, 2024). Community-based organizations also play a key role in awareness campaigns and segregation efforts. Integrating such stakeholders into Maiduguri's waste management structure could improve sustainability and reduce government burden.

➢ *Empirical Review*

Recent empirical studies across Nigeria and beyond provide valuable insights into the dynamics of waste generation, reduction, and institutional management:

- Shitu (2023) analyzed household waste practices in Maiduguri and found that income, education, and accessibility significantly influence waste disposal behavior. Households with tertiary education were 40% more likely to engage in segregation than those without formal education.
- Ibrahim (2023) examined institutional waste in Maiduguri, noting that schools and hospitals generate between 0.6–0.8 kg/person/day of waste, dominated by paper and organic matter. Lack of collection bins and irregular municipal service were key barriers.
- Etim (2024) investigated Lagos's PPP model and reported that privatization increased collection efficiency by 28% between 2019 and 2023. The study recommended replicating contractual models in other cities with modifications for local context.
- Abubakar et al. (2022) compared Abuja and Kano, identifying funding gaps and insufficient landfill engineering as the main environmental risks. The study advocated decentralization of waste governance and community monitoring.
- Eneh (2025) studied recycling entrepreneurship in Enugu and highlighted that small-scale recyclers recover up to 25% of plastics and metals. Government support through microcredit improved business sustainability.
- Ferronato and Torretta (2023) reviewed circular economy transitions in low-income cities and concluded that informal sector integration and education are the most cost- effective waste reduction strategies.

Collectively, these studies confirm that socio-economic factors, institutional capacity, and policy enforcement remain key determinants of sustainable waste management outcomes across Nigerian cities.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

➢ *Gaps in the Literature*

While substantial progress has been made in studying urban waste management in Nigeria, several knowledge gaps persist:

- Limited focus on secondary cities: Most research centers on Lagos, Abuja, and Port Harcourt, with few empirical analyses of Maiduguri's unique socio-political context (Shitu, 2023).
- Insufficient integration of institutional and household data: Few studies examine both household and institutional waste together, resulting in fragmented policy recommendations.
- Weak longitudinal data: There is a lack of time-series studies assessing seasonal variation and the impact of population displacement on waste patterns in Maiduguri.
- Limited policy evaluation: Research often stops at diagnosis without evaluating the performance of existing interventions like PPPs and EPR programs.
- Behavioral studies gap: Few14 researchers have explored the behavioral and cultural dimensions influencing household participation in waste segregation and composting.

Addressing these gaps will enhance evidence-based policymaking and enable the design of scalable waste reduction models suited for urban centers like Maiduguri.

➢ *Summary of Reviewed Literature*

This chapter reviewed global and Nigerian perspectives on solid waste management, emphasizing the relevance of the 3Rs principle and the circular economy framework. Studies consistently highlight that Nigeria's waste sector is constrained by institutional weakness, inadequate funding, and public apathy. However, lessons from Lagos and Kano demonstrate that strategic reforms— especially PPPs, EPR enforcement, and awareness campaigns—can yield significant results.

For Maiduguri, the literature underscores the urgent need for integrated approaches combining technical solutions (segregation, composting), behavioral change (community participation), and institutional support (BOSEPA reform). The identified gaps justify the empirical research conducted in this study to assess household and institutional waste reduction strategies in Maiduguri Metropolis.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

CHAPTER THREE
RESEARCH METHODOLOGY

➢ *Introduction*

This chapter presents the methods and procedures employed in conducting the research titled *"Assessment of Sustainable Solid Waste Reduction Strategies: A Case Study of Households and Institutions in Maiduguri Metropolis, Nigeria."* It explains the research design, population, sampling techniques, instrument of data collection, methods of data analysis, and ethical considerations. The methodology provides the framework through which reliable data were collected and analyzed to address the study objectives.

➢ *Research Design*

The study adopted a descriptive survey research design. This design was chosen because it enables the researcher to collect and analyze data that reflect the opinions, attitudes, and behaviors of respondents regarding waste management practices in the study area. The descriptive survey design is particularly suitable for studies aimed at describing existing conditions without manipulating variables. It allows for the systematic collection of quantitative data from both households and institutions to assess sustainable solid waste reduction strategies in Maiduguri Metropolis.

➢ *Area of the Study*

The study was conducted in Maiduguri Metropolis, the capital city of Borno State, Nigeria. Maiduguri is located in the northeastern region of the country and serves as the administrative and commercial hub of Borno State. The metropolis is made up of several densely populated areas such as Bulumkutu, Gwange, Bolori, and London Ciki, among others. The choice of Maiduguri as the study area was influenced by the rapid urbanization, increasing population, and the growing challenge of waste generation and management within the city. The area is home to various public and private institutions, residential settlements, and markets that contribute to the volume of solid waste generated daily. This makes Maiduguri a suitable case for assessing sustainable solid waste reduction strategies among households and institutions.

➢ *Population of the Study*

The target population of the study consisted of households and institutional workers (both public and private) within Maiduguri Metropolis. These include residents, administrative staff of schools, hospitals, and government ministries, as well as business owners and community representatives. The population was considered appropriate because both households and institutions play vital roles in waste generation, handling, and management processes.

➢ *Sample Size and Sampling Technique*

A total of 50 respondents were selected from both households and institutions across Maiduguri Metropolis. The study employed a stratified random sampling technique, dividing the population into two strata — households and institutions. From each stratum, simple random sampling was used to select participants. This method ensured that the responses obtained reflected the perspectives of both individual residents and institutional representatives.

The sample was considered adequate to provide reliable and valid information for analysis, given the descriptive nature of the research and the manageable population size of the study area.

➢ *Instrument for Data Collection*

The main instrument for data collection was a structured questionnaire titled *"Survey Questionnaire on Sustainable Solid Waste Reduction Strategies."* The questionnaire was divided into five sections:

- Section A: Demographic characteristics of respondents (e.g., gender, age, occupation, education level).
- Section B: Household waste generation and disposal practices.
- Section C: Institutional waste management policies and practices.
- Section D: Awareness and attitude towards sustainable waste management.
- Section E: Challenges and suggested solutions to effective waste reduction.

The questionnaire was designed with both closed-ended and open-ended questions to enable respondents to provide quantitative data and qualitative insights. The instrument was developed after a thorough review of literature and was validated by experts in environmental management and research methodology.

➢ *Method of Data Collection*

The researcher personally administered the questionnaires with the assistance of trained field workers. This approach ensured maximum response and allowed clarification of any questions raised by respondents. The questionnaires were distributed to selected households and institutional offices within Maiduguri Metropolis. Respondents were given adequate time to complete the forms, after which they were collected and sorted for analysis. The data collection process lasted for approximately two weeks.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

- *Method of Data Analysis*

Data collected were coded and analyzed using descriptive statistical tools such as frequency counts, percentages, and tables. This enabled the researcher to summarize and interpret the responses in a clear and meaningful manner. The results were presented in tables under Chapter Four, where each item was discussed in relation to the research objectives and reviewed literature. The analysis helped in identifying trends, comparing household and institutional practices, and drawing conclusions on sustainable waste reduction strategies.

- *Validity and Reliability of the Instrument*

The instrument was subjected to both content and face validity by two experts in environmental studies and research methodology from the University of Maiduguri. Their feedback was used to refine and improve the questionnaire for clarity and relevance. To ensure reliability, a pilot test was conducted using 10 respondents outside the main study area. The responses were analyzed using the test-retest method, yielding a reliability coefficient of 0.82, which indicated that the instrument was consistent and dependable for data collection.

- *Ethical Considerations*

Ethical standards were observed throughout the research process. Respondents were assured of confidentiality, and participation was entirely voluntary. They were informed about the purpose of the research and were free to withdraw at any stage without penalty. The researcher ensured that no part of the study caused harm, discomfort, or exposure of personal information. All collected data were used solely for academic purposes.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

CHAPTER FOUR
DATA PRESENTATION, ANALYSIS AND DISCUSSION

➢ *Introduction*

This chapter presents the analysis and interpretation of data collected through the structured questionnaire administered to households and institutions within Maiduguri Metropolis. The results are presented in tables showing frequencies and percentages, followed by descriptive explanations. The analysis focuses on the demographic characteristics of respondents, household and institutional waste management practices, awareness, and the challenges associated with solid waste reduction strategies. A total of 50 valid responses were analyzed, comprising both individual household respondents and institutional representatives.

➢ *Demographic Characteristics of Respondents*

Understanding the demographic features of respondents provides insight into the background and diversity of participants in the study. Table 1–5 present details such as gender, age, educational level, occupation, and marital status.

Table 1 Gender Distribution of Respondents

Gender	Frequency	Percentage (%)
Male	32	64
Female	18	36
Total	**50**	**100**

Source: Field Survey, 2025

Table 1 shows that 64% of respondents were male while 36% were female. This implies that more men participated in the study, possibly due to higher male representation in both institutional employment and community leadership within Maiduguri.

Table 2 Age Distribution of Respondents

Age Group	Frequency	Percentage (%)
18–25 years	10	20
26–35 years	18	36
36–45 years	14	28
46 years and above	8	16
Total	**50**	**100**

Most respondents (36%) fall within the age group of 26–35 years, indicating that the participants are predominantly young adults who are active and knowledgeable about waste management practices in their homes and workplaces.

Table 3 Educational Qualification of Respondents

Qualification	Frequency	Percentage (%)
Primary Education	6	12
Secondary Education	12	24
Diploma/NCE	14	28
Bachelor's Degree	12	24
Postgraduate	6	12
Total	**50**	**100**

Table 3 reveals that the majority of respondents (28%) hold Diploma/NCE qualifications, while 24% possess either secondary or bachelor's education. This suggests that most respondents are educated enough to understand the environmental and health implications of poor waste management.

Table 4 Occupation of Respondents

Occupation	Frequency	Percentage (%)
Civil Servant	16	32
Trader/Businessperson	10	20
Student	8	16
Artisan	8	16
Unemployed	8	16
Total	**50**	**100**

The table shows that 32% of the respondents are civil servants, followed by traders (20%) and students (16%). This distribution supports the inclusion of both household and institutional views in the study since public servants often represent institutional

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

settings.

Table 5 Marital Status of Respondents

Marital Status	Frequency	Percentage (%)
Single	14	28
Married	30	60
Divorced/Widowed	6	12
Total	**50**	**100**

The majority of respondents (60%) are married, implying they are likely responsible for household management and solid waste disposal decisions.

Table 6 Major Type of Waste Generated

Type of Waste	Frequency	Percentage (%)
Food Waste	18	36
Plastic Waste	12	24
Paper/Cardboard	8	16
Metal/Glass	6	12
Others	6	12
Total	**50**	**100**

Food and plastic waste are the most common types of waste generated in Maiduguri households, representing 36% and 24% respectively. This reflects the consumption pattern of residents and points to the need for composting and recycling initiatives.

Table 7 Method of Waste Disposal Used by Households

Disposal Method	Frequency	Percentage (%)
Open Dumping	22	44
Burning	10	20
Door-to-Door Collection	8	16
Burying	6	12
Recycling	4	8
Total	**50**	**100**

Table 7 indicates that 44% of respondents practice open dumping, while only 8% engage in recycling. This suggests that unregulated waste disposal remains prevalent, posing environmental and health risks in Maiduguri.

Table 8 Awareness of Waste Segregation Practices

Response	Frequency	Percentage (%)
Aware	28	56
Not Aware	22	44
Total	**50**	**100**

The findings show that 56% of respondents are aware of waste segregation practices, although actual implementation remains low. This highlights a gap between awareness and practical adoption of sustainable waste management methods.

Table 9 Existence of Waste Management Policy

Response	Frequency	Percentage (%)
Yes	22	44
No	6	12
Don’t Know	18	36
No Response	4	8
Total	**50**	**100**

Only 44% of institutions confirmed having a waste management policy, while 36% were uncertain. This implies weak policy implementation and poor institutional coordination on waste management within Maiduguri Metropolis.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

Table 10 Frequency of Waste Collection in Institutions

Frequency	Frequency	Percentage (%)
Daily	12	24
Weekly	20	40
Occasionally	14	28
Not Collected	4	8
Total	**50**	**100**

The result reveals that 40% of institutional respondents indicated weekly waste collection, while 28% said it occurs occasionally. This irregular collection schedule contributes to environmental pollution around institutional premises.

Table 11 Institutional Challenges in Managing Solid Waste

Challenge	Frequency	Percentage (%)
Inadequate Funding	12	24
Lack of Trained Personnel	10	20
Poor Infrastructure	8	16
Low Awareness	12	24
Irregular Waste Collection	8	16
Total	**50**	**100**

The findings identify inadequate funding and low awareness (each 24%) as the leading institutional challenges. These problems hinder effective waste management and sustainability in Maiduguri Metropolis

- *Discussion of Findings*

The findings of this study clearly reveal the multidimensional nature of solid waste management challenges in Maiduguri Metropolis. Both households and institutions contribute to the quantity and type of waste generated, and their practices significantly affect the city's environmental sustainability.

The dominance of food and plastic waste confirms earlier studies by Gbadebo and Ojo (2022) and Shitu (2023), who reported similar patterns in northern Nigerian cities. The predominance of organic waste suggests opportunities for composting programs that could reduce landfill pressure and promote urban agriculture. Meanwhile, the high percentage of plastic waste highlights the growing threat of non-biodegradable materials, calling for stronger recycling initiatives and enforcement of Nigeria's ban on single-use plastics (Reuters, 2024).

The method of waste disposal remains a major environmental concern. Most households still engage in open dumping (44%) and burning (20%), consistent with Ogwueleka (2009) and Donuma et al. (2024), who identified these practices as leading causes of air pollution and drainage blockage. This indicates that public awareness and infrastructure for door-to-door collection are insufficient. Sustainable alternatives such as community waste bins, regulated collection points, and recycling depots should therefore be prioritized.

Institutional findings also demonstrate weak implementation of environmental policies. Although 44% of institutions acknowledged the existence of waste management policies, enforcement is poor due to inadequate funds, low technical capacity, and irregular waste collection schedules. This situation corroborates Adewole (2009) and Omokaro & Nwachukwu (2025), who found that many Nigerian organizations have environmental guidelines that remain largely inactive due to poor governance and lack of follow-up.

Furthermore, the results reveal a mismatch between awareness and practice—56% of respondents are aware of segregation, but only a fraction apply it. This aligns with behavioral studies such as Eneh (2025), which show that awareness alone does not translate into sustainable action unless accompanied by motivation, enforcement, and incentives.

Overall, the study demonstrates that sustainable solid waste management in Maiduguri requires a holistic approach integrating policy reform, public participation, education, and technological innovation. Public-private partnerships (PPPs), as practiced in Lagos (Etim, 2024), could be adapted to Maiduguri to improve efficiency and accountability.

The implications of these findings are far-reaching. Without immediate action, open dumping and burning will continue to degrade air quality, block drainage systems, and expose communities to disease outbreaks. However, if the city invests in decentralized composting, recycling cooperatives, and continuous environmental education, it can gradually transition toward a circular economy model where waste becomes a resource rather than a nuisance.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

- *In General, the Study Confirms that Sustainable Waste Reduction in Maiduguri Requires:*

✓ Improved institutional capacity and funding,
✓ Community participation,
✓ Strong public awareness campaigns, and
✓ The establishment of recycling programs.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter provides a summary of the key findings of the study, conclusions drawn from the research, and recommendations for future and practical or policy interventions.

➢ *Summary of Findings*

The study titled *"Assessment of Sustainable Solid Waste Reduction Strategies: A Case Study of Households and Institutions in Maiduguri Metropolis, Nigeria"* was designed to evaluate how solid waste is managed in Maiduguri and to identify strategies that can improve sustainability. Data were obtained from 50 respondents using a structured questionnaire. Based on the analysis in Chapter Four, the following key findings were made:

- *Demographic Composition:*

The respondents were predominantly male (64%), and most were young adults between 26–35 years of age. The majority of participants had at least secondary education, indicating an appreciable level of literacy that can support environmental awareness and responsible waste management.

- *Household Waste Characteristics:*

The major types of waste generated in households were food waste (36%) and plastic waste (24%), indicating that biodegradable and non-biodegradable materials constitute the largest portions of domestic refuse in Maiduguri.

- *Waste Disposal Methods:*

The most common disposal practice among households was open dumping (44%), followed by burning (20%). Only 8% of respondents engaged in recycling. This shows that improper waste disposal remains a dominant practice in Maiduguri, which contributes to environmental degradation and health hazards.

- *Awareness and Attitude:*

Although 56% of respondents were aware of waste segregation and sustainable waste practices, only a small portion of them practiced it consistently. This demonstrates a gap between awareness and practical implementation of sustainable waste reduction.

- *Institutional Waste Management:*

About 44% of institutional respondents indicated that their organizations had formal waste management policies, while 36% were unaware of any. Waste collection is irregular, with 40% reporting weekly collections and 28% saying it happens only occasionally.

- *Challenges to Sustainable Waste Management:*

The major challenges identified include inadequate funding (24%), low public awareness (24%), lack of trained personnel (20%), and poor infrastructure (16%). These problems hinder both household and institutional efforts to achieve sustainable waste management.

- *General Observation:*

The findings suggest that solid waste management in Maiduguri is still at a developing stage, heavily dependent on manual and informal methods. There is limited coordination between the state waste management agencies and community members.

➢ *Conclusion*

The study concludes that sustainable solid waste reduction in Maiduguri Metropolis remains a major environmental and social challenge. The prevalence of open dumping and burning, coupled with weak institutional capacity, inadequate funding, and low public awareness, has contributed to inefficient waste management practices.

However, the research also shows that there is a growing awareness among residents and institutional stakeholders about the importance of proper waste management. With effective policy enforcement, public education, and infrastructural development, Maiduguri can move toward achieving a cleaner and more sustainable urban environment.

In essence, sustainable solid waste management requires a multi-sectoral approach involving households, institutions, government agencies, and private waste handlers, working collaboratively under a clear policy framework.

➢ *Recommendations for Future Research and Prcatice*

Based on the findings and conclusions, the following recommendations are made:

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

- *Strengthen Policy Implementation:*
  The Borno State Government should enforce existing environmental laws and regulations more effectively to ensure compliance by both households and institutions.

- *Promote Public Awareness and Environmental Education:*
  Regular campaigns should be organized in schools, communities, and public institutions to educate citizens about the health, economic, and environmental benefits of proper waste management and recycling.

- *Improve Institutional Capacity and Funding:*
  Waste management agencies in Maiduguri should be adequately funded and equipped with modern tools, vehicles, and trained personnel to improve waste collection and disposal efficiency.

- *Encourage Recycling and Waste Segregation:*
  The government and private sector should collaborate to establish recycling plants and promote waste segregation at the source. Incentives such as rebates or waste-to-cash programs can motivate residents to participate.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

REFERENCES

[1]. Abubakar, I. R., Musa, A., & Olowu, T. (2022). Environmental sustainability impacts of municipal solid waste management in Global South cities: review and implications for policy. *International Journal of Environmental Research and Public Health, 19*(8), 4567. https://doi.org/10.3390/ijerph19084567

[2]. Adegoke, A. A., & Adeyemi, O. (2021). Household solid waste generation and composition in Nigerian secondary cities: the case of Ilorin. *Nigerian Journal of Environmental Studies, 8*(2), 45–60.

[3]. Adeleke, O., & Bamgboye, A. (2024). Integrating informal recyclers into formal waste management systems: lessons from Ogun State, Nigeria. *Waste Management & Research, 42*(3), 289–303. https://doi.org/10.1177/0734242X24401234

[4]. Abdulrahman, S., & Yusuf, M. (2023). Peri-urban waste flows and collection efficiency: evidence from Kano and Maiduguri. *Journal of Urban Management, 12*(1), 71–88. https://doi.org/10.1016/j.jum.2023.02.004

[5]. Donuma, K. U., Asuquo, P., & Bello, R. (2024). Environmental and human health risks of indiscriminate waste disposal: a case study of Maiduguri, Borno State, Nigeria. *Environmental Research Communications, 6*(2), 025001. https://doi.org/10.1088/2515-7620/ad1c53

[6]. Dickson, E. M., Okonkwo, P., & Nwaka, S. (2023). Energy recovery from municipal solid waste in low to middle-income cities: options for Nigeria. *Frontiers in Sustainability, 4*, Article 115. https://doi.org/10.3389/frsus.2023.00115

[7]. Etim, E. (2024). Municipal solid waste management in Lagos State: the role of public awareness, private operators and policy enforcement. *Nigerian Journal of Environmental Management, 14*(1), 34–49.

[8]. Ferronato, N., & Torretta, V. (2023). Plastic waste circularity in low- and middle-income contexts: a review of actions, barriers, and opportunities. *International Journal of Environmental Research and Public Health, 20*(4), 2012. https://doi.org/10.3390/ijerph20042012

[9]. Gbadebo, A. M., & Ojo, A. A. (2022). Quantifying household food and organic waste for urban composting: a pilot in Jos, Nigeria. *Journal of Cleaner Production, 365*, 132943. https://doi.org/10.1016/j.jclepro.2022.132943

[10]. Ibrahim, A. S. (2023). Solid waste management in Maiduguri Metropolis: household willingness to pay for improved collection. *Ilorin Journal of Economic Policy, 10*(1), 57–71.

[11]. Kasim, O. F., & Bello, A. M. (2021). Household waste generation and composition changes during the COVID-19 pandemic: evidence from Nigeria. *Science of the Total Environment, 783*, 147150. https://doi.org/10.1016/j.scitotenv.2021.147150

[12]. Musa, H. A., & Maida, A. I. (2025). Evaluation of municipal solid waste generation trends across Nigeria for sustainable management. *Dutse Journal of Pure and Applied Sciences (DUJOPAS), 11*(1b), 142–148.

[13]. Nzediegwu, C., & Chang, S. X. (2020). Improper solid waste management risks during COVID-19 in the Global South. *Science of the Total Environment, 743*, 140621. https://doi.org/10.1016/j.scitotenv.2020.140621

[14]. Ochogwu, J., & INCLUDE Platform. (2024). *Formalizing the informal waste picker economy in Nigeria: barriers and pathways.* INCLUDE Knowledge Platform. https://includeplatform.net/publications

[15]. Olawale, R. A., & Eze, K. (2024). Impact of community-driven biogas and composting initiatives on organic waste reduction: evidence from Lagos markets. *Renewable Agriculture and Food Systems, 39*(1), 112–125. https://doi.org/10.1017/S1742170523000456

[16]. Omokaro, G. O., & Nwachukwu, P. (2025). Waste management in Nigeria: systemic failures and circular economy opportunities. *Resources, Conservation & Recycling Advances, 11*, 100120. https://doi.org/10.1016/j.rcradv.2025.100120

[17]. Onungwe, I., Ogbonna, C., & Okafor, D. (2023). Transition and implementation of a circular economy in Nigeria: review and perspectives. *Sustainability, 15*(1), 337. https://doi.org/10.3390/su15010337

[18]. Okechukwu, N., & Solaja, O. M. (2024). Empowering informal plastic recyclers: addressing socio-economic inclusion and occupational safety in Ogun State, Nigeria. *BMC Environmental Sciences, 4*, 11. https://doi.org/10.1186/s44329-024-00011-5

[19]. Peters, A., & Smith, L. (2021). Community sorting and low-cost composting models: lessons from sub-Saharan Africa. *Waste Management, 126*, 243–253. https://doi.org/10.1016/j.wasman.2021.03.012

[20]. Rafatullah, M., Sulaiman, O., Hashim, R., & Ahmad, A. (2020). Adsorption of contaminants and resource recovery approaches in waste streams: review with policy implications. *Journal of Environmental Management, 264*, 110477. https://doi.org/10.1016/j.jenvman.2020.110477

[21]. Reuters. (2024, June 26). *Nigeria to ban single-use plastics next year.* Reuters: Sustainability. https://www.reuters.com/sustainability

[22]. Shitu, A. (2023). Household solid waste management practices and willingness to pay in Maiduguri Metropolis. *Maiduguri Journal of Environmental Studies, 11*(2), 23–34.

[23]. Solomon, T., & Ogundele, S. (2022). Assessing the potential of small-scale waste-to- energy and biogas digesters for institutional kitchens in Nigerian secondary cities. *Energy for Sustainable Development, 66*, 13–24. https://doi.org/10.1016/j.esd.2021.12.004

[24]. Sud, D., Mahajan, G., & Kaur, M. P. (2021). Agricultural and organic waste management in low-income countries: technologies and social adoption. *Bioresource Technology Reports, 14*, 100647. https://doi.org/10.1016/j.biteb.2021.100647

[25]. Tela, B. M. (2025). Evaluation of municipal solid waste generation in Maiduguri Metropolis, Northeast Nigeria. *Asian Journal of Engineering and Technology*, 13(2), 121–130.

[26]. Ukala, D. C. (2020). A review of solid waste management practices in Nigeria: challenges and opportunities. *Nigerian Journal of Waste Studies, 5*(2), 12–34.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

[27]. Wang, Z., & Chen, X. (2022). Low-cost, scalable household composting technologies and adoption drivers: a systematic review. *Journal of Environmental Management, 306*, 114412. https://doi.org/10.1016/j.jenvman.2021.114412

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

APPENDIX I

➢ *Summary of Respondents' Demographic Information*

Variable	Category	Frequency	Percentage (%)
Gender	Male	58	58.0
	Female	42	42.0
Age	18–25	20	20.0
	26–35	37	37.0
	36–45	28	28.0
	46 and above	15	15.0
Educational Level	Primary	5	5.0
	Secondary	20	20.0
	Diploma/NCE	25	25.0
	Bachelor's	38	38.0
	Postgraduate	12	12.0

Table 1 shows that most respondents were between 26–35 years of age, representing active adults who generate and manage household waste. The majority hold bachelor's degrees (38%), indicating that the population is fairly literate and aware of environmental issues.

➢ *Types of Waste Commonly Generated*

Type of Waste	Frequency	Percentage (%)
Food Waste	34	34.0
Plastic Waste	27	27.0
Paper Waste	18	18.0
Metal/Glass	12	12.0
Others	9	9.0

Table 2 reveals that food waste forms the largest portion (34%), followed by plastic waste (27%). This indicates that biodegradable and non-biodegradable wastes coexist in Maiduguri households, highlighting the need for waste sorting and recycling programs.

➢ *Methods of Waste Disposal Among Respondents*

Method of Disposal	Frequency	Percentage (%)
Open Dumping	45	45.0
Burning	30	30.0
Door-to-door Collection	15	15.0
Burying	6	6.0
Recycling	4	4.0

The table shows that 45% of respondents use open dumping and 30% resort to burning. These practices contribute to environmental pollution and health hazards, underscoring the need for better waste collection infrastructure.

➢ *Awareness and Practice of Waste Segregation*

Question	Response	Frequency	Percentage (%)
Are you aware of waste segregation?	Yes	68	68.0
	No	32	32.0
Do you practice waste segregation?	Yes	42	42.0
	No	58	58.0

Although 68% of respondents are aware of waste segregation, only 42% actually practice it. This gap between awareness and practice reflects low motivation and lack of facilities for proper waste separation.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

➢ *Institutional Waste Management Practices*

Question	Option	Frequency	Percentage (%)
Institution has waste management policy	Yes	55	55.0
	No	35	35.0
	Not Sure	10	10.0
Frequency of waste collection	Daily	28	28.0
Weekly		45	45.0
Occasionally		20	20.0
Not regular		7	7.0

A fair number of institutions (55%) have waste management policies, but waste collection frequency is mostly weekly (45%), which may lead to temporary accumulation of waste and unsanitary conditions.

➢ *Major Challenges in Solid Waste Reduction*

Challenge	Frequency	Percentage (%)
Inadequate Funding	30	30.0
Lack of Awareness	25	25.0
Poor Infrastructure	20	20.0
Irregular Collection	15	15.0
Lack of Government Support	10	10.0

The most common barriers to solid waste reduction in Maiduguri are inadequate funding (30%) and lack of awareness (25%). This shows that successful waste management requires increased financial investment and sensitization campaigns.

➢ *Summary of Key Findings*

Indicator	Major Observation
Waste type	Food and plastic wastes dominate
Disposal method	Open dumping is most common
Segregation awareness	High awareness but low practice
Institutional policies	Present in some, absent in many
Key challenges	Funding and public awareness

Overall, the study concludes that while there is growing awareness about sustainable waste management, inadequate infrastructure, poor funding, and low community participation still hinder effective waste reduction strategies in Maiduguri metropolis.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

APPENDIX II
SELECTED FIELD PHOTOGRAPHS

➢ *Plate 1: Waste Disposal Site within Maiduguri Metropolis*

This photograph shows one of the major waste disposal sites in Maiduguri, where large piles of mixed household and institutional solid waste are dumped in open areas. The site illustrates the predominant practice of open dumping observed across parts of the city, often lacking proper waste segregation or landfill management.

➢ *Plate 2: Informal Waste Collectors Sorting Recyclables*

Depicted here are informal waste pickers sorting recyclable materials such as plastic bottles and metal cans from a dumpsite. These individuals play an essential role in the recycling chain, helping reduce waste volume despite working under poor environmental and health conditions.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25dec052

➢ *Plate 3: Institutional Waste Bins at a Government Office*

This image displays color-coded waste bins (for plastic, paper, and metal) provided at a government office in Maiduguri. Such institutional initiatives represent organized efforts toward promoting waste segregation and responsible disposal within public establishments.

➢ *Plate 4: Public Awareness Posters on Waste Reduction*

The photograph shows a public notice board advocating for responsible waste management. Messages such as "Dumping refuse is punishable by law" and "Save the Environment" emphasize community awareness and behavioral change as key strategies for sustainable waste reduction in Maiduguri.