**EVALUATION OF SOLID WASTE MANAGEMENT PRATICES IN BADARAWA WARD OF KADUNA NORTH LOCAL GOVERNMENT AREA, KADUNA STATE.**

**POST GRADUATE DIPLOMA PROJECT REPORT**

**BY**

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**THIS PROJECT IS SUBMITTED TO THE DEPARTMENT OF GEOGRAPHY, FACULTY OF ART AND SOCIAL SCIENCES IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF POSTGRADUATE DIPLOMA IN ENVIRONMENTAL MANAGEMENT**

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**POST GRADUATE SCHOOL,**

**KADUNA.**

**DECEMBER, 2023**

# DECLARATION

I hereby declare that this work titled The Evaluation Of Solid Waste Management Pratices In Badarawa Ward Of Kaduna North Local Government Area, Kaduna State. is the product of my own research effort, undertaken under the supervision of Dr. Aliyu Dadan GarbaProfessor of the Department of Geography and has not been presented and will not be presented elsewhere for the award of a degree or certificate. All sources have been duly acknowledged.

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# CERTIFICATION

This is to certify that the research work for this project titled The Evaluation Of Solid Waste Management Pratices In Badarawa Ward Of Kaduna North Local Government Area, Kaduna State and the subsequent preparation of this project by Ahmed Samira Umar NDA/PGS/FASS/PGDEM/P09745 were carried out under my supervision.

Dr Aliyu Dadan Garba

Supervisor

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# APPROVAL PAGE

This is to certify that this research titled The Evaluation Of Solid Waste Management Pratices In Badarawa Ward Of Kaduna North Local Government Area, Kaduna State has been examined and approved for the award of the degree of Post Graduate Diploma In Environmental Management of the Department of Geography in the Post Graduate School of the Nigerian Defence Academy.

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# DEDICATION

I dedicate this work to God Almighty for His grace upon me from the beginning of my program in Nigerian Defence Academy to the end. To God be the glory.

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## CHAPTER ONE

## INTRODUCTION

## 1.1 Background to the Study

According to Wikipedia Waste (or wastes) are unwanted or unusable materials. Waste is any substance discarded after primary use, or is worthless, defective and of no use. A by-product, by contrast is a joint product of relatively minor economic value. A waste product may become a by-product, joint product or resource through an invention that raises a waste product's value above zero.

The National Environmental Management: Waste Amendment Act, 2019 (NEM: WAA, 2019) defines waste as any substance, material or object that is unwanted, rejected, abandoned, discarded or disposed of, or that is intended or required to be discarded or disposed of, by the holder of that substance, material or object, whether or not such substance, material or object can be re-used, recycled or recovered and includes all wastes. Waste can be classified by physical state (solid, liquid, gases) (NEM: WAA, 2019). Solid waste can be further characterized by original use (packaging waste, food waste etc.), by material (glass, paper, wood, etc.) and by physical properties (combustible, compostable, recyclable) (Tchobanoglous & Kreith, 2019).

The NEM: WAA classifies waste into two classes based on the risk it poses, specifically general and hazardous waste. General waste is defined as waste that does not pose an immediate hazard or threat to health or the environment (NEM: WAA, 2019). Hazardous waste is defined as waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical, or toxicological characteristics of that waste, have a detrimental impact on health and the environment and includes hazardous substances, materials, or objects within business waste, residue deposits, and residue stockpiles (NEM: WAA, 2019).

Municipal solid waste (MSW) is defined to include refuse from households, non-hazardous solid waste from industrial, commercial, and institutional establishments (including hospitals), market waste, yard waste, and street sweepings. Municipal solid waste (MSW) is defined by Cointreau (2018) as non air and sewage emission created within and disposed of by a municipality, including household garbage, commercial refuse, construction and demolition debris, dead animals, and abandoned vehicles. Municipal solid waste is generally made up of paper, vegetable matter, plastics, metals, textiles, rubber, and glass (USEPA, 2018).

The solid waste management problem in Nigerian cities is becoming more alarming. The volume and range of solid wastes generated daily in Nigeria has been increasing within the last few years. This is mainly due to the high population growth, urbanization, industrialization and general economic growth (Ogwueleka, 2020).

Cities are regarded as the most efficient agents of production (Hardoy, Mitlin and Satherthwaite, 2021). This population increase compounds the problems of solid waste management. Worse still, government agencies responsible for managing solid waste, especially in urban areas are either nonexistent or ineffective.

Urban land use become complex as the city grows in population and physical size and so does the solid waste generation increase in volume and varieties. Urban land uses vary from residential, commercial, industrial, institutional; and others, with each category generating its own peculiar type of solid waste. However, residential land use constitutes the single most important generator of solid waste in Nigeria urban areas (Adegoke, 2019). Because of the complexity of the household wastes, the socio-economic structure of the urban population becomes a major determinant of the spatial structure of solid waste problems in our cities. (Uwadiegwu, 2019) in a study noted that the quantity of municipal solid waste produced depends upon the living standard of the residents, urbanization and industrialization.

Nigeria has undergone rapid urbanization during the past fifty years. The numbers of urban dwellers are expected to double between 1987 and 2022 (Ogwueleka, 2020). Urbanization implies the expansion of slum areas and the creation of new ones. Population growth intensifies the pressure on urban infrastructure in many cities in Nigeria that are already over burden with the provision of urban services. Most cities lack the resources to meet the demand for services such as water, sanitation and solid waste management.

Solid waste disposal is the disposal of normally solid or semi-solid materials, resulting from human and animal activities that are useless, unwanted, or hazardous. Solid waste typically may be classified as garbage, rubbish, ashes, large wastes, dead animals, sewage treatment solids, industrial waste, mining waste and agricultural wastes.

The common waste disposal method are sanitary landfill which is the disposal of waste material or refuse by burying it in natural or excavated holes, depressions, incineration; burning the refuse to ashes. There is also the compost heaps where the refuse is left to degrade by aerobic microorganism and its used as fertilizer, then the resource recovery, a process of recovering energy and reusable materials from solid waste before decomposition or landfill. The resources also goes further to be utilized by the principal of 3Rs (reduce, reuse, and recycle) (Taiwo, 2021).

Badarawa, nestled within the confines of Kaduna city and situated under the purview of the Kaduna North local government area, stands as a dynamic urban enclave brimming with its own unique character. This urban locality finds itself bordered by the vibrant neighborhoods of Unguwan Sarki, Unguwan Dosa, Malali, and the esteemed Nigerian Defence Academy, Kaduna.

This study is to learn how the resident of Badarawa Kaduna metropolis perceive the rate of solid waste generation and management in the area and the actions put in place to combat the health and environmental hazard posed by the indiscriminate disposal of solid waste.

## 1.2 Statement of Problems

The resident of neighborhood of Badarawa in Kaduna are dealing with a big problem related to how they manage their solid waste. Because more people are living there and there are many businesses, there is a lot more garbage being produced. Unfortunately, the way they are getting rid of this garbage is not good. They are putting it in the wrong places and not managing it properly. This means that there are piles of trash on the sides of the roads, at the entrance of markets, and even in the paths where water should flow. This is making the area look dirty and also causing health and environmental problems for the people who live there and the local government.

The current way of managing garbage in Badarawa is causing a lot of problems that are all connected. The more garbage they create, and the worse they manage it, the more the environment is getting damaged. This is even affecting the water they use, making it dirty. Bugs and animals that spread diseases are also growing in the garbage heaps. This is all making life harder for the people living there. One big issue is that there isn't a good plan in place to manage the garbage, and the places and tools needed to manage it aren't enough. Also, the people in the neighborhood aren't all working together because they have different ideas about how to handle the garbage.

Even though there are rules and organizations from the government that should take care of the garbage situation, there are still problems. This is because the solutions in place right now aren't enough to really fix the garbage issue. So, it's important to really understand what the people who live in Badarawa think about the garbage problem. We need to find out how much garbage they see, how they think it's being managed, and if they feel the steps taken to stop the health and environmental risks caused by bad garbage disposal are good enough. By figuring out these things, we can understand why there are problems with garbage management and come up with better ways to solve them.

## 1.3 Research Question

1. What are the components of solid waste produced in Badarawa ward Kaduna, North Local Goverment Area?
2. How does the increasing population in Badarawa contribute to the rise in solid waste generation?
3. What are the main challenges and consequences of improper solid waste disposal in Badarawa?
4. How do differing perceptions and behaviors towards waste disposal affect waste management in the community?
5. What is the role of Goverment and private sector in managing the solid waste in Badarawa ward kaduna north.

## 1.4 Aims and Objectives

The aim of this study is to investigate the current state of solid waste management in the Badarawa area of Kaduna city and propose effective strategies for improved waste disposal practices and environmental sustainability.

**Objectives:**

1. To assess the extent of solid waste generation in the Badarawa area and its impact on the local environment.
2. To identify the key challenges and factors contributing to the improper disposal of solid waste in Badarawa.
3. To analyze the existing waste management practices in the area, including collection, transportation, and disposal methods.
4. To examine the role of community awareness and participation in shaping waste management behaviors among residents.
5. To investigate the role of goverment and other stakeholders in managing solid waste in Badarawa ward, kaduna

## 1.4 Significance of the Study

When there is improvement in solid waste disposal and management the general public, buyers and sellers in the study area will be of great benefit as it will help improve their health. Also, this research will be of benefit to the Kaduna environmental protection authority.

Improper disposal of plastic waste and the problems associated with it has become a general problem to the people living within and outside the environment. The study will analyze; the volume, rate of plastic waste generation and the causes of the problems associated with plastic waste.

Since plastic wastes are not biodegradable, and they exist everywhere. Nevertheless, recycling plastic wastes significantly decreases the amount of plastic waste that goes to landfills. This helps to reduce land and water pollution.

These are some of the benefits of plastic waste management if they are properly managed;

1. Properly managing plastic waste brings various benefits,
2. including environmental protection,
3. resource conservation,
4. energy efficiency,
5. reduced landfill usage,
6. recyling of plastic products.

## 1.5       Justification of the studys

Solid waste management is an important and integral part of our society and therefore needs to be acknowledged as one of the few things that may help to preserve the beauty and splendor of Badarawa, for future generations. Waste generation increases with population expansion and economic development.  Improperly managed solid waste poses a risk to human health and the environment. Uncontrolled dumping and improper waste handling causes a variety of problems, including contaminating water, attracting insects and rodents, and increasing flooding due to blocked drainage canals or gullies. In addition, it may result in safety hazards from fires or explosions.  Improper waste management also increases greenhouse gas (GHG) emissions, which contribute to climate change. Planning for and implementing a comprehensive program for waste collection, transport, and disposal, along with activities to prevent or recycle waste can eliminate or at least reduce these problems.

This study will have the following importance: Firstly, the study will contribute a better theoretical understanding of the overall features of solid waste and physical factors on the process of municipal solid waste management on the whole population; Secondly, the study will give some guide line information to policy makers, municipality, solid waste managers and researchers about the pre-existing situation of municipal solid waste management in the area. Thirdly, it may also important in putting base line information to the next work who would like to conduct detailed and comprehensive studies in the town and other study area. Fourthly, the study will contribute better to understand the present status of solid waste management and handling practices in Badarawa and finally its ultimate significance is achieving the objective of the study.

## 1.6 Study Area

## 1.6.1 Location

The study is focused on the neighborhood of Badarawa, which is situated in Kaduna North, a local government area in Kaduna State, North West Nigeria. Badarawa is located at approximately 10.5589° North latitude and 7.4679° East longitude, with an elevation of 610 meters (2,001 feet) above sea level. Its postal code is 800.

## 1.6.2 Geographic Features

Badarawa is bordered by several neighboring areas, including Unguwan Sarki, Unguwan Dosa, Malali, and the prestigious Nigerian Defence Academy, Kaduna. The neighborhood itself consists of smaller towns, such as Kwaru (including Kwaru majalisa and kwarun Ajilo), Malali (comprising Malali Village and Malali G.R.A), Majalisa, Unguwan Yero, Unguwan Shekara, Unguwan Gado, and Unguwan mai samari. Badarawa is further subdivided into two primary areas: Badarawa Village and Badarawa G.R.A. This study area is of particular interest due to its urban nature, the increasing population, and the various challenges associated with solid waste management. Understanding the specific circumstances in Badarawa will contribute to addressing solid waste-related issues effectively.

## CHAPTER TWO

## CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

## 2.1 Introduction

The literature review plays a important role in this research by examining the existing work about solid waste management. Its analyze studies and writings to better understanding of the current experience in this field. This helps us identifing gaps, trends, and important findings from previous research, which will guide my own study's goals. Through this review, enhance what we know, bring in fresh viewpoints, and lay the groundwork for our research's framework.

## 2.2 Research's Conceptual Framework

conceptual framework aims to provide an in-depth exploration of existing research and studies related to solid waste management practices, their effects on the environment, and various methods employed for waste collection, disposal, and recycling. This section will synthesize key findings from prior research to establish a foundation for the current study on solid waste management in Badarawa, Kaduna.

## 2.2.1 Sources of Solid Waste

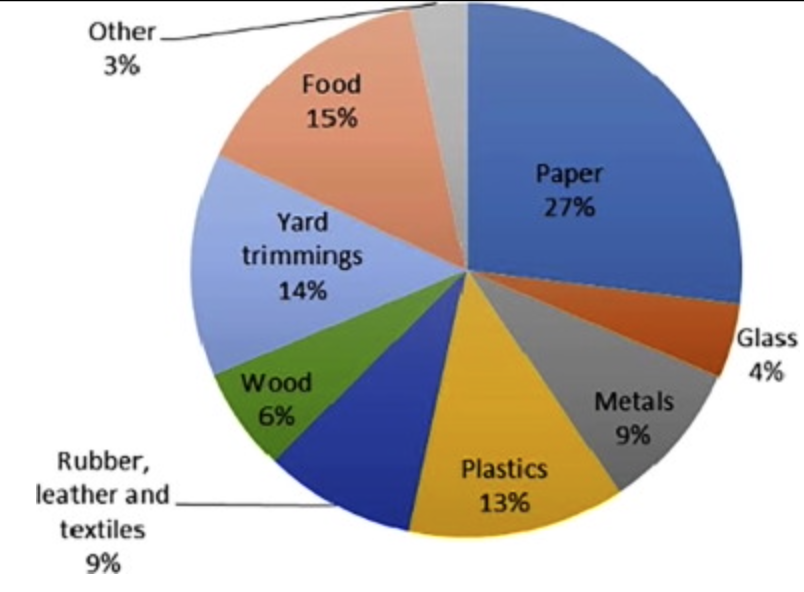


Figure 2.1: Solid waste chart (Source: semanticscholar.org/paper/Analysis-of-Institutional-Solid-Waste-Generation-in-badarawa-kaduna/2a881ce12e11bd040529e8a56fd6ab4574f87f)

Solid waste originates from various sectors and activities, contributing to the growing challenge of waste management. This section presents an overview of the major sources of solid waste, highlighting the diversity of contributors to this issue. Residential areas, including homes and apartments, generate significant amounts of solid waste. This waste stream includes a variety of materials such as food wastes, plastics, paper, glass, leather, cardboard, metals, yard wastes, ashes, and special items like electronics, tires, batteries, old mattresses, and used oil (Reed, 2022). These wastes are typically collected from household bins and containers for further processing.

1. **Industrial Sources:** Industries, both light and heavy manufacturing, play a crucial role in solid waste generation. They produce wastes such as housekeeping waste, food waste, packaging waste, ashes, construction and demolition materials, special wastes, medical wastes, and hazardous materials (Nwosu, 2018). These wastes stem from various manufacturing processes and require proper disposal methods to prevent environmental contamination.
2. **Commercial Sources:** Commercial establishments contribute significantly to the solid waste stream. Hotels, markets, restaurants, stores, and office buildings generate waste materials such as plastics, food waste, metals, paper, glass, wood, cardboard, and other hazardous materials (Reed, 2022). The waste produced by commercial facilities underscores the need for effective waste management practices to mitigate environmental impact.
3. **Institutional Sources:** Institutional centers like schools, colleges, prisons, and government facilities also contribute to solid waste generation. Common waste materials from these sources include glass, rubber waste, plastics, food waste, wood, paper, metals, cardboard, electronics, and hazardous waste (Nathason, 2018). Proper waste management is essential to ensure that waste from institutions is disposed of safely and responsibly.
4. **Construction and Demolition Sites:** Construction and demolition activities yield significant amounts of solid waste. These sites produce materials such as steel, concrete, wood, plastics, rubber, copper wires, dirt, and glass (Joseph, 2018). Managing waste from construction and demolition activities requires careful planning and effective disposal methods to prevent environmental harm.
5. **Municipal Services:** Urban centers contribute substantially to the solid waste crisis. Waste generated from municipal services includes street cleaning, waste from parks and beaches, wastewater treatment plants, landscaping waste, and recreational area waste (Adeyemi et al., 2018). The waste produced from municipal services necessitates proper collection and disposal to maintain the cleanliness and health of urban environments.
6. **Treatment Plants and Sites:** Treatment plants and various manufacturing plants also generate solid waste. These facilities produce industrial process waste, unwanted specification products, plastics, metal parts, and other waste materials (Abbas et al., 2019). Proper waste management in these sectors is essential to prevent environmental pollution and protect public health.
7. **Agriculture:** Agricultural activities, including crop farms, orchards, dairies, vineyards, and feedlots, contribute to the solid waste stream. Agricultural waste comprises agricultural wastes, spoiled food, pesticide containers, and other hazardous materials (Pires et al., 2018). Effective waste management in agriculture is crucial for maintaining sustainable farming practices and minimizing environmental impact.
8. **Biomedical Sources:** Biomedical facilities, such as hospitals and chemical manufacturing firms, generate specific types of waste. Hospitals produce waste like syringes, bandages, used gloves, drugs, paper, plastics, and chemicals (Nathason, 2018). Proper disposal of biomedical waste is critical to prevent contamination and safeguard public health.

The diverse range of sources contributing to solid waste highlights the complexity of waste management challenges. Effective waste management strategies must address these various sectors to ensure environmental protection and sustainable practices.

## 2.2.2 Sources and Effects of Poor Solid Waste Management

Inadequate or improper management of solid waste can lead to a multitude of negative consequences for both the environment and public health. This section outlines the significant effects of poor solid waste management practices.

1. **Environmental Degradation:** Improper disposal of solid waste can result in environmental degradation. Accumulated waste can block water drains, causing flooding and water stagnation. Rainwater combining with decomposing waste can lead to groundwater and surface water pollution, contaminating valuable water resources (Saleh, 2020). Solid waste dumpsites release hazardous chemicals into groundwater, surface water, soil, and the air through leachate and landfill gas (Ogwueleka, 2019). Such pollution undermines ecosystem health and disrupts natural processes.
2. **Spread of Diseases:** Poor waste management creates breeding grounds for disease-carrying vectors like rodents and insects. Accumulated waste provides a conducive environment for pathogens to thrive, leading to the spread of diseases such as cholera, typhoid, dysentery, and malaria (Ajibade, 2020). The decomposition of organic waste releases foul odors and pathogens that can contaminate the air and soil, posing risks to nearby communities (Akinbile and Yussof, 2021).
3. **Aesthetic and Health Impact:** Unmanaged waste piles contribute to the unsightliness of urban and rural areas. This diminishes the aesthetic value of the environment and reduces community pride. Additionally, the presence of waste can lead to negative psychological effects on residents and visitors, affecting their well-being (Zander, 2019). The combination of unpleasant sights and odors impacts the overall quality of life in affected areas.
4. **Soil and Water Pollution:** Solid waste, when not properly managed, can contaminate soil and water resources. Hazardous materials from discarded products and industrial waste can leach into the soil, leading to soil degradation and fertility loss (Nwosu, 2018). Polluted soil can affect agricultural productivity and pose long-term health risks to humans and animals that consume contaminated produce.
5. **Air Pollution:** Improper waste disposal, such as burning waste in open areas, releases harmful gases and particulates into the atmosphere. Incineration of waste materials can emit pollutants that contribute to air pollution, causing respiratory problems and other health issues among local populations (Thompson, 2018). Gaseous emissions from waste combustion can contribute to smog formation and worsen air quality.
6. **Habitat Destruction:** Improper waste disposal can lead to habitat destruction and harm to wildlife. Accumulated waste in natural habitats can alter ecosystems, disrupt habitats, and lead to the decline of certain species. Wildlife may ingest or become entangled in waste materials, resulting in harm to both animals and ecosystems.
7. **Fire Hazards:** Accumulated waste, particularly in densely populated areas, increases the risk of fire outbreaks. The presence of flammable materials mixed with waste can lead to uncontrolled fires that pose risks to nearby structures and communities. Poorly managed waste piles are susceptible to spontaneous combustion and can exacerbate fire incidents.
8. **Economic Costs:** The negative effects of poor solid waste management have economic implications. Health care costs may rise due to increased disease prevalence resulting from waste-related issues. Tourism and property values may decline in areas marred by waste accumulation and pollution. Additionally, resources needed to address waste-related problems divert funds from other development initiatives.

the repercussions of poor solid waste management are far-reaching and multifaceted. Addressing these challenges requires comprehensive waste management practices that prioritize environmental sustainability, public health, and economic well-being.

## 2.2.3 Methods of Solid Waste Management

Effective solid waste management involves employing various methods to handle, treat, and dispose of waste materials in ways that minimize environmental impact and ensure public health and safety. This section highlights several key methods of managing solid waste.

1. **Sanitary Landfill:** Sanitary landfills are commonly used for waste disposal in many regions. In this method, waste is spread in thin layers, compacted, and covered with soil or plastic foam to minimize odors and prevent water contamination (El-Haggar, 2020). Modern landfills incorporate impermeable liners to prevent leachate from reaching groundwater. Properly managed landfills are designed to capture and manage landfill gases, primarily methane, which can be potentially hazardous and contribute to climate change.
2. **Incineration:** Incineration involves burning solid waste at high temperatures to reduce its volume and convert it into ash and gases. This method is particularly effective for reducing the volume of waste and destroying hazardous materials (Adeyemi et al., 2018). Advanced incineration technologies aim to minimize emissions and recover energy from the combustion process. However, careful monitoring is required to ensure that emissions do not adversely affect air quality.
3. **Recovery and Recycling:** Recycling involves collecting and processing waste materials to extract valuable resources for reuse in manufacturing new products. This method helps conserve raw materials, reduce energy consumption, and decrease the demand for landfill space (Recycling Council of British Columbia, 2018). Various types of waste, such as paper, glass, plastics, and metals, can be recovered and recycled. Recycling also plays a crucial role in closing material cycles and promoting sustainable resource management.
4. **Composting:** Composting is the biological decomposition of organic waste materials under controlled conditions. This method produces nutrient-rich compost that can be used to enrich soil and support plant growth (Pires et al., 2018). Proper composting reduces the volume of organic waste, prevents methane emissions from landfilling, and contributes to soil health and fertility.
5. **Pyrolysis:** Pyrolysis is a thermal treatment process that involves heating solid waste in the absence of oxygen to produce gases, liquids, and solids. The process can recover energy and valuable materials from waste, while minimizing emissions compared to traditional combustion (Owen, 2019). Pyrolysis is often used for waste materials that are challenging to recycle through conventional methods.
6. **Waste-to-Energy:** Waste-to-energy technologies involve converting solid waste into energy through various processes such as mass-burn incineration, gasification, and anaerobic digestion. These methods generate heat, electricity, or biofuels from waste materials, contributing to energy production while reducing the volume of waste that needs to be landfilled (Owen, 2019). However, careful management is required to mitigate environmental and health risks associated with emissions and residue.
7. **Source Reduction and Waste Minimization:** Preventing waste generation at the source is a crucial component of sustainable waste management. This approach involves designing products with longer lifespans, reducing packaging materials, and promoting reuse and repair. By minimizing waste generation at its origin, this method reduces the overall environmental and economic burden of waste management (Young, 2012).

In summary, effective solid waste management requires a combination of methods that prioritize resource recovery, minimize environmental impact, and promote sustainable practices. Each method has its own advantages and challenges, and the choice of method should be guided by local conditions, regulations, and environmental considerations.

## 2.2.4 Waste Collection and Transportation

Waste collection and transportation are critical components of effective solid waste management systems. Proper collection and transportation methods are essential to ensure that waste is removed from its source and transported to appropriate disposal or treatment facilities. This section examines various aspects of waste collection and transportation, including methods, challenges, and innovations.

1. **Household Waste Collection:** In urban and residential areas, household waste collection is a fundamental process. Waste collectors, whether municipal employees or private contractors, visit neighborhoods to collect waste from households. The waste is typically placed in bins, containers, or bags by residents for collection. In some regions, waste collection vehicles follow set routes, making scheduled stops to gather waste. In certain cases, residents interact with collectors directly, handing over their waste for disposal (Townend, 2018). Effective household waste collection ensures that waste is promptly removed from residential areas, minimizing unsanitary conditions and environmental pollution.
2. **Commercial Waste Collection:** Similar to household waste, waste collection from commercial establishments is crucial. Businesses, markets, restaurants, and other commercial facilities generate waste materials that require proper collection. Waste collection considerations for commercial entities include the type and size of bins, placement of bins, and the frequency of servicing. Overfilled bins can lead to littering, while hazardous waste like used petrol cans can pose fire risks during compaction (Walker et al., 2020). Efficient commercial waste collection methods help maintain clean and safe commercial areas.
3. **Innovative Waste Collection Methods:** In recent years, waste collection methods have seen innovative developments aimed at improving efficiency and sustainability. Some notable advancements include:

* **Automated Vacuum Waste Collection Systems:** These systems use underground pipes and vacuum technology to transport waste directly from households to collection stations. Cities like Abu Dhabi, Barcelona, and New York have adopted these systems to reduce the need for conventional waste collection vehicles (Wagner, 2020).
* **IoT-Enabled Garbage Cans:** Internet of Things (IoT) technology is being integrated into garbage cans to monitor fill levels and optimize collection routes. This minimizes unnecessary collections and reduces fuel consumption.
* **Electric Garbage Trucks:** Electric garbage trucks are being introduced as a more environmentally friendly alternative to traditional diesel-powered trucks. They produce fewer emissions and lower noise pollution.
* **Waste Sorting Robots:** Robots equipped with sensors and AI are being used in waste sorting facilities to automate the separation of recyclable materials from mixed waste streams.
* **Pyrolysis and Gasification:** Advanced waste-to-energy methods such as pyrolysis and gasification involve converting solid waste into gases, liquids, and solids in oxygen-controlled environments. These methods can reduce waste volume and produce energy-rich gases (Owen, 2019).

1. **Challenges in Waste Collection and Transportation:** Despite advancements, waste collection and transportation continue to face challenges. Inadequate infrastructure, improper waste disposal habits, and inconsistent collection services can lead to accumulation of waste in public spaces. In some regions, waste collection vehicles might not have proper access to certain areas, hindering efficient collection. Additionally, lack of awareness and education about proper waste disposal practices can contribute to environmental pollution.
2. **Regulatory and Policy Aspects:** Many waste collection practices are governed by local regulations and policies. Waste ordinances stipulate collection charges, recycling requirements, and guidelines for handling hazardous waste. Additionally, some countries have implemented extended producer responsibility (EPR) policies, requiring manufacturers to manage the disposal of their products after their useful life, thus encouraging sustainable product design and disposal.

Efficient waste collection and transportation are integral to maintaining a clean and healthy environment. Innovations in technology, policy development, and public awareness are all essential for addressing the challenges associated with waste collection and ensuring sustainable waste management practices.

## 2.3 Review of Related Works

The literature reviewed comprises studies and research from various sources, shedding light on the critical issues of waste management in Nigeria. Adebola (2020) conducted an independent study on the informal private sector's role in solid waste management in Lagos State, highlighting the complexities of waste handling practices. Ajibade (2020) evaluated the quality of packed goods for human consumption, reflecting the need for effective waste management to maintain public health.

Arnold and Justine (2019) discussed integrated sustainable waste management, emphasizing the multifaceted nature of selecting appropriate technologies for effective waste disposal. Baabereyir (2019) delved into urban environmental problems in Ghana, focusing on social and environmental injustice in solid waste management. Cointreau (2019) offered a project guide for environmental management of urban solid waste in developing countries, emphasizing the need for practical solutions.

Ogwueleka (2019) conducted an in-depth analysis of municipal solid waste management in Nigeria, outlining the challenges faced by the country in waste disposal practices. Onwughara (2018) explored issues related to roadside disposal habits of municipal solid waste, emphasizing the environmental impacts and the need for sound management practices.

The works of Puopiel (2018) and Saleh (2020) addressed solid waste management in Ghana and Kano, respectively, revealing the significance of effective waste disposal strategies for maintaining environmental safety and public health. Umar (2019) investigated solid household waste generation, disposal, and impact in Nasarawa LGA, Kano State, underscoring the need for proper waste management.

Waste collection considerations include type and size of bins, positioning of the bins, and how often bins are to be serviced. Overfilled bins result in rubbish falling out while being tipped. Hazardous rubbish like empty petrol cans can cause fires igniting other trash when the truck compactor is operating. Bins may be locked or stored in secure areas to avoid having nonpaying parties placing rubbish in the bin (Walker et al., 2018). The cost of old waste is also a concern in collection of waste across the globe. Automated vacuum waste collection systems that are located underground are also actively used in various parts of the world like Abu Dhabi, Barcelona, Leon, Mecca and New York etc. The utilization of the subsurface space can provide the setting for the development of infrastructure which is capable of addressing in a more efficient manner the limitations of existing waste management schemes (Wagner, 2019).

This technique also minimizes operational costs, noise and provides more flexibility. There are various new innovations like IoT- enabled garbage cans, electric garbage trucks, waste sorting robots and mechanisms etc are also being developed and deployed at various sites.

According to Nnaji (2015), more than 50 percent of residents of Maiduguri in Northern Nigeria and Ughelli in Southern Nigeria dispose of their waste in open dumps. Although open dumpsites disposal method is a commonly adopted method of disposal in Nigeria and other developing countries, which involves people disposing of their waste on open grounds most often indiscriminately, they are generally unsanitary, unsightly and smelly, attracting rats, insects, snakes and flies (Udoh & Inyang, 2016). Onwughara et al. (2010) reported other nonobvious implications of open dumpsites such as landfill gases and leachate which contributes to global warming and urban ozone problem thereby harming both humans and the natural environment. Similarly, (Aluko et al., 2003) reported characteristics of leachates found at dumpsites at Ibadan, Nigeria and the serious problems they possess on contaminating the land and water around them. Dumpsites in the southern part of Nigeria are largely unsuitable owing to the highly waterlogged characteristics of the region (Leton & Omotosho, 2004). This calls for geological assessment of areas before designing dumpsites.

Although, there are many other forms and methods of waste disposal outside landfilling, such as composting (Sha’Ato, 2007), waste reuse, source reduction and recycling (Longe et al., 2009) and incineration (Somorin et al., 2017; Onwughara et al., 2010), the option chosen should be beneficial to the environment and should require less energy, less resource use and limited pollution rate. As observed by Kofoworola (2007), the treatment of waste does not exist, as such, collected waste that are transported to dumpsites are burnt most often to reduce the volume of waste which results in air pollution and the release of harmful gases to the atmosphere. To this effect, Longe et al. (2009) advise the adoption of waste reduction, recycling and reuse as an alternative

The overall management of solid waste in Nigeria is poor (Amasuomo & Baird, 2016). Various studies (Oyeniyi, 2011; Oguntoyinbo, 2012; Amuda et al., 2014; Olukanni et al., 2016) have highlighted various challenges facing SWM in Nigeria across various states. Some of these challenges include inadequate environmental policies and legislations (Agunwamba,1998; Nzeadibe & Anyadike, 2012; Ezeah & Robert, 2014), which points out loop holes in policies and non-existence of policies in some states towards waste management. Although good policies exist, implementation remains a challenge. Other challenges include poor funding, low level of government support, limited environmental awareness, inadequate facilities, corruption, politics, inappropriate technology, urbanization and low public participation (Ayotamuno & Gobo, 2004; Kofoworola 2007; Imam et al. 2008; Ogwueleka, 2009b; Solomon, 2009).

Public awareness and participation is one of the remedies to the problems of waste management in Nigeria, Amalu and Ajake (2014), pointed the need for community education programs to adequately educate the people on environmental issues. Ezeah and Roberts (2014) revealed that there exist low levels of public education on municipal solid waste among the sample population in Abuja, as such, proposed a sustained public education on waste prevention, management and reuse. In the same line, Nwosu and Okoye (2019) proposed a framework for sustainable public participation in waste management. As it is evident in various other studies, (Wahab & Kehinde, 2014; Amuda et al., 2014; Maiyaki et al., 2018), where they promote public participation, non-governmental participation, private sector participation and stakeholders participation in waste management over the years, the problem of solid waste management still exist.

Effective solid waste management can also be achieved through citizen mobilization and environmental education, strengthening of public agencies, a responsible government, logistics and infrastructural improvement, legislation, appropriate technologies, monitoring and surveillance (Uwadiegwu, 2013). Also, there is a need for a holistic program commonly ignored in waste programs that integrates all the economic, technical, cultural, social and psychological factors in conjunction with the adoption of a more modern management practice so as to achieve efficiency in waste management (Agunwamba, 1998).

This underscores the common challenges faced by many Nigerian cities, including the inadequate management of waste, which poses threats to both public health and the environment. The reviewed works provide a comprehensive understanding of the issues at hand, setting the stage for a focused investigation into the effects of waste management practices in Badarawa Kaduna North LGA.

## CHAPTER THREE

## METHODOLOGY

## 3.1 Introduction

this chapter outline the methodology used in the study to investigate and address the issues related to waste management in Nigeria. The methodology is crucial for understanding how data was collected, analyzed, and interpreted. This section provides an overview of the research approach, data collection methods, and analytical techniques employed in the study. It offers insights into how the study was conducted and how the results were derived.

## 3.2 Research Design

The research design for this study is a mixed-method approach that combines both quantitative and qualitative research methods. This approach is chosen to provide a comprehensive and in-depth understanding of solid waste management practices in Badarawa Ward, Kaduna North Local Government.

## Rationale for Mixed-Methods Approach:

The mixed-method research design offers several advantages. Firstly, it allows for a quantitative assessment of waste generation, collection, and disposal, enabling statistical analysis of key variables. This quantitative data will help in understanding the magnitude of waste issues and identifying trends or patterns. Secondly, the qualitative component enables a deeper exploration of the social, cultural, and environmental factors influencing waste management practices. It helps to uncover community perspectives, attitudes, and the underlying reasons for specific behaviors.

## Quantitative Research:

A quantitative research approach will be employed to collect numerical data related to solid waste generation, collection, and disposal. The quantitative aspect of the study is essential for providing numerical estimates and patterns that can be analyzed statistically.

## Qualitative Research:

Qualitative research is instrumental in gathering insights into the behaviors, attitudes, and perceptions of the residents of Badarawa Ward regarding solid waste management. Qualitative data will be collected through interviews, focus group discussions, and observations.

## Triangulation:

By using both quantitative and qualitative methods, the study aims to triangulate findings, enhancing the validity and reliability of the results. This approach also allows for a more holistic understanding of solid waste management in the study area. The combination of research designs will help answer the research questions comprehensively and provide a deeper understanding of the challenges and opportunities associated with waste management in Badarawa Ward, Kaduna North Local Government.

## 3.3 Population of the Study

The population of the study area, Badarawa Ward, located in Kaduna North Local Government, Kaduna State, was estimated to be approximately 67,864 in the year 2021 (Kaduna State Bureau of Statistics, 2021). This population figure provides the demographic context for the research on solid waste management within the area. It is important to acknowledge that population figures can fluctuate over time due to factors such as birth rates, migration, and urban development.

This study specifically focuses on this population to assess the impact of solid waste management practices on the environment, public health, and the general well-being of the residents in Badarawa Ward. Understanding the dynamics of the local population is vital for comprehending the scale of waste generation and the challenges associated with managing solid waste effectively in a densely populated urban area.

## 3.4 Sampling Technique

A random sampling technique will be employed to select the sample for this study. A portion of the residents and stakeholders in Badarawa Ward will be chosen as the sample for data analysis. To determine the appropriate sample size, the Kerrie and Morgans (1970) method for calculating sample size based on population size and desired precision will be applied:

**n = N / (1 + N \* e^2)**

Where:

* **n** represents the sample size.
* **N** is the population size.
* **e** stands for the level of precision or degree of accuracy, set at 0.095 to allow for a 5% error margin.

Based on the projected population of 67,864 for the year 2021, the sample size (n) can be calculated as follows:

**n = 67,864 / (1 + 67,864 \* 0.095^2)**

**n ≈ 129**

Therefore, a minimum sample size of 129 residents and stakeholders will be selected for the survey to ensure a representative sample. To account for potential non-responses or incomplete surveys, 135 questionnaires will be prepared and distributed within Badarawa Ward.

## 3.5 Data Collection and Instruments

The research will involve a range of data collection methods to comprehensively investigate solid waste management practices in Badarawa Ward. These methods include:

## 3.5.1 Primary Data

This research will incorporate both qualitative and quantitative methods. Primary data will be collected through questionnaires, observations, and interviews.

## 3.5.2 Observation

Direct observations will be made to understand how solid waste is generated, stored, collected, transported, and disposed of, and how it is managed within Badarawa Ward. The observations will encompass activities related to waste generation, disposal practices, storage systems, and transportation. Data acquired through this method will require qualitative analysis.

## 3.5.3 Questionnaire

Data will be collected through questionnaires, which will be distributed in both printed and digital formats. For the digital questionnaire, a platform like Google Forms will be utilized to facilitate access and participation. The questionnaire will be designed to capture quantitative data effectively. An online survey method will be employed to enhance the reach and convenience of data collection.

## 3.5.4 Interview

In the Badarawa region of Kaduna State, oral interviews with disposal collectors, KEPA (Kaduna Environmental Protection Agency), and other local government representatives will be undertaken. This strategy seeks to compile thorough data on a range of waste management-related topics in the research region. Insights about waste generation, storage, collection, transfer, transportation, disposal procedures, and general management techniques will be solicited from participants. To get significant insights into the dynamics of solid waste management in the community, a qualitative analysis of the collected data will be conducted**.**

## 3.5.5 Focus Group Discussions

Focus group discussions will be organized within the community to engage residents and stakeholders in open dialogues regarding solid waste management. These discussions will offer a platform for participants to share their experiences, concerns, and suggestions. They will be organized based on the diversity of the participants, including community members from different socioeconomic backgrounds, waste management authorities, community leaders, and environmental experts. Focus group discussions encourage the generation of qualitative data that reflects the diverse perspectives within the community.

## 3.6 Data Analysis Techniques

Data analysis will be conducted using a combination of quantitative and qualitative methods:

**Quantitative Data Analysis:** For the quantitative data collected through surveys and questionnaires, statistical software like SPSS (Statistical Package for the Social Sciences) will be employed for analysis. Descriptive statistics, including frequencies, percentages, and averages, will be calculated to summarize key findings. Inferential statistical techniques, such as chi-square tests, will be applied to identify associations and relationships between variables. These analyses will provide a quantifiable understanding of solid waste management practices within Badarawa Ward.

**Qualitative Data Analysis:** Qualitative data from in-depth interviews, focus group discussions, and observations will be transcribed, coded, and thematically analyzed. This process involves identifying recurring themes, patterns, and emerging insights. Qualitative analysis software like NVivo may be used to facilitate this process. Quotes and excerpts from participants will be included to support qualitative findings. This qualitative analysis will provide a deeper understanding of the underlying causes, consequences, and perspectives related to solid waste management.

## 3.7 Ethical Considerations

Ethical considerations will be strictly adhered to throughout the research process to ensure the protection of participants and the integrity of the study. Key ethical principles that will be upheld include:

**Informed Consent:** All participants will be provided with clear and comprehensive informed consent forms. These forms will explain the purpose of the study, the voluntary nature of participation, and participants' rights. Written consent will be obtained from each participant.

**Privacy and Confidentiality:** Participants' identities and personal information will be kept strictly confidential. Data collected from surveys, interviews, and discussions will be anonymized, and any identifying information will be removed to protect participants' privacy. The data will be stored securely and reported only in aggregated, anonymous form.

**Voluntary Participation:** All participants will be informed that their involvement in the study is entirely voluntary. They will have the right to withdraw from the study at any stage without facing any consequences. Their decision to participate or withdraw will not affect their access to services or relationships within the community.

**Respect for Cultural Sensitivities:** The research team will demonstrate respect for the cultural norms and values of the community, ensuring that questions and interactions are culturally appropriate and sensitive.

**Contact Information:** Participants will be provided with contact information for the researchers, including names, phone numbers, and email addresses. They will be encouraged to reach out if they have questions, concerns, or experience discomfort during or after their participation.

The informed consent process will ensure that participants are well-informed, willing, and comfortable with their involvement in the research. This approach upholds ethical standards, respects individual autonomy, and safeguards participants' rights and privacy throughout the study.

## CHAPTER FOUR

## DATA PRESENTATION AND ANALYSIS

## 4.1 Introduction

This chapter presents the analysis of data collected in the study titled "Evaluation of Solid Waste Management Practice in Badarawa Ward of Kaduna North Local Government, Kaduna State." The data was obtained through primary sources, including questionnaires, interviews, and observations. The analysis focuses on various aspects of solid waste management in Badarawa Ward, encompassing components of solid waste materials, methods of storage and collection, transportation systems, disposal methods, and the overall efficiency of waste management.

## 4.2 Primary Data Analysis (Questionnaire)

Primary data collection was conducted through surveys involving residents and stakeholders in Badarawa Ward. Questionnaires were administered to gather relevant data, and quantitative analysis techniques were applied for interpretation. A total of 135 questionnaires were prepared and distributed as follow 100 questionnaires was distributed within the residentail area, 20 copies was distributed around mini markets and store in Badarawa ward, 10 persons were interviewed, , the respondents were 2 official of Kaduna Environment Protection Agency, 6 disposal collectors and 2 local official of the market area and 5 persons for focus group discussion to ensure a representative sample.

## 4.3 Quantitative Analysis

## 4.3.1 Length of Stay in Badarawa Ward

To assess the reliability of respondents' perspectives on waste management, the duration of their stay in Badarawa Ward was examined. The results are presented in Table 4.1 and Figure 4.1.

|  |  |  |
| --- | --- | --- |
| **Length of Stay** | **Frequency** | **Percentage (%)** |
| Less than 1 year | 28 | 20.74 |
| 1-2 years | 37 | 27.41 |
| 3-5 years | 42 | 31.11 |
| More than 5 years | 28 | 20.74 |
| Total | 135 | 100 |

**Table 4.1: Length of Stay in Badarawa Ward**

**Figure 4.1: Length of Stay in Badarawa Ward**

Figure 4.1: visually illustrates the duration of respondents' stay in Badarawa Ward, providing insights into the experience of residents and stakeholders in the area regarding waste management.

## 4.3.2 Awareness of Waste Management Practices

To gauge the level of awareness among respondents about appropriate waste disposal methods, their awareness of waste management practices was investigated. The results are summarized in Table 4.2 and Figure 4.2.

|  |  |  |
| --- | --- | --- |
| **Awareness Level** | **Frequency** | **Percentage (%)** |
| Very Aware | 63 | 46.67 |
| Moderately Aware | 35 | 25.93 |
| Slightly Aware | 22 | 16.30 |
| Not Aware at All | 15 | 11.11 |
| Total | 135 | 100 |

*Table 2: Awareness of Waste Management Practices*

*Figure 2: Awareness of Waste Management Practices*

Figure 2 presents the distribution of respondents' awareness levels regarding waste management practices, shedding light on the knowledge within the community.

## 4.3.3 Methods of Waste Collection

The study explores the methods of waste collection utilized in Badarawa Ward. The results are outlined in Table 4.3 and Figure 4.3.

|  |  |  |
| --- | --- | --- |
| **Waste Collection Method** | **Frequency** | **Percentage (%)** |
| Door-to-Door Collection | 78 | 57.78 |
| Communal Collection | 32 | 23.70 |
| Self-Disposal | 25 | 18.52 |
| Total | 135 | 100 |

*Table 3: Methods of Waste Collection*

*Figure 4.3: Methods of Waste Collection*

## 4.4 Qualitative Analysis

Qualitative data was collected through interviews and observations, contributing valuable insights into the waste management situation in Badarawa Ward. This section presents key themes and observations from qualitative sources.

**Challenges in Waste Management:** Interviews with local residents and waste management personnel unveiled several challenges in the existing waste management system. The most common issues reported were insufficient resources, including a limited number of waste collection vehicles, inadequate waste disposal infrastructure, and a shortage of personnel. These constraints often led to delays in waste collection and accumulation of waste in certain areas.



*Figure 4.4 Waste Separation And Disposal Badarawa Ward Dumping Site*

**Community Engagement:** Observations in the field highlighted the significant role of community engagement in waste management. Some neighborhoods exhibited strong community involvement, with residents actively participating in waste separation and disposal. In these areas, residents organized regular clean-up drives and promoted the proper disposal of waste. This proactive approach significantly contributed to maintaining cleaner surroundings.

**Informal Waste Sorting:** Informal waste sorting was observed at some waste collection points within the ward. Individuals, often informal waste pickers, manually sorted through the waste to recover recyclable materials. While this practice helped in recycling efforts, it also raised concerns about the safety and hygiene of those involved. The need for regulating and formalizing such activities was evident.

**Public Awareness:** Interviews with local residents indicated varying levels of awareness regarding waste management practices. While some expressed a clear understanding of proper waste disposal methods and the potential environmental and health impacts of poor waste management, others were less informed. This disparity highlighted the importance of enhancing public awareness through educational campaigns.

**Waste Management Education:** Several respondents emphasized the need for educational programs and campaigns aimed at increasing public awareness about waste management best practices. They suggested that government agencies and non-governmental organizations should play a more active role in educating the public about the consequences of improper waste disposal and the benefits of responsible waste management.

**Waste-to-Energy Potential:** Interviews with experts in the field of waste management suggested the untapped potential for waste-to-energy projects in Badarawa Ward. Proper waste sorting, recycling, and processing could not only contribute to cleaner waste management but also generate renewable energy resources. These findings highlighted the possibility of addressing waste issues while simultaneously promoting sustainable energy solutions in the ward. The qualitative analysis unveiled the multifaceted nature of waste management in Badarawa Ward, where community involvement, public awareness, and potential innovations in waste-to-energy could play vital roles in addressing the existing challenges.

## 4.5 Observation



Figure 4.5:  Solid Waste Disposal In The Study Area(Badarawa Ward).

The observation component of this study provided valuable firsthand insights into the state of waste management in Badarawa Ward. Through on-site visits and fieldwork, several key observations were made, shedding light on the current practices and challenges in waste management:

**Waste Accumulation:** In several areas of Badarawa Ward, waste accumulation was evident. Piles of uncollected waste were visible in open spaces, along streets, and even in drainage channels. The delay in waste collection and the accumulation of waste were noticeable, reflecting challenges in the timeliness of waste removal.

**Improper Disposal:** The practice of improper waste disposal was widespread in certain neighborhoods. Residents frequently disposed of waste in open areas, empty plots, and even within drainage systems. Such practices contributed to environmental pollution, blocked drainage, and posed health risks to the community.

**Community-Led Efforts:** In contrast, some communities demonstrated a high level of engagement in waste management. Residents in these areas actively participated in waste separation, recycling, and organized regular clean-up exercises. Their proactive approach contributed to maintaining cleaner and more organized neighborhoods.

**Informal Waste Sorting:** At various waste collection points, informal waste pickers were observed manually sorting through waste to recover recyclable materials. This practice had a dual impact: it contributed to recycling efforts and offered livelihood opportunities for the waste pickers. However, it also raised concerns about their health and safety, suggesting the need for improved working conditions and waste sorting facilities.

**Overloaded Collection Vehicles:** Waste collection vehicles in some areas appeared to be overloaded, which could compromise the efficiency of waste collection and disposal. This might be attributed to the high volume of generated waste and a shortage of collection vehicles. Addressing this issue is crucial for timely and efficient waste removal.

**Waste Burning:** In a few instances, open burning of waste materials was observed. Residents resorted to burning waste to reduce its volume, often without realizing that this practice could release harmful pollutants into the air. Promoting alternative waste reduction methods is imperative to mitigate the adverse environmental and health effects.

**Lack of Adequate Bins:** In certain neighborhoods, a lack of adequate waste bins or containers was noticeable. This led residents to place waste in open areas and empty plots, contributing to improper disposal practices. Providing sufficient waste receptacles could help address this issue.

**Varying Degrees of Cleanliness:** The cleanliness of different areas within Badarawa Ward varied significantly. While some neighborhoods were notably clean and well-maintained, others struggled with waste management, leading to visible waste accumulation and pollution.

These observations collectively depict the complex and multifaceted nature of waste management in Badarawa Ward. While some areas exhibit promising community-driven initiatives, others face challenges related to the timely collection of waste and proper disposal practices. Addressing these challenges and fostering community engagement are essential steps toward improving waste management in the ward.

## CHAPTER FIVE

## CONCLUSION AND RECOMMENDATIONS

## 5.1 Summary

In this study, an in-depth examination of solid waste management practices in Badarawa Ward, Kaduna North Local Government, was conducted. The research employed a mixed-methods approach, combining quantitative surveys and qualitative interviews to gather comprehensive insights into waste generation, collection, disposal, and overall management in the community.

The quantitative analysis involved the administration of 135 questionnaires, providing statistical data on various aspects of waste management. The findings indicated that a significant percentage of residents had been living in Badarawa for 1-5 years, with varying levels of awareness about waste management practices. Door-to-door waste collection emerged as the predominant method, showcasing the existing infrastructure for waste management.

Qualitative analysis through interviews with stakeholders, including disposal collectors and local government representatives, unveiled challenges in the current waste management system. Insufficient resources, including limited waste collection vehicles and inadequate disposal infrastructure, were identified as primary issues. These constraints often resulted in delays in waste collection, contributing to the accumulation of waste in certain areas.

## 5.2 Conclusion

The study concludes that while there are existing waste management practices in Badarawa Ward, there are notable challenges that hinder the effectiveness of the system. The identified challenges, including resource limitations and delays in waste collection, need urgent attention to enhance the overall waste management infrastructure.

The duration of residents' stay in Badarawa, coupled with their varying levels of awareness about waste management, underscores the importance of community engagement and education initiatives. The predominance of door-to-door waste collection suggests an established system that, with improvements, could significantly contribute to efficient waste management. The analysis of data obtained through questionnaires, interviews, observations, and qualitative analysis has shed light on various aspects of waste management, including components of solid waste materials, methods of storage and collection, transportation systems, disposal methods, and the overall efficiency of waste management.

The findings of this study highlight both strengths and challenges in the existing waste management practices in Badarawa Ward:

1. **Community Engagement:** In several areas, strong community engagement and proactive initiatives have resulted in better waste management. Residents are actively participating in waste separation, recycling, and community clean-up efforts, which have contributed to cleaner and more organized neighborhoods.
2. **Waste Accumulation:** On the downside, waste accumulation and delays in waste collection were observed in some parts of the ward. These challenges stem from factors such as inadequate collection infrastructure, overloading of collection vehicles, and, at times, inefficient collection practices.
3. **Improper Disposal:** Improper waste disposal, including the practice of disposing of waste in open areas and drainage channels, has led to environmental pollution and health risks. Proper waste disposal remains a significant concern.
4. **Informal Waste Sorting:** The observation of informal waste pickers manually sorting through waste has highlighted the need for improved working conditions and waste sorting facilities. While this practice supports recycling, it also necessitates safety measures.
5. **Variability in Cleanliness:** The cleanliness of different areas within Badarawa Ward showed considerable variation. Some neighborhoods maintained high levels of cleanliness, while others struggled with waste management, leading to visible waste accumulation and environmental pollution.

In light of these findings, it is evident that there are opportunities for enhancing waste management in Badarawa Ward. The following recommendations are made to address the observed challenges and further improve waste management practices in the ward.

## 5.3 Recommendations

**5.3.1 Strengthen Collection Infrastructure:** Efforts should be made to improve waste collection infrastructure, including the provision of an adequate number of collection vehicles and bins. Overloaded vehicles should be avoided to ensure timely waste collection.

**5.3.2 Awareness and Education:** Community-based awareness and education programs are essential to promote proper waste disposal practices. These programs should emphasize the environmental and health implications of improper disposal and encourage residents to take an active role in waste management.

**5.3.3 Formalize Waste Sorting:** To ensure the safety and welfare of informal waste pickers, there is a need to formalize waste sorting practices. This can include providing sorting facilities and personal protective equipment to those engaged in this activity.

**5.3.4 Community Clean-Up Initiatives:** Community-led clean-up initiatives should be encouraged and supported. These initiatives not only enhance the overall cleanliness of neighborhoods but also foster a sense of responsibility among residents.

**5.3.5 Waste Reduction Practices:** Promoting waste reduction practices, such as minimizing waste burning and advocating for alternative methods of waste volume reduction, is crucial for environmental protection.

**5.3.6 Government and NGO Collaboration:** Collaboration between government bodies, non-governmental organizations, and local communities is essential for comprehensive waste management. Government agencies can provide resources and guidelines, while NGOs can support awareness campaigns and community engagement.

**5.3.7 Regular Monitoring and Evaluation:** The waste management system should incorporate regular monitoring and evaluation to assess its effectiveness. This process will help identify areas in need of improvement and track progress.

**5.3.8 Encourage Recycling:** Efforts to promote recycling should be intensified. Establishing recycling centers and providing incentives for recycling can significantly reduce the volume of waste sent to landfills.

By implementing these recommendations, Badarawa Ward can progress toward a more effective and sustainable waste management system. Community involvement, infrastructure development, and increased awareness are key elements in this endeavor. Additionally, the collaboration of various stakeholders, from local government authorities to non-governmental organizations, is vital for the success of these initiatives.

This study underscores the importance of proactive measures in waste management to ensure a cleaner, healthier, and more sustainable environment for the residents of Badarawa Ward and the broader Kaduna North Local Government area.

## Questionnaire

**SURVEY ON SOLID WASTE MANAGEMENT IN BADARAWA WARD, KADUNA NORTH LOCAL GOVERNMENT**

*Introduction: Thank you for participating in this survey. Your responses will help us better understand and address issues related to solid waste management in Badarawa Ward. All responses are confidential and will be used for research purposes only.*

**Demographic Information:**

1. Age:
   * Under 18
   * 18-30
   * 31-45
   * 46-60
   * Over 60
2. Gender:
   * Male
   * Female
   * Other (please specify)
3. How long have you lived in Badarawa Ward?

**Waste Generation:**

1. How often do you generate solid waste in your household?
   * Daily
   * Weekly
   * Monthly
   * Rarely
   * Never
2. What types of waste materials do you most commonly generate? (Check all that apply)
   * Plastics
   * Organic waste
   * Paper
   * Glass
   * Metals
   * E-waste
   * Other (please specify)
3. Do you separate your waste into different categories for disposal?
   * Yes
   * No

**Waste Collection:**

1. How often is solid waste collected in your neighborhood?
   * Daily
   * Weekly
   * Monthly
   * Irregularly
   * Not sure
2. Are there formal waste collection services in your area?
   * Yes
   * No
3. If yes, are you satisfied with the waste collection services provided?
   * Very Satisfied
   * Satisfied
   * Neutral
   * Dissatisfied
   * Very Dissatisfied
4. If no, how do you currently manage your waste?

**Waste Disposal:**

1. How do you typically dispose of your solid waste?
   * Open dumping
   * Municipal landfill
   * Incineration
   * Recycling
   * Composting
   * Other (please specify)
2. Are you aware of the potential environmental and health risks associated with improper waste disposal?
   * Yes
   * No

**Community Perceptions:**

1. How would you rate the overall cleanliness of Badarawa Ward?
   * Very Clean
   * Clean
   * Neutral
   * Dirty
   * Very Dirty
2. Are there community initiatives or programs related to waste management in your area?
   * Yes
   * No
3. If yes, have you ever participated in such initiatives?
   * Yes
   * No

**Additional Comments:**

1. Please share any additional comments, suggestions, or concerns related to solid waste management in Badarawa Ward:

**Thank you for your participation!**

**Oral Interview Questions for Waste Management Stakeholders**

**Introduction:**

1. Can you please introduce yourself and your role in waste management in the Badarawa region?

**Waste Generation:**

1. What are the major sources of solid waste generation in the Badarawa community?
2. Can you provide insights into the types of solid waste commonly generated in this region?
3. How has the volume of waste generation changed over the past few years?

**Waste Storage:**

1. What are the common practices for waste storage among households and businesses in Badarawa?
2. Are there specific guidelines or regulations for waste storage in this community?

**Waste Collection:**

1. How is the process of waste collection organized in Badarawa?
2. What challenges, if any, are faced by waste collectors during the collection process?
3. Are there specific schedules for waste collection, and how are they communicated to the residents?

**Waste Transfer and Transportation:**

1. Can you elaborate on the methods used for transferring waste from collection points to disposal sites?
2. What transportation systems are in place for moving waste within and outside the community?

**Waste Disposal Procedures:**

1. What are the primary methods of waste disposal employed in the Badarawa region?
2. Are there designated disposal sites, and how are they managed to prevent environmental degradation?

**General Management Techniques:**

1. How effective are the current waste management practices in addressing environmental and health concerns?
2. Are there ongoing initiatives or projects aimed at improving waste management in Badarawa?

**Regulatory Framework:**

1. Can you outline the existing regulations or policies related to waste management in Kaduna State?
2. How is the Kaduna Environmental Protection Agency (KEPA) involved in overseeing waste management activities?

**Challenges and Solutions:**

1. What are the main challenges faced in solid waste management in Badarawa, and how are they being addressed?
2. In your opinion, what steps could be taken to enhance waste management practices in the community?

**Community Involvement:**

1. How actively is the community involved in waste management efforts?
2. Are there community-based initiatives or awareness programs related to waste management?

**Future Plans:**

1. Are there any upcoming projects or plans aimed at improving waste management in the Badarawa region?
2. What role do you see technology playing in the future of waste management in Kaduna State?

**Closing:**

1. Is there any additional information or insights you would like to share regarding waste management in Badarawa?

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